European Commission

IMPROVING ENVIRONMENTAL SUSTAINABILITY OF DEEP SEA FISHERIES WITH EMPHASIS ON THE CONSERVATION OF VULNERABLE MARINE ECOSYSTEMS (VMES)

EUROPEAN MARITIME AND FISHERIES FUND (EMFF)

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Improving environmental sustainability of deep sea fisheries with emphasis on the conservation of Vulnerable Marine Ecosystems (VMEs)

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EXECUTIVE SUMMARY

The present specific study has the dual purpose of assessing and improving scientific data and advice, as well as relevant management measures, regarding the environmental sustainability of Deep Sea Fishing (DSF) and the conservation of Vulnerable Marine Ecosystems (VMEs). In addition, the ultimate objective of this contract is that the identified best practices shall inform and strengthen European Union (EU) policy choices, in particular in the context of its participation in Regional Fisheries Management Organizations (RFMOs), and provide a "model regulation" of VMEs, as well as in the context of any possible revision of Council Regulation (EC[1]) No 734/20082. To this end, the following tasks were being carried out:

Task 1: Update/expand worldwide the comparative analysis of the state of the art undertaken under SC08 in the protection and conservation of VMEs and the management of fisheries activities that can impact them.

The objective of this task is to expand and complement the previous SC08 study[3], providing a review of the work developed in support of VME protection and identification of mitigation measures from the impacts of bottom fishing (and, where appropriate, from other human activities) in five relevant countries (USA, Canada, Argentina, Australia and New Zealand). This task was developed in three consecutive steps: (i) Selection of the case study areas outside the EU; (ii) Data and information reviews: Individual reports by country (Annex 1); and (iii) Comparative analysis, using an approach adapted from Fletcher (2020)[4]. It is essential to exercise caution when interpreting the outcomes from this task, as they rely only on publicly available information and therefore, interpretation of the results must be approached very carefully, recognizing the potential limitations and uncertainties associated with the present analysis. The individual country reports contain a useful summary of publicly available information on the work undertaken by the countries. The review was designed to cover 6 key topics related to the protection of VMEs and the identification of impact mitigation measures. This information provided an overview of how each country is addressing the key topics (including the main gaps), particularly in waters under national jurisdiction. It also expands on the knowledge of the state of play obtained under the previous SC08 study, which focused on approaches developed in the high seas by intergovernmental organizations. The analysis conducted provide a better understanding of how different countries deal with DSF management and VMEs conservation efforts. The analysis showed that all countries reviewed have implemented some form of governance and data collection frameworks for DSF and VMEs, with specific regulations and bodies for management, research and enforcement, and that most have described sensitive species and habitats in some way. Moreover, some countries have made significant efforts towards co-management, involving a variety of stakeholders. The assessment of bottom fishing impacts has in general a good degree of implementation for almost all countries (addressing, in some cases, the issue of the impacts of activities other than fishing), just like the mapping of sensitive species and habitats. Sometimes the approach adopted is broader and focuses more on the identification, designation and protection of essential fish habitats, or in the assessments of risk for benthic habitats, rather

[1] European Commission

[2] Council Regulation (EC) No 734/2008 of 15 July 2008 on the protection of vulnerable marine ecosystems in the high seas from the adverse impacts of bottom fishing gears. Official Journal of the European Union, L 201, 30 July 2008, 6 pp. The purpose of this regulation was to transpose the measures contained in UNGA Resolution 61/105 into Union law for ships flying flags of its Member States, for those areas of the high seas where no RFMO had been established or where no interim measures were put in place during negotiations for the establishment of an RFMO.

[3] EASME/EMFF/2017/1.3.2.6/08 - Scientific approach for the assessment and management of deep sea fisheries and ecosystems in RFMOs and RFBs.

[4] Fletcher, W.J. 2020. A review of the application of the FAO ecosystem approach to fisheries (EAF) management within the areas beyond national jurisdiction (ABNJ). Rome, FAO. https://doi.org/10.4060/cb1509en

than assessing significant adverse impacts (SAIs) on corals and sponges. There is room for improvement in impact mitigation and protection measures, as some documented vulnerable areas still remain unprotected, but in general, progress is being made in this area. Most countries have successfully implemented some kind of monitoring of VME impacts, or such implementation is still partially in progress, or is planned. Finally, the differences between countries and the gaps identified are explained either by the different development of management frameworks, or by the availability and accessibility of information or the degree of detail of the information available.

Task 2: Critical review of FAO 2008 DSF guidelines and compilation and development of best practices and recommendations on key aspects related to the conservation of VMEs and management of DSF.

The aim of this task is to conduct a critical review of FAO[5] 2008 DSF guidelines and to compile and develop best practices and recommendations on key aspects related to the conservation of VMEs and management of DSF in the high seas. From the work carried out, it is clear that many aspects related to the protection of VMEs need to be improved, starting necessarily with creating operational definitions of key concepts (such as VME and VME geomorphological elements) and determining acceptable thresholds of protection level for VMEs. The lack of biological and distribution information of VME indicator taxa, which also prevents evaluating their vulnerability using FAO criteria, was identified as an important issue. This can be overcome by carrying out further research of the species that form VMEs. Then, it is evident that identifying VMEs remains a difficult task. Direct observations from research surveys are only available for a small portion of the seabed, so RFMOs must rely on indirect approaches (such as species distribution models) to identify VMEs, with a higher associated uncertainty. And even such approaches are not within the reach of many RFMOs because there are simply not enough data regarding the distribution of VME taxa to apply them. Nevertheless, it must be emphasized that this situation does not justify the lack of action or implementation of measures to protect VMEs, and that a precautionary approach must be applied by default. Regarding the measures to protect VMEs, the majority of the RFMOs with competence over bottom fisheries on the high seas have adopted regulations to prevent SAIs on VMEs through area-based management approaches. This includes areas closed to bottom fishing designated to protect VMEs. Although such area closures can offer protection from direct impacts of bottom-contact fishing gears, the long-term viability of the protected VMEs will depend on understanding the wider context of VME functioning (for example, identifying sources of recruitment and considering the connectivity among different areas). In addition, climate change should be also considered, because it might lead to shifts in VME distributions by changing or reducing suitable habitat for VME species. Thus, understanding how climate change can affect the distribution of deep-sea species is critically important for developing appropriate area closures (or adapting the existing ones) and other measures. Finally, the restoration of damaged VMEs must be given more attention, as there is evidence that this can be achieved, at least to some degree, through long-term protection of heavily trawled areas. Detailed information on this task can be found in Annex 3 (Deliverable 1).

Task 3: Overview and critical analysis of existing by-catch mitigation and management approaches in DSF, and development of recommendations for improving by-catch management in DSF.

The main objective was to conduct an overview and critical analysis of existing bycatch mitigation and management approaches in DSF, and development of recommendations for improving bycatch management in DSF, considering the

[5] The Food and Agriculture Organization of the United Nations

following RFMOs and fishing areas: CCAMLR[6], GFCM[7], NAFO[8], NEAFC[9], NPFC[10], SEAFO[11], SIOFA[12], SPRFMO[13] and FAO Area 41 (SW[14] Atlantic). The review of existing bycatch mitigation and management approaches in DSF allowed us understanding the current state of the protection of bycaught species in different RFMOs. Current conservation measures were critically assessed, which allowed us identifying their advantages and limitations, and effectiveness according to existing evidence. From this study, it is clear that RFMOs are advancing at different paces. Perhaps the biggest issue that remains, and that slows down bycatch mitigation efforts, is the generalised lack of data that still exists in many RFMOs regarding the interactions of vulnerable species with fisheries, that can end up as bycatch. This is especially evident for elasmobranchs, marine mammals and seabirds. As GFCM well acknowledges, the lack of data on the occurrence and level of bycatch hinders the ability to manage and apply rules on fishing vessel activities. Even where data exists, the lack of statistically robust and harmonized sampling designs limits its value and, for example, prevents comparisons between different fishing fleets and areas. Therefore, actions shall be implemented (or continued) to achieve adequate monitoring programs and frameworks that can provide sound bycatch data collection are urgently required. Once this data becomes available, better measures can be designed to protect bycaught species in DSF. Detailed information on the diversity of practices and measures implemented to reduce and manage bycatch in DSF across the RFMOs are in the Annex 4 (Deliverable 2) of the present report.

Task 4: Criteria for the establishment of footprints and historical fishing, and the development of a framework for exploratory fisheries and scientific surveys.

The objective of this task is focused on the review of the existing criteria/methods for characterisation of fishing footprint (Annex 5) in DSF in relevant RFMOs (NAFO, NEAFC, SEAFO, GFCM, NPFC, SPRFMO, SIOFA and CCAMLR), as well as in FAO Area 41. Furthermore, a framework for exploratory fisheries (Annex 6) and research activities not related to fisheries (Annex 7) were developed. Although the concept of fishing footprint is not specifically defined in the FAO Guidelines, in practice, in most RFMOs the terms "fishing footprint", "bottom fishing footprint", "existing bottom fishing areas", "existing deep-sea bottom fishing areas" are equivalent and generally refer to the same concept (i.e. those locations in which some level of bottom fishing activity has previously been conducted in a reference period). The findings from Deliverable 3 (see Annex 5) show that there is a wide variety of methods being used in the different RFMOs to define the fishing footprints, with NAFO, NEAFC and CCAMLR having the most advanced experience. In addition, when studying the fishery footprint, several key issues must be taken into account: (i) Data (e.g. needs, compilation, availability and quality); (ii) International cooperation (e.g. research, management, sharing of information); (iii) Potential of new methodologies, complementary data sources and approaches (e.g. methods to improve footprint resolution, AIS[15]); and (iv) financing needs. Most of RFMOs adopted regulations on bottom fishing, incorporating relevant elements from the UNGA[16] resolution 61/105, and the FAO DSF Guidelines, including the adoption of exploratory fishing protocols (see Annex 6). CCAMLR is the most prominent regulator of this issue, while GFCM does not have a specific legal framework and NAFO and NEAFC have amended their

[6] Commission for the Conservation of Antarctic Marine Living Resources
[7] General Fisheries Commission for the Mediterranean
[8] Northwest Atlantic Fisheries Organisation
[9] North East Atlantic Fisheries Commission
[10] North Pacific Fisheries Commission
[11] South East Atlantic Fisheries Organisation
[12] Southern Indian Ocean Fisheries Agreement
[13] South Pacific Regional Fisheries Management Organisation
[14] South West
[15] Automatic Identification System
[16] United Nations General Assembly

protocols several times. In general terms, RFMOs follow similar specific procedures and preliminary assessments. An exceptional case is SIOFA that has not clearly defined what an exploratory fishery is. Most of the RFMOs, with the exception of GFCM, have implemented specific conservation and management measures to prevent SAI on VMEs and in most RFMOs, monitoring of exploratory fisheries is mandatory, including the deployment of on-board observers. In most RFMOs, their own scientific advisory bodies have the functions of encouraging, promoting cooperation and coordinating the international scientific research (see Annex 7). By contrast, in the case of NEAFC, ICES[17] is in charge of these functions. Most of the RFMOs have developed research work plans for their advisory bodies in a multiannual or annual basis, including planning of research priorities. Only SEAFO has developed specific guidelines for fisheries research and basic marine science activity. Furthermore, there is a variety of approaches in the RFMOs regarding conservation and management measures related to scientific research. The issue of the impact of research on VMEs is addressed in the conservation and management measures of some RFMOs (e.g. NEAFC, SEAFO, SIOFA and CCAMLR) or is currently being monitored (e.g. NAFO). The regulation of scientific research is a current issue in some RFMOs and several initiatives are being carried out in this regard (e.g. NAFO, SPRFMO and SIOFA). Finally, the review of the diversity of approaches used by the RFMOs, considering their strengths and weaknesses, has been very useful to identify the potential key elements for the development of frameworks for exploratory fisheries and scientific research, which are described in detail in Annexes 6 and 7.

Task 5: Critical review of the effectiveness of existing measures and management tools, and/or combinations thereof, for the protection and conservation of VMEs in the high seas.

The objective in this task is to provide a critical review of the effectiveness of existing management tools, including the move-on rule, and measures to assess impacts and/or combinations thereof (including spatial management tools) for the conservation of VMEs and identify best practices in RFMOs. In the absence of information, originally a precautionary approach had been used and underwater features such as seamounts where VMEs were likely to occur were closed to fishing. There is no actual agreement, however, on how to define and delimit VMEs. Today, some RFMOs are still applying the precautionary approach. For measures to be effective, the distribution and connectivity of VMEs must be better understood. Identifying the presence, distribution, and abundance of an indicator species defines the state of that species at a moment (or period) in time. It does not define the composition of an associated community, the suite of species interactions that define and sustain the community, or the flows of materials and energy that define the bounds of the ecosystem. Details about species interactions (e.g. population connectivity, energy flow that mediates growth and reproduction, and interactions mediated by the local oceanographic regime) that will be needed to understand and predict the extent to which fishing and other human activities produce SAIs. A key issue is that move-on rules were not originally intended as stand-alone measures to protect VMEs from SAIs. They should only be considered as temporary measures until spatial protection measures are implemented. Detailed information on this task is in the Annex 8 (Deliverable 4) of the present report.

[17] International Council for the Exploration of the Sea

Task 6: Identify gaps in research and priority scientific topics (by region).

The objective of task 6 was to identify gaps in research and priority scientific topics by region (RFMOs and FAO Area 41 regarding Council Regulation (EC) No 734/2008), with a view to improving our understanding and knowledge of VME identification, and to design a framework for future RFMO observer schemes to identify, record and report on VME associated taxa. This will contribute towards strengthening the science used to develop management measures to reduce or mitigate impacts on VMEs. This was done primarily through reviewing reports from the groups responsible for managing VMEs within each RFMO as well as other summaries. The main gaps in data are related to the life history of VME species, in terms of their longevity, fragility, larval dispersion and mobility. Without a better knowledge of these traits the effectiveness of various mitigation measures is difficult to assess. Specifically, whether current threshold levels are suitable, what is the ideal distance for a move-on rule, if any, and how best to spatially manage an area to balance maximum protection with minimum interference to fishing. Although fishing vessels are not an effective sampling tool, observer programmes provide a valuable source of data a relatively low cost. All RFMOs in this study had some form of observer programme in place with a requirement to collect data on VMEs when encountered. Annex 9 provides guidelines, based on programmes already in place, for the collection and recording of VME data by observers. Furthermore, data requirements related to Council Regulation (EC) No 734/2008 are summarized in Annex 10, which outlines the information that needs to be submitted by EU vessels, how the information is evaluated, encounter rules and Vessel Monitoring System (VMS) and observer requirements.

Task 7: Identify areas, topics and policy options with potential scope and added-value in promoting consistency among relevant organisations and with relevance to any possible revision of Regulation 734/2008.

The objective of this task is to identify those aspects with potential scope and added-value in promoting consistency among RFMOs and with relevance to any possible revision of Council Regulation (EC) No 734/2008. The comparison of the different concepts and definitions in the context of the FAO DSF Guidelines, allowed us to obtain the following conclusions: (i) In most of RFMOs, main "key concepts" (Annex 11) are defined based on the FAO DSF Guidelines (e.g. SAI, VME, bottom fishing). However, the list of "key concepts" described by the Guidelines is brief and could be expanded and improved; (ii) Some concepts are not clearly defined by the FAO DSF Guidelines, nevertheless the different RFMOs have adopted similar definitions based (or inspired) on the "spirit" of the Guidelines (e.g. fishing footprint, encounter); (iii) There are different approaches in the RFMOs regarding the implementation of some concepts (e.g. lists of VME indicators, VME indicator units/threshold levels); (iv) Some gaps were identified regarding the framework for VMEs under Council Regulation (EC) No 734/2008 (e.g. the concept "VME" is defined, but not "VME indicator", a move-on rule is specified but the concept "encounter" is not clearly defined, lack of indicators and threshold levels). In addition, there is no definition for "fishing footprint" concept in areas under this regulation. Some of these gaps could complicate its effective implementation; (v) The use of a similar set of definitions of main "key concepts" related to VME/DSF management could help in promoting consistency between organizations and DSF regulations (main "key concepts" should be clearly defined and equivalent concepts should have the same meaning in the different organizations and DSF regulations.

A total of 11 key topics were brought up and discussed with the goal of providing opportunities for promoting consistency across RFMOs, including some that pertain to any possible revision of Council Regulation (EC) No 734/2008. In general, there is a diversity of approaches in the different RFMOs with regard to all the topics that were discussed. They cover a wide range of aspects related to: (i) Fisheries management and conservation (such as by-catch mitigation, including VME indicator species, Framework for VMEs and Measures to combat IUU[18] fishing activities); (ii) Scientific research and data collection (including Frameworks for Exploratory Fisheries, for Scientific Research, including mitigation of impacts from research, for Observers on board, including VMEs data collection, for collection and reporting of data, including quality control and fishing footprint), and; (iii) Ecosystem-based fisheries management (SAI assessment, requirements and methods, Work plans of the RFMO scientific advisory bodies, Framework for advice on management options to reduce the risk of SAI and to the protection of VMEs, while limiting potential losses to fishers). After considering these wide range of aspects, a set of lessons learnt was identified. These may be useful for promoting consistency among relevant RFMOs, as well as for any possible revision of Council Regulation (EC) No 734/2008.

Task 8: Support the evaluation of Council Regulation (EC) No 734/2008 on the protection of VMEs.

The aim of this task was to analyse the extent to which the Council Regulation (EC) No 734/2008 (the Regulation) is effective, efficient, still relevant given the current needs, coherent and complementary to other interventions and has achieved EU added value (Annex 12, Deliverable 5). We also aimed to identify where the Regulation needs to be updated to reflect best practices and best available science, as well as providing recommendations on how the Regulation can be updated (if needed) to reflect the findings. This was done through both a stakeholder consultation (Annex 13), to gather the views of people impacted by its implementation, and by analysing information from other Tasks in this project. Despite several efforts to get stakeholders to take part, the response was too low. It is therefore difficult to draw any key conclusions. However, given that the key area covered by the Regulation is FAO Area 41 which is mainly fished by Spanish flagged vessels, the respondents included two members of the Spanish fishing sector, a member of the IUCN[19] Fisheries Expert Group, and a scientist from an EU research institute. Despite the low sample size, the views discussed in this report are informative of the different aspects of the Regulation and, along with the information taken from other Tasks, should inform aspects on how and which areas of the Regulation could be updated/revised if that decision is taken.

[18] Illegal, unreported and unregulated fishing
[19] International Union for Conservation of Nature

SOMMAIRE EXÉCUTIF

La présente étude spécifique a pour double objectif d'évaluer et d'améliorer les données scientifiques et les conseils, ainsi que les mesures de gestion pertinentes, concernant la durabilité environnementale de la pêche en haute mer (DSF[20]) et la conservation des écosystèmes marins vulnérables (EMV). De plus, l'objectif ultime de ce contrat est que les meilleures pratiques identifiées éclairent et renforcent les choix politiques de l'Union européenne (UE)[21], en particulier dans le cadre de sa participation aux organisations régionales de gestion des pêches (ORGP), et fournissent une "réglementation modèle" des EMV, ainsi que dans le contexte d'une éventuelle révision du règlement du Conseil (CE) n° 734/2008[22]. À cette fin, les tâches suivantes étaient en cours :

Tâche 1: Mettre à jour/élargir au niveau mondial l'analyse comparative de l'état de l'art réalisée dans le cadre de SC08[23] sur la protection et la conservation des EMV ainsi que la gestion des activités de pêche pouvant les affecter.

L'objectif de cette tâche est d'étendre et de compléter l'étude SC08 précédente en fournissant une revue des travaux réalisés en faveur de la protection des EMV et de l'identification des mesures d'atténuation des impacts de la pêche profonde (et, le cas échéant, d'autres activités humaines) dans cinq pays pertinents (États-Unis, Canada, Argentine, Australie et Nouvelle-Zélande). Cette tâche a été développée en trois étapes consécutives: (i) Sélection des zones d'étude en dehors de l'UE; (ii) Examens des données et des informations: rapports individuels par pays (Annexe 1); et (iii) Analyse comparative, en utilisant une approche adaptée de Fletcher (2020)[24]. Il est essentiel de faire preuve de prudence lors de l'interprétation des résultats de cette tâche, car ils reposent uniquement sur des informations disponibles publiquement et donc, l'interprétation des résultats doit être abordée avec beaucoup de précaution, en reconnaissant les limitations et les incertitudes potentielles associées à cette analyse. Les rapports individuels par pays contiennent un résumé utile des informations disponibles publiquement sur les travaux réalisés par les pays. L'examen a été conçu pour couvrir 6 thèmes clés liés à la protection des EMV et à l'identification des mesures d'atténuation des impacts. Ces informations ont donné un aperçu de la manière dont chaque pays aborde les thèmes clés (y compris les principales lacunes), en particulier dans les eaux relevant de leur juridiction nationale. Cela élargit également les connaissances de l'état des lieux obtenues dans le cadre de l'étude SC08 précédente, qui se concentrait sur les approches développées en haute mer par des organisations intergouvernementales. Les analyses réalisées permettent de mieux comprendre comment différents pays abordent la gestion de la pêche en haute mer et les efforts de conservation des EMV. L'analyse a révélé que tous les pays examinés ont mis en place des cadres de

[20] Pêche en haute mer/Deep sea fisheries
[21] La Commission européenne
[22] Règlement (CE) No 734/2008 du Conseil du 15 juillet 2008 relatif à la protection des écosystèmes marins vulnérables de haute mer contre les effets néfastes de l'utilisation des engins de pêche de fond. Journal officiel de l'Union européenne, L 201, 30 juillet 2008, 6 p. L'objectif de ce règlement était de transposer les mesures contenues dans la résolution 61/105 de l'AGNU dans le droit de l'Union pour les navires battant pavillon de ses États membres, dans les zones de haute mer où aucune ORGP n'a été établie ou dans lesquelles aucune mesure provisoire n'a été mise en place pendant les négociations en vue de l'établissement d'une ORGP.
[23] EASME/EMFF/2017/1.3.2.6/08 - Scientific approach for the assessment and management of deep sea fisheries and ecosystems in RFMOs and RFBs.
[24] Fletcher, W.J. (2020) A review of the application of the FAO ecosystem approach to fisheries (EAF) management within the areas beyond national jurisdiction (ABNJ). Rome, FAO. https://doi.org/10.4060/cb1509en

gouvernance et de collecte de données pour la pêche en haute mer et les EMV, avec des réglementations spécifiques et des organismes chargés de la gestion, de la recherche et de l'application, et que la plupart ont décrit de manière quelconque les espèces et habitats sensibles. De plus, certains pays ont déployé des efforts importants en matière de cogestion, impliquant une variété d'acteurs. L'évaluation des impacts de la pêche profonde est généralement bien mise en œuvre dans presque tous les pays (abordant, dans certains cas, la question des impacts d'activités autres que la pêche), tout comme la cartographie des espèces et habitats sensibles. Parfois, l'approche adoptée est plus large et se concentre davantage sur l'identification, la désignation et la protection des habitats essentiels des poissons, ou sur l'évaluation des risques pour les habitats benthiques, plutôt que sur l'évaluation des impacts Effets néfastes notables (SAI[25]) sur les coraux et les éponges. Il y a encore des possibilités d'amélioration des mesures d'atténuation des impacts et de protection, car certaines zones vulnérables répertoriées restent encore sans protection, mais dans l'ensemble, des progrès sont réalisés dans ce domaine. La plupart des pays ont mis en place avec succès une forme de surveillance des impacts sur les EMV, ou une telle mise en œuvre est encore partiellement en cours, ou est prévue. Enfin, les différences entre les pays et les lacunes identifiées s'expliquent soit par le développement différent des cadres de gestion, soit par la disponibilité et l'accessibilité des informations ou le degré de détail des informations disponibles.

Tâche 2: Évaluation critique des directives de la FAO de 2008 sur la pêche en haute mer et compilation et élaboration de meilleures pratiques et recommandations sur les aspects clés liés à la conservation des EMV et à la gestion de la pêche en haute mer.

L'objectif de cette tâche est de réaliser une évaluation critique des directives internationales de la FAO[26] de 2008 sur la pêche en haute mer, ainsi que de compiler et d'élaborer des meilleures pratiques et recommandations sur les aspects clés liés à la conservation des EMV et à la gestion de la pêche en haute mer en haute mer. Les travaux réalisés ont clairement montré que de nombreux aspects liés à la protection des EMV doivent être améliorés, en commençant nécessairement par la création de définitions opérationnelles des concepts clés (tels que les EMV et les éléments géomorphologiques des EMV) et la détermination de seuils acceptables de niveau de protection pour les EMV. Le manque d'informations biologiques et de répartition des taxons indicateurs des EMV, qui empêche également d'évaluer leur vulnérabilité selon les critères de la FAO, a été identifié comme un problème important. Cela peut être résolu en réalisant des recherches approfondies sur les espèces qui constituent les EMV. Ensuite, il est évident que l'identification des EMV reste une tâche difficile. Les observations directes des campagnes de recherche ne sont disponibles que pour une petite partie du fond marin, de sorte que les ORGP doivent s'appuyer sur des approches indirectes (telles que les modèles de distribution des espèces) pour identifier les EMV, avec une incertitude associée plus élevée. De plus, même de telles approches ne sont pas accessibles à de nombreux ORGP car il n'y a tout simplement pas suffisamment de données concernant la répartition des taxons des EMV pour les appliquer. Néanmoins, il convient de souligner que cette situation ne justifie pas le manque d'action ou de mise en œuvre de mesures pour protéger les EMV, et qu'une approche précautionneuse doit être appliquée par défaut. En ce qui concerne les mesures visant à protéger les EMV, la majorité des ORGP compétents pour la pêche en haute mer ont adopté des réglementations visant à prévenir les SAI sur les EMV grâce à des approches de gestion fondées sur des zones. Cela comprend des zones

[25] Effets néfastes notables/Significant Adverse Impacts
[26] L'Organisation des Nations unies pour l'alimentation et l'agriculture.

fermées à la pêche de fond désignées pour protéger les EMV. Bien que de telles fermetures de zones puissent offrir une protection contre les impacts directs des engins de pêche à contact avec le fond, la viabilité à long terme des EMV protégées dépendra de la compréhension du contexte plus large du fonctionnement des EMV (par exemple, l'identification des sources de recrutement et la prise en compte de la connectivité entre différentes zones). De plus, le changement climatique devrait également être pris en compte, car il peut entraîner des changements dans la répartition des EMV en modifiant ou réduisant l'habitat adapté aux espèces d'EMV. Ainsi, comprendre comment le changement climatique peut affecter la distribution des espèces des profondeurs est d'une importance critique pour développer des fermetures de zones appropriées (ou adapter celles existantes) et d'autres mesures. Enfin, il faut accorder une plus grande attention à la restauration des EMV endommagées, car des preuves montrent que cela peut être réalisé, du moins dans une certaine mesure, grâce à la protection à long terme des zones fortement pêchées. Des informations détaillées sur cette tâche se trouvent dans l'Annexe 3 (Livrable 1).

Tâche 3: Aperçu et analyse critique des approches existantes en matière de réduction et de gestion des prises accessoires dans la pêche en haute mer, et élaboration de recommandations pour améliorer la gestion des prises accessoires dans la pêche en haute mer.

L'objectif principal était de réaliser une vue d'ensemble et une analyse critique des approches existantes en matière de réduction et de gestion des prises accessoires dans la pêche en haute mer, ainsi que d'élaborer des recommandations pour améliorer la gestion des prises accessoires dans la pêche en haute mer, en tenant compte des ORGP et des zones de pêche suivantes : CCAMLR[27], GFCM[28], NAFO[29], NEAFC[30], NPFC[31], SEAFO[32], SIOFA[33], SPRFMO[34] et la zone 41 de la FAO (Atlantique Sud-Ouest). L'examen des approches existantes en matière de réduction et de gestion des prises accessoires dans la pêche en haute mer nous a permis de comprendre l'état actuel de la protection des espèces prises accessoirement dans les différents ORGP. Les mesures de conservation actuelles ont été évaluées de manière critique, ce qui nous a permis d'identifier leurs avantages et leurs limitations, ainsi que leur efficacité en fonction des preuves existantes. À partir de cette étude, il est clair que les ORGP progressent à des rythmes différents. Peut-être le plus grand problème qui persiste et qui ralentit les efforts de réduction des prises accessoires est le manque généralisé de données qui existe encore dans de nombreux ORGP concernant les interactions des espèces vulnérables avec les pêcheries, qui peuvent se terminer en tant que prises accessoires. Cela est particulièrement évident pour les élasmobranches, les mammifères marins et les oiseaux marins. Comme le reconnaît bien le GFCM, le manque de données sur l'occurrence et le niveau des prises accessoires entrave la capacité à gérer et à appliquer des règles sur les activités des navires de pêche. Même lorsque des données existent, le manque de plans d'échantillonnage statistiquement robustes et harmonisés limite leur valeur et empêche, par exemple, les comparaisons entre différentes flottes de pêche et différentes zones. Par conséquent, des mesures doivent être mises en œuvre (ou poursuivies) pour mettre en place des programmes de surveillance adéquats et des cadres pouvant permettre une collecte de données solide sur les prises accessoires.

[27] Commission for the Conservation of Antarctic Marine Living Resources
[28] General Fisheries Commission for the Mediterranean
[29] Northwest Atlantic Fisheries Organisation
[30] North East Atlantic Fisheries Commission
[31] North Pacific Fisheries Commission
[32] South East Atlantic Fisheries Organisation
[33] Southern Indian Ocean Fisheries Agreement
[34] South Pacific Regional Fisheries Management Organisation

Une fois ces données disponibles, de meilleures mesures peuvent être conçues pour protéger les espèces prises accessoirement dans la pêche en haute mer. Des informations détaillées sur la diversité des pratiques et des mesures mises en œuvre pour réduire et gérer les prises accessoires dans la pêche en haute mer au sein des ORGP se trouvent dans l'Annexe 4 (Livrable 2) du présent rapport.

Tâche 4: Critères pour l'établissement des empreintes et de l'historique de la pêche, et élaboration d'un cadre pour les pêches exploratoires et les enquêtes scientifiques.

L'objectif de cette tâche est axé sur l'examen des critères/méthodes existants pour la caractérisation de l'empreinte de pêche (Annexe 5) dans les DSF au sein des ORGP pertinentes (NAFO, NEAFC, SEAFO, GFCM, NPFC, SPRFMO, SIOFA et CCAMLR), ainsi que dans la zone FAO 41. De plus, un cadre pour les pêches exploratoires (Annexe 6) et les activités de recherche non liées à la pêche (Annexe 7) a été élaboré. Bien que le concept d'empreinte de pêche ne soit pas spécifiquement défini dans les directives de la FAO, dans la pratique, dans la plupart des ORGP, les termes "empreinte de pêche", "empreinte de pêche en fond", "zones existantes de pêche en fond", "zones profondes existantes de pêche en fond" sont équivalents et font généralement référence au même concept (c'est-à-dire les endroits où une certaine activité de pêche en fond a été réalisée précédemment sur une période de référence). Les résultats du Livrable 3 (voir Annexe 5) montrent qu'il existe une grande variété de méthodes utilisées dans les différentes ORGP pour définir les empreintes de pêche, avec NAFO, NEAFC et CCAMLR ayant l'expérience la plus avancée à cet égard. De plus, lors de l'étude de l'empreinte de pêche, plusieurs problématiques clés doivent être prises en compte : (i) les données (par exemple, les besoins, la compilation, la disponibilité et la qualité) ; (ii) la coopération internationale (par exemple, la recherche, la gestion, le partage d'informations) ; (iii) le potentiel de nouvelles méthodologies, de sources de données complémentaires et d'approches, par exemple, des méthodes pour améliorer la résolution de l'empreinte, Systèmes d'identification automatique (AIS[35]); et (iv) les besoins de financement. La plupart des ORGP ont adopté des réglementations sur la pêche en fond, intégrant des éléments pertinents de la résolution 61/105 de l'AGNU[36] et des directives de la FAO sur les DSF, y compris l'adoption de protocoles de pêche exploratoire (voir Annexe 6). La CCAMLR est l'organisme de réglementation le plus important dans ce domaine, tandis que la GFCM ne dispose pas d'un cadre juridique spécifique et que la NAFO et la NEAFC ont modifié leurs protocoles à plusieurs reprises. En termes généraux, les ORGP suivent des procédures spécifiques similaires et effectuent des évaluations préliminaires. Un cas exceptionnel est celui de la SIOFA qui n'a pas clairement défini ce qu'est une pêche exploratoire. La plupart des ORGP, à l'exception de la GFCM, ont mis en place des mesures spécifiques de conservation et de gestion pour prévenir les captures accessoires sur les EMV, et dans la plupart des ORGP, la surveillance des pêches exploratoires est obligatoire, y compris le déploiement d'observateurs à bord. Dans la plupart des ORGP, leurs propres organes consultatifs scientifiques ont pour fonction d'encourager, de promouvoir la coopération et de coordonner la recherche scientifique internationale (voir Annexe 7). En revanche, dans le cas de la NEAFC, le CIEM[37] est responsable de ces fonctions. La plupart des ORGP ont élaboré des plans de travail de recherche pour leurs organes consultatifs sur une base pluriannuelle ou annuelle, y compris la planification des priorités de recherche. Seule la SEAFO a élaboré des lignes directrices spécifiques pour la recherche sur les pêcheries et les

[35] Systèmes d'identification automatique/Automatic Identification System
[36] Assemblée générale des Nations Unies/United Nations General Assembly
[37] Conseil International pour l'Exploration de la Mer

sciences marines de base. De plus, il existe une variété d'approches dans les ORGP en ce qui concerne les mesures de conservation et de gestion liées à la recherche scientifique. La question de l'impact de la recherche sur les écosystèmes marins vulnérables est abordée dans les mesures de conservation et de gestion de certaines ORGP (par exemple, la NEAFC, la SEAFO, la SIOFA et la CCAMLR) ou est actuellement surveillée (par exemple, la NAFO). La réglementation de la recherche scientifique est un problème actuel dans certaines ORGP et plusieurs initiatives sont en cours à cet égard (par exemple, la NAFO, la SPRFMO et la SIOFA). Enfin, l'examen de la diversité des approches utilisées par les ORGP, en tenant compte de leurs forces et faiblesses, a été très utile pour identifier les éléments clés potentiels pour l'élaboration de cadres pour les pêches exploratoires et la recherche scientifique, qui sont décrits en détail dans les Annexes 6 et 7.

Tâche 5: Examen critique de l'efficacité des mesures et des outils de gestion existants, et/ou de leurs combinaisons, pour la protection et la conservation des EMV en haute mer.

L'objectif de cette tâche est de fournir un examen critique de l'efficacité des outils de gestion existants, y compris la règle de déplacement, et des mesures pour évaluer les impacts et/ou des combinaisons de ceux-ci (y compris les outils de gestion spatiale) pour la conservation des EMV et d'identifier les meilleures pratiques dans les ORGP. En l'absence d'informations, une approche de précaution avait été adoptée à l'origine et les caractéristiques sous-marines telles que les monts sous-marins susceptibles d'abriter des EMV avaient été fermés à la pêche. Il n'existe toutefois aucun accord sur la manière de définir et de délimiter les EMV. Aujourd'hui, certaines ORGP appliquent encore l'approche de précaution. Pour que les mesures soient efficaces, la distribution et la connectivité des EMV doivent être mieux comprises. L'identification de la présence, de la distribution et de l'abondance d'une espèce indicatrice définit l'état de cette espèce à un moment (ou une période) donné. Il ne définit pas la composition d'une communauté associée, l'ensemble des interactions entre les espèces qui définissent et soutiennent la communauté, ou les flux de matières et d'énergie qui définissent les limites de l'écosystème. Les détails concernant les interactions entre les espèces (par exemple, la connectivité des populations, le flux d'énergie qui sert de médiateur à la croissance et à la reproduction, et les interactions médiées par le régime océanographique local) qui seront nécessaires pour comprendre et prévoir dans quelle mesure la pêche et d'autres activités humaines produisent des SAI. Un point essentiel est que les règles de déplacement n'ont pas été conçues à l'origine comme des mesures autonomes de protection des EMV contre les SAI. Elles ne doivent être considérées que comme des mesures temporaires jusqu'à ce que des mesures de protection spatiale soient mises en œuvre. Des informations détaillées sur cette tâche figurent à l'Annexe 8 (Livrable 4) du présent rapport.

Tâche 6: Identifier les lacunes dans la recherche et les sujets scientifiques prioritaires (par région).

L'objectif de la tâche 6 était d'identifier les lacunes dans la recherche et les sujets scientifiques prioritaires par région (ORGP et zone 41 de la FAO concernant le règlement du Conseil (CE) n° 734/2008), en vue d'améliorer notre compréhension et notre connaissance de l'identification des EMV, et de concevoir un cadre pour les futurs programmes d'observation des ORGP afin d'identifier, d'enregistrer et de faire rapport sur les taxons associés aux EMV. Cela contribuera à renforcer les connaissances scientifiques utilisées pour élaborer des mesures de gestion visant à réduire ou à atténuer les incidences sur les EMV. Pour ce faire, nous avons principalement examiné les rapports des groupes responsables de la gestion des EMV au sein de chaque ORGP, ainsi que d'autres résumés. Les principales lacunes en matière de données concernent le cycle de vie des espèces d'EMV, en termes de longévité, de fragilité, de dispersion larvaire et de mobilité. Sans une meilleure connaissance de ces caractéristiques, il est difficile d'évaluer l'efficacité des différentes mesures d'atténuation. En particulier, il s'agit de savoir si les seuils actuels sont appropriés, quelle est la distance idéale pour une règle de déplacement, le cas échéant, et quelle est la meilleure façon de gérer une zone dans l'espace afin d'équilibrer une protection maximale avec une interférence minimale pour la pêche. Bien que les navires de pêche ne constituent pas un outil d'échantillonnage efficace, les programmes d'observation constituent une source précieuse de données à un coût relativement faible. Toutes les ORGP ayant participé à cette étude ont mis en place un programme d'observation sous une forme ou une autre, avec l'obligation de collecter des données sur les EMV lorsqu'ils sont rencontrés. L'Annexe 9 fournit des lignes directrices, basées sur les programmes déjà en place, pour la collecte et l'enregistrement des données relatives aux EMV par les observateurs. En outre, les exigences en matière de données liées au règlement (CE) n° 734/2008 du Conseil sont résumées à l'Annexe 10, qui décrit les informations qui doivent être soumises par les navires de l'UE, la manière dont les informations sont évaluées, les règles relatives aux rencontres et les exigences en matière de Système de Surveillance par Satellite des Navires (SSN[38]) et d'observateurs.

Tâche 7: Identifier les domaines, les sujets et les options politiques ayant une portée potentielle et une valeur ajoutée dans la promotion de la cohérence entre les organisations pertinentes et en rapport avec toute révision possible du Règlement 734/2008.

L'objectif de cette tâche est d'identifier les aspects ayant une portée potentielle et une valeur ajoutée dans la promotion de la cohérence entre les ORGP et avec une pertinence pour toute révision possible du Règlement du Conseil (CE) No 734/2008. La comparaison des différents concepts et définitions dans le contexte des directives internationales sur la gestion de la pêche profonde en haute mer de la FAO, nous a permis d'obtenir les conclusions suivantes : (i) Dans la plupart des ORGP, les principaux "concepts clés" sont définis sur la base des directives de la FAO (par exemple, SAI, EMV, pêche de fond). Toutefois, la liste des "concepts clés" décrits dans les directives de la FAO est brève et pourrait être élargie et améliorée ; ii) certains concepts ne sont pas clairement définis dans directives de la FAO, mais les différentes ORGP ont adopté des définitions similaires basées (ou inspirées) de l'"esprit" des directives (par exemple, l'empreinte de pêche, la rencontre) ; iii) les ORGP adoptent des approches différentes en ce qui concerne la mise en œuvre de certains concepts (par exemple, les listes d'indicateurs de l'EMV, unités d'indicateurs d'EMV/niveaux de seuil) ; iv) certaines lacunes ont été identifiées en ce qui concerne le cadre des EMV au titre du règlement (CE) n° 734/2008 du Conseil (par exemple, le concept d'"EMV" est défini, mais pas celui d'"indicateur d'EMV", une règle de déplacement est spécifiée, mais le concept de "rencontre" n'est pas clairement défini, il n'y a pas d'indicateurs ni de niveaux de seuil). En outre, il n'existe aucune définition du concept d'"empreinte de pêche" dans les zones relevant de ce règlement. Certaines de ces lacunes pourraient compliquer sa mise en œuvre effective ; v) l'utilisation d'un ensemble similaire de définitions des principaux "concepts clés" liés à la gestion de l'EMV/du DSF pourrait contribuer à promouvoir la cohérence entre les organisations et les règlements du DSF (les principaux "concepts clés" devraient être clairement définis et les concepts équivalents devraient avoir la même signification dans les différentes organisations et les différents règlements du DSF. Au total, 11 sujets clés ont été abordés et discutés dans le but d'offrir des possibilités de

[38] Système de Surveillance par Satellite des Navires /Vessel Monitoring System (VMS)

promouvoir la cohérence entre les ORGP, y compris certains qui se rapportent à toute révision éventuelle du règlement (CE) n° 734/2008 du Conseil. D'une manière générale, il existe une diversité d'approches dans les différentes ORGP en ce qui concerne tous les sujets qui ont été discutés. Elles couvrent un large éventail d'aspects liés à : (i) la gestion et la conservation de la pêche (comme l'atténuation des prises accessoires, y compris les espèces indicatrices d'EMV, le cadre pour les EMV et les mesures de lutte contre les activités de pêche INN[39]); (ii) la recherche scientifique et la collecte de données (y compris les cadres pour la pêche exploratoire, pour la recherche scientifique, y compris l'atténuation des impacts de la recherche, pour les observateurs à bord, y compris la collecte de données sur les EMV, pour la collecte et la communication des données, y compris le contrôle de la qualité et l'empreinte de la pêche), et ; (iii) la gestion des pêches fondée sur les écosystèmes (évaluation de l'SAI, exigences et méthodes, plans de travail des organes consultatifs scientifiques des ORGP, cadre pour les avis sur les options de gestion visant à réduire le risque d'SAI et à protéger les EMV, tout en limitant les pertes potentielles pour les pêcheurs). Après avoir examiné ce large éventail d'aspects, une série d'enseignements ont été tirés. Ceux-ci peuvent être utiles pour promouvoir la cohérence entre les ORGP concernées, ainsi que pour toute révision éventuelle du règlement (CE) n° 734/2008 du Conseil.

Tâche 8: Soutenir l'évaluation du règlement (CE) n° 734/2008 du Conseil relatif à la protection des EMV.

L'objectif de cette tâche était d'analyser dans quelle mesure le règlement (CE) n° 734/2008 du Conseil (le règlement) est efficace, efficient, toujours pertinent compte tenu des besoins actuels, cohérent et complémentaire par rapport à d'autres interventions et a atteint la valeur ajoutée de l'UE (Annexe 12; Livrable 5). Nous avons également cherché à identifier les domaines dans lesquels le règlement doit être mis à jour pour refléter les meilleures pratiques et les meilleures données scientifiques disponibles, et à formuler des recommandations sur la manière dont le règlement peut être mis à jour (si nécessaire) pour refléter les conclusions de l'étude. Pour ce faire, nous avons procédé à une consultation des parties prenantes, afin de recueillir les avis des personnes concernées par la mise en œuvre du règlement, et nous avons analysé les informations recueillies dans le cadre d'autres tâches de ce projet. Malgré plusieurs efforts pour faire participer les parties prenantes, le taux de réponse a été trop faible. Il est donc difficile de tirer des conclusions importantes. Cependant, étant donné que la zone clé couverte par le règlement est la zone FAO 41, qui est principalement pêchée par des navires battant pavillon espagnol, les répondants comprenaient deux membres du secteur de la pêche espagnol, un membre du groupe d'experts de la pêche de l'UICN[40] et un scientifique d'un institut de recherche de l'UE. Malgré la faible taille de l'échantillon, les opinions discutées dans ce rapport sont instructives sur les différents aspects du règlement et, avec les informations recueillies dans le cadre d'autres tâches, devraient permettre de déterminer comment et quels domaines du règlement pourraient être mis à jour/révisés si une telle décision était prise.

[39] Pêche illicite, non déclarée et non réglementée/Illegal, undeclared and unregulated fishing (IUU)
[40] Union internationale pour la conservation de la nature/International Union for Conservation of Nature

1. INTRODUCTION

General introduction to this specific contract and study

EASME/CINEA commissioned the AZTI led consortium (AZTI, CEFAS, CSIC, IEO, IPMA, IRD, MRAG-EU and WMR) for the Framework Contract EASME/EMFF/2019/014 for the "*Provision of scientific* advice for fisheries beyond EU waters". The present **Final Report** refers to the D9 of the Specific Contract (SC) Nº 01 under this framework, which title is ***"Improving environmental sustainability of deep sea fisheries with emphasis on the conservation of Vulnerable Marine Ecosystems (VMEs)"***.

The Union's Common Fisheries Policy (CFP) Regulation (EU) No 1380/2013, sets out the objectives and general rules which form the basis for deep sea fisheries (DSF) management. It establishes the legal framework for the conservation, management and sustainable exploitation of "living marine biological resources" and marine ecosystems concerned, in line with the ecosystem approach, where such activities take place on the territory of EU Member States or in Union waters or are carried out by EU fishing vessels outside Union waters. Furthermore, in June 2008, the European Union adopted Council Regulation (EC) No 734/2008[41] on the protection of VMEs in the high seas from the adverse impacts of bottom fishing gears. Its purpose was to transpose the measures contained in the United Nations General Assembly (UNGA) Resolution 61/105 into Union law for ships flying flags of its Member States, for those areas of the high seas where no Regional Fisheries Management Organizations (RFMOs) had been established or where no interim measures were put in place during negotiations for the establishment of an RFMO. This was necessary because the EU has numerous vessels conducting bottom fishing in areas not regulated by an RFMO, or any arrangement with competence to regulate such fishing activities, and where the establishment of such organisation cannot be expected in the short term, particularly the South West Atlantic (FAO Area 41).

The Commission is considering whether it is now necessary to review and update Regulation (EC) No 734/2008 to ensure that it reflects the most recent scientific advice and best practices, although this political decision has not been taken so far. Considering its involvement in various RFMOs managing DSFs and in view of the possible updating of such Regulation, DG MARE has undertaken a reflection to identify orientations to guide future actions. Amongst others, these orientations touch upon the need to consider improvements in scientific knowledge and corresponding best practice, and on reinforcing RFMOs action for the protection of VMEs.

Various countries and RFMOs have adopted a range of approaches on the protection of VMEs and this raises the question of the need to promote and ensure an appropriate level of consistency across RFMOs. The identification of best practices could be helpful in the context of any possible revision of Regulation 734/2008. In this context, the present specific study has the dual purpose of assessing and improving scientific data and advice as well as relevant management measures, regarding the environmental sustainability of DSF and the protection of VMEs.

The ultimate objective of this contract is that the identified best practices shall, where appropriate, inform and strengthen EU policy choices, in particular in the context of

[41] Council Regulation (EC) No 734/2008 of 15 July 2008 on the protection of vulnerable marine ecosystems in the high seas from the adverse impacts of bottom fishing gears Official Journal of the European Union, L 201, 30 July 2008, 6 pp.

its participation in RFMOs and Regional Fisheries Bodies (RFBs), and provide a "model regulation" of VMEs, as well as in the context of any possible revision of its Regulation 734/2008. They could also contribute to the development of proposals for improving the conservation of VMEs and the management of DSF to be tabled at those organisations, including at the UN and FAO. The final aim is to have an additional tool in place to assess the most appropriate VME policy.

The starting point for the development of this study are the outputs of previous initiatives (e.g. recent desk-based studies related to DSF management and VME conservation, EU research projects, etc.). In this regard, it is noteworthy that in 2018 the European Commission commissioned a specific study[42] aiming at providing a comprehensive review and analysis of the scientific approaches adopted and in development by each of the RFMOs and RFBs that manage bottom-fishing activities. Its findings demonstrated the panoply of methodologies and criteria that are currently in place across RFMOs. This study (hereafter "SC08") provides an appropriate starting point upon which to compare and contrast the performance of different RFMOs, with respect to DSF, and with a particular focus on the avoidance and mitigation measures designed to conserve and protect VMEs, species, habitats and biodiversity in the deep sea.

This report provides the information and results of all the work carried out throughout the study. It includes the key content of all tasks and deliverables. In addition, the deliverables and relevant information from some sub-tasks have been included as annexes.

Tasks performed

Within this study the following tasks have been carried out:

- **Task 0. Project management**

  0.1 Management

  Project management and Quality Control (QC)

  Report Writing, peer and editorial reviews

  0.2 Meetings

- **Task 1. Update/expand worldwide the comparative analysis of the state of the art undertaken under SC08 in the protection and conservation of VMEs and the management of fisheries activities that can impact them.**

  1.1 Data availability and governance

  1.2 Description of sensitive species/habitats

  1.3 Assessment of bottom fishing impacts

  1.4 Mapping of sensitive species/habitats

  1.5 Impact mitigation/protection measures

[42] EASME/EMFF/2017/1.3.2.6/08 - Scientific approach for the assessment and management of deep sea fisheries and ecosystems in RFMOs and RFBs.

1.6 Monitoring of VME impacts

- **Task 2. Critical review of FAO 2008 DSF guidelines and compilation and development of best practices and recommendations on key aspects related to the conservation of VMEs and management of DSF.**

    2.1 Review the 2008 DSF FAO Guidelines

    2.2 Compilation of best practices

    Deliverable 1 (D1): Compilation of best practices guidance on key aspects related to the conservation of VMEs and management of DSF (Review of the implementation of the FAO Guidelines in the high seas)

- **Task 3. Overview and critical analysis of existing by-catch mitigation and management approaches in DSF, and development of recommendations for improving by-catch management in DSF.**

    3.1 Effectiveness of by-catch management

    3.2 Areas with gaps/improvements needed

    3.3 Recommendations for by-catch management

    Deliverable 2 (D2): Guidelines for improving by-catch management in DSF

- **Task 4. Criteria for the establishment of footprints and historical fishing, and the development of a framework for exploratory fisheries and scientific surveys.**

    4.1 Criteria and methodologies for fishing footprints

    4.2 Approaches for "exploratory fisheries" and options

    4.3 Framework for research activities not related to fisheries

    Deliverable 3 (D3): Review of existing and recommended criteria and methodologies for the establishment of historical and cumulative fishing footprints

- **Task 5. Critical review of the effectiveness of existing measures and management tools, and/or combinations thereof, for the protection and conservation of VMEs in the high seas.**

    5.1 Analysis of management approaches, methodology and decisions making tools

    5.2 Recommendations on existing approaches, alternatives and best practices

    Deliverable 4 (D4): Review of the effectiveness of existing management tools in different RFMOs

- **Task 6. Identify gaps in research and priority scientific topics (by region).**

- **Task 7. Identify areas, topics and policy options with potential scope and added-value in promoting consistency among relevant organisations and with relevance to any possible revision of Regulation 734/2008.**

- **Task 8. Support the evaluation of Council Regulation (EC) No 734/2008 on the protection of VMEs**.

8.1 Description of the current situation

8.2 Effectiveness, efficiency, relevance, coherence and added value

8.3 Stakeholder consultation

8.4 Conclusions and recommendations

Deliverable 5 (D5): Standalone document that includes all outputs from Subtask 8.1 to Subtask 8.4, each of which organised as an independent chapter of the document (Task 8 - Support the evaluation of council regulation (EC) No 734/2008)

2. ACRONYMS

AAD	Australian Antarctic Division
ABARES	Australian Bureau of Agricultural & Resource Economics & Sciences
ABFMs	Area-Based Fisheries Management Measures
ABNJ	Areas Beyond National Jurisdiction
ACS	Argentina Continental Shelf
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AMSIS	Australian Marine Spatial Information System
As	Agreements
AUV	Autonomous Underwater Vehicle
AZTI	Fundación AZTI
BOEM	Bureau of Ocean Energy Management
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CECAF	Fishery Committee for the Eastern Central Atlantic
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CFP	Common Fisheries Policy
CFP	Consejo Federal Pesquero
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CoE	Centre of Expertise
CONICET	Consejo Nacional de Investigaciones Científicas y Técnicas
COVID-19	Coronavirus disease 2019
CPL	Consortium Project Leader
CSAS	Canadian Science Advisoty Secretariat
CSIC	Consejo Superior de Investigaciones Científicas
CSP	Conservation Services Programme
DAFF	Department of Agriculture, Fisheries and Forestry
DCF	Data Collection Framework
DFO	Fisheries and Oceans Canada
DG MARE	EU Directorate-General for Maritime Affairs and Fisheries
DOC	Department of Conservation
DSCRTP	Deep Sea Coral Research and Technology Program
DSF	Deep-sea Fisheries
EASME	Executive Agency for Small and Medium-sized Enterprises
EBSA	Ecologically or Biologically Significant Areas
EC	European Commission
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EMFF	European Maritime and Fisheries Fund
EP	Environmental Plan
ERAs	Ecological Risk Assessments
ERAF	Ecological Risk Assessment Framework
ERAEF	Ecological Risk Assessment for the Effects of Fishing
ERM	Ecological Risk Management
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FHPP	Fish and Habitat Protection Program
FMP	Faros del Mar Patagónico
FMP	Fishery Management Plan
FNZ	Fisheries New Zealand
FPP	Fisheries Protection Program
FRDC	Fisheries Research and Development Corporation
FWC	Framework Contract
GEF	Global Environment Facility
GFCM	General Fisheries Commission for the Mediterranean
HAPCs	Habitat Areas of Particular Concern
HERMIONE	Hotspot Ecosystem Research and Man's Impact on European seas
HSFCA	High Seas Fishing Compliance Act
ICES	International Council for the Exploration of the Sea
ID	Identification Guides
IEO	Instituto Español de Oceanografía
IFMPs	Integrated Fisheries Management Plans
INIDEP	Instituto Nacional de Investigación y Desarrollo Pesquero
IPMA	Instituto Português do Mar e da Atmosfera
IQ	Individual Quota

IRD	Institut de recherche pour le développement
ITQ	Individual Transferable Quota
IUCN	International Union for Conservation of Nature
MAC	Maximum Allowable Catch
MFish	Ministry of Fisheries
MfE	Ministry for the Environment
MPAs	Marine Protected Areas
MPI	Ministry for Primary Industries
MRAG EU	MRAG Europe
MS	Member States (EU)
MSFD	Marine Strategy Framework Directive
MSFCMA	Magnuson–Stevens Fishery Conservation and Management Act
NAFO	Northwest Atlantic Fisheries Organisation
NEAFC	North East Atlantic Fisheries Commission
NEREIDA	NAFO Potential Vulnerable Marine Ecosystems. Impacts of Deep-sea Fisheries
NIC	NIWA Invertebrate Collection
NIWA	National Institute of Water and Atmospheric Research
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NPFC	North Pacific Fisheries Commission
NRA	NAFO Regulatory Area
NRCan	Natural Resources Canada
NZTCS	New Zealand Threat Classification System
OER	Ocean Exploration and Research
OEN	Ocean Networks Canada
OSPAR	Oslo and Paris Conventions
QC	Quality Control
QMS	Quota Management System
RCAs	Rockfish Conservation Areas
RFBs	Regional Fisheries Bodies
RFMC	Regional Fishery Management Council
RFMOs	Regional Fisheries Management Organisations
ROV	Remotely Operated Vehicle
RSC	Royal Society of Canada
SAI	Significant Adverse Impact
SC	Specific Contract Leader
SC08	EASME/EMFF/2017/1.3.2.6/08 - Scientific approach for the assessment and management of deep sea fisheries and ecosystems in RFMOs and RFBs
SCL	Specific Contract Leader
SDMs	Species Distribution Models
SEAFO	South East Atlantic Fisheries Organisation
SeBAs	Sensitive Benthic Areas
SEWPAC	Department of Sustainability, Environment, Water, Population and Communities
SGF	Sediment, geomorphology and fauna
SiBAs	Significant Benthic Areas
SIH	Serious or Irreversible Harm
SIOFA	Southern Indian Ocean Fisheries Agreement
SMEFF	Sustainable Management Of External Fishing Fleets
SPONGES	Deep-sea Sponge Grounds Ecosystems of the North Atlantic an integrated approach towards their preservation and sustainable exploitation
SPRFMO	South Pacific Regional Fisheries Management Organisation
ToR	Terms of reference
UN	United Nations
UNGA	United Nations General Assembly
USGS	U.S. Geological Survey
VMEs	Vulnerable Marine Ecosystems
WDWTF	Western Deep-Water Trawl Fishery
WECAF	Western Central Atlantic Fishery Commission
WGDEC	ICES/NAFO Working Group on Deep-water Ecology
WMR	Wageningen Marine Research

3. OBJECTIVES, METHODS, MAIN RESULTS AND CONCLUSIONS BY TASK

TASK 1 - Update/expand worldwide the comparative analysis of the state of the art undertaken under SC08 in the protection and conservation of VMEs and the management of fisheries activities that can impact them.

Objectives

The objective of the present desk-based research is to expand the comparative analysis of **SC08**[43], providing a review of the work developed in support of VME protection and identification of mitigation measures from the impacts of bottom fishing, in a number of selected case study areas (five relevant countries) not covered by the SC08, as a complement of that study.

Methodology

To achieve this objective, the work was developed in three consecutive steps:

Step 1. Selection of the case study areas outside the EU: Five countries

Step 2. Data and information reviews: Individual reports by country

Step 3. Comparative analysis

SELECTION OF COUNTRIES

According to the discussions of the 26th March 2021 meeting[44] with DG MARE and CINEA, the following five countries were included in the review (Figure 1):

1. United States of America (USA)
2. Canada
3. Argentina
4. Australia
5. New Zealand

Such countries meet most of the "Criteria of Relevance" indicated by DG MARE in the *SC01 Request of Services*: (i) Geographical location towards a RFMO or Areas under the scope of Regulation (EC) No 734/2008 (Figure 1); (ii) Existence of prominent policies in place and (iii) Presence of a substantial fleet undertaking bottom fishing.

[43] EASME/EMFF/2017/1.3.2.6/08 - Scientific approach for the assessment and management of deep sea fisheries and ecosystems in RFMOs and RFBs.

[44] A preliminary list of seven potential countries to be included in the review was selected by the consortium and then, an exploration of the quality and availability of information in relation to the criteria of relevance (indicated by DG MARE) was conducted. According to the results of this exploration and the discussions during *the "remote meeting with DG MARE to agree on which 5 countries are to be considered as the most appropriate for the review (26th March 2021)",* a final list of five countries was agreed. See Inception Report.

SCOPE OF THE REVIEW

The scope of the review covers two main aspects:

a. *Thematic scope:* deep-sea fisheries[45] (DSF) management, particularly the work developed by the countries in support of the protection of VME[46] and the identification of mitigation measures from the impacts of bottom fishing, and if relevant, the main aspects related to interactions of activities other than fishing[47] (e.g. oil and gas exploration and exploitation) with DSF and VME.

b. *Geographical scope:* national jurisdiction and areas beyond national jurisdiction.

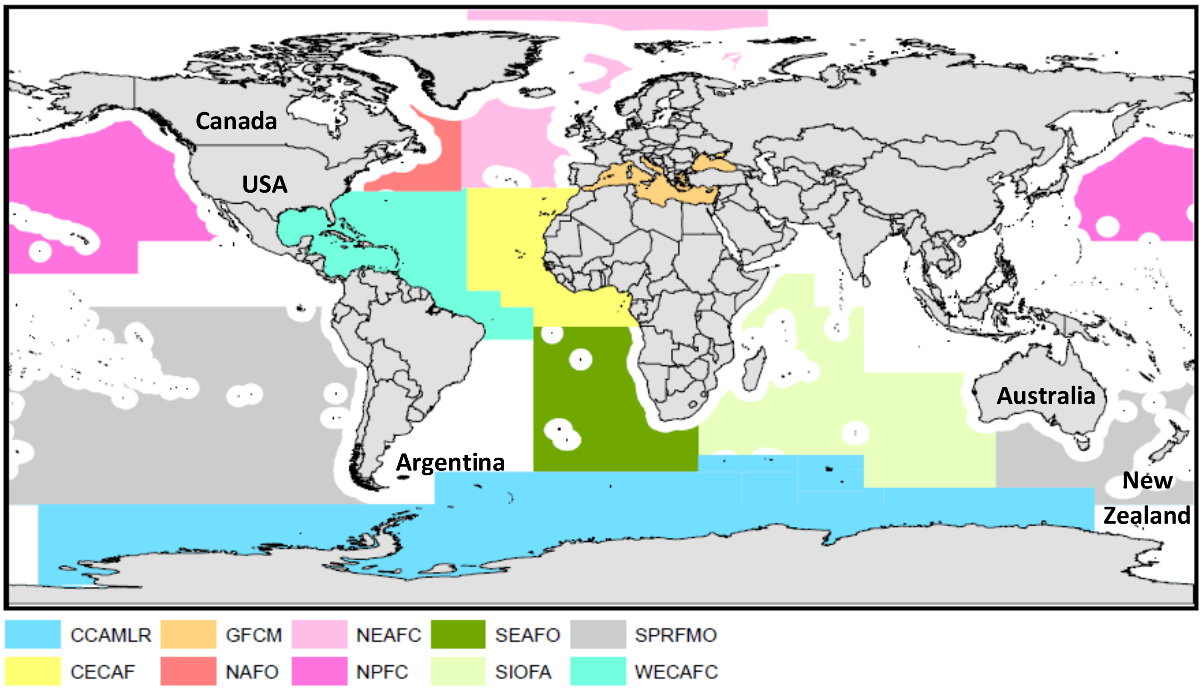

Figure 1. Geographical location of the five selected countries towards a RFMO or areas under the scope of *Regulation (EC) No 734/2008*. Modified from SC08.

KEY TOPICS OF THIS REVIEW

This review was designed to cover the key elements related to the protection of VMEs and the identification of impact mitigation measures. In this regard, for each country,

[45] For the purpose of this review, DSF are defined as fisheries that occur both in areas under national jurisdiction and in areas beyond national jurisdiction and have the following two characteristics: (i) the total catch (everything brought up by the gear, including VME indicator species) includes species that can only sustain low exploitation rates; and (ii) the fishing gear is likely to contact the seafloor during the normal course of fishing operations. These two characteristics are in line with FAO DSF Guidelines (FAO, 2009) definitions. Coastal States may apply these Guidelines within their national jurisdiction, as appropriate (paragraph 10).
[46] As defined in FAO DSF Guidelines (FAO, 2009), paragraphs 14, 15, 16 and 42.
[47] It is an important issue in certain high seas areas such as NAFO Regulatory Area.

the data and information describing the methods and approaches used were reviewed with the aim to address the following key topics (Sub-tasks 1.1 to 1.6):

1. Data availability and governance frameworks
2. Description of sensitive species and habitats
3. Assessment of bottom fishing impacts
4. Mapping of sensitive species and habitats
5. Impact mitigation and protection measures
6. Monitoring of VMEs impacts

In order to ensure consistency between the previous (SC08) and the present (SC01) study, as well as in the types of data and information to be reviewed, these key topics are based on the SC08 methodology, with special emphasis on DSF and the conservation of VMEs. This is particularly important for the comparative analysis, as this information will support such analysis.

The information on the key topics was collected by the consortium through a review of a wide variety of sources (see Section Data and information reviews: individual reports by country), related with the description of each of the topics. Such questions were developed during the planning phase of Task 1 and were used to guide the reviews (Step 2). They were then reorganized to facilitate the evaluation phase (Step 3).

The key topics and questions that guided the reviews had been designed based on the SC08, which focuses on approaches developed by intergovernmental organizations (RFMOs). Nevertheless, some of them have been updated for a better coverage of the specific objectives of SC01, which focuses on approaches developed by individual governments (countries).

DATA AND INFORMATION REVIEWS: INDIVIDUAL REPORTS BY COUNTRY

In the present desk-study, as in the case of the SC08, the sources of data and information used were quite diverse (e.g. published material and data from official websites, published scientific and management reports and papers, FAO and UN documents, personal communication and other relevant sources).

With the aim to standardize the reviews, an individual report was generated for each country. For each individual country report, the data and information collated was structured using the six key topics mentioned in previous Section (Key topics of this review). The individual reports produced (see Annex 1) provide a comprehensive description of the state of the art in each country regarding such topics, based on the publicly available information. The questions about key topics guided the reviews. The main references are included - generally as footnotes - and a list of acronyms is collected. The following challenges were identified during the data collation:

- In general, the search for information from the countries resulted more laborious and time consuming than in the case of RFMOs (e.g. several websites and sources of data *vs* RFMOs centralized websites). In some cases, complex frameworks and different management approaches are in place, with several regulations and layers of jurisdiction to review (e.g. local, state, federal, high seas), and different institutions involved in science, management, and enforcement (e.g. Institutes, Ministries, Agencies, etc.). Moreover, some information resulted scattered and difficult to locate.

- Some of the questions that guided the reviews were difficult to address in detail in the case of certain countries. This subsequently led to a reorganization of the questions. In general, information available resulted heterogeneous, due the diversity of concepts and approaches (e.g. VME *vs* Essential Fish Habitat), as well as the different development of the VME frameworks, across the five countries reviewed.

COMPARATIVE ANALYSIS CRITERIA

Based on the information collated within each of the individual country reports (Annex 1), an analysis was undertaken with the aim to compare the work developed by each of the five countries in support of the protection of VMEs and the identification of mitigation measures from the impacts of bottom fishing, and when relevant, from activities other than fishing (e.g. oil and gas exploration and exploitation). The heterogeneity of the available information made comparative analysis challenging.

To carry out the assessments, an approach adapted from Fletcher (2020)[48] was used. According to this methodology, the present assessments are related to the degree that the six key topics were being considered and addressed/implemented within the countries, rather than focusing on the outcomes. The criteria employed were adapted for use in this analysis in order to enable the reviews for each country to be undertaken in a consistent and objective manner (Fletcher, 2020).

A set of questions were raised in order to assess each of the six key topics (Table 1) with the aim of addressing the main aspects that are relevant to the management of DSF, with emphasis on the conservation of VMEs.

ASSESSMENTS AND SCORING

For the six key topics previously identified as the most relevant for the review and their specific questions (Table 1), the current status in each country was assessed using a semiqualitative methodology (Fletcher, 2020). The scores used for the assessment are presented in Table 2.

The assessments were based on the available data and information collated between 2021 and 2022. Detailed data and information for each of the countries are available in their individual reports (Annex 1). Moreover, a series of review tables including a summary of the score justification, main gaps, comments and sources of information are presented for each country (Annex 2). It should be noted that the Individual Review Tables by Country presented in Annex 2 only includes a summary of the material used to justify the scoring. To get a full picture of what has been used in the analysis (including the data sources), each of the review tables should be read in conjunction with the corresponding Individual Report by Country (Annex 1). It is important that, in addition to the scoring, the review tables indicate where specific gaps have been identified, as well as any other comments.

[48] Fletcher, W.J. 2020. A review of the application of the FAO ecosystem approach to fisheries (EAF) management within the areas beyond national jurisdiction (ABNJ). Rome, FAO. https://doi.org/10.4060/cb1509en

Table 1. Assessment key topics (in bold type) and questions (in italics).

1. Data availability and governance frameworks	
1.1	*Are there governance frameworks and specific government departments related to DSF/activities other than fishing (research, monitoring, management and enforcement)?*
1.2	*Are data on catches, landings and bycatch (including VMEs/sensitive species and habitats) routinely collected and assessed?*
1.3	*Are VMS data routinely recorded, stored and assessed and is a bottom fishing footprint available?*
1.4	*Does the government departments related to DSF/activities other than fishing have a website?*
1.5	*Are reports and other types of information and data on DSF/VMEs/sensitive species and habitats publicly available?*
2. Description of sensitive species and habitats	
2.1	*Are biodiversity indicators available?*
2.2	*Has a definition of VME concept or an alternative concept (e.g. sensitive species and habitats) been agreed?*
2.3	*Are there VME species/VME features lists available?*
2.4	*Have VMEs/sensitive species and habitats been identified and described?*
3. Assessment of bottom fishing impacts	
3.1	*Are bottom fisheries formally assessed?*
3.2	*Has a bottom fishing footprint been defined?*
3.3	*Are routine fishery independent surveys or other relevant surveys conducted to assess impacts?*
3.4	*Are observer programmes implemented?*
3.5	*Are there methods described and conducted for assessing Significant Adverse Impacts on VMEs/sensitive species and habitats?*
4. Mapping of sensitive species and habitats	
4.1	*Are routine fishery independent surveys or other relevant surveys to sample VMEs indicators/sensitive species and habitats?*
4.2	*Are scientific observer programs implemented to sample VME indicator species?*
4.3	*Have habitat suitability models/species distribution models been developed to map VMEs/sensitive species and habitats?*
4.4	*Have the VMEs/sensitive species and habitats been mapped?*
5. Impact mitigation and protection measures	
5.1	*Are there any VME encounter rules/thresholds which the bottom fisheries use?*
5.2	*Are there any VME bottom fishery closures or MPA in place?*
5.3	*Are there any BFIAs/ bottom fishery exploratory protocols required?*
5.4	*Are there any bottom gear restrictions/depth restrictions/ freezing of the historical footprint adopted as mitigation and protection measure?*
5.5	*Are there any VMEs impact mitigation and protection measure adopted regarding activities other than fishing.*
6. Monitoring of VMEs impacts	
6.1	*Are VMEs/sensitive species and habitats routinely monitored in bottom fisheries?*
6.2	*Are activities other than fishing considered in the long-term monitoring of VMEs/sensitive species and habitats?*
6.3	*Are there any plans for the long-term monitoring of VMEs/sensitive species and habitats (including activities other than fishing)?*

Table 2. Scoring methodology. Adapted from Fletcher (2020).

Score	Description and rationale
3	Fully covered. All relevant aspects of this issue are currently covered by the management system.
2.5	Mostly (in progress) mostly/fully. Each of the main gaps is actively being addressed.
2	Mostly or partially in progress. While many aspects are already being covered, there are clear gaps.
1	Partially or developing. Only some aspects are currently covered or are just beginning to be considered.
0	Nil. No evidence that this issue has been formally considered.
n/a	Not applicable.

In addition to the scores for each of the six **key topics assessed by individual country** (Figures 2 to 6) and the subsequent identification of the main gaps, the scores for the **key topics were compared across all countries**. This provided an overview of the progress in the work developed in support of the protection of VMEs and identification of mitigation measures, across the countries (Figure 7). This overall assessment made possible to compare the countries and to visualize whether there are consistent trends, and therefore whether the gaps and progress are specific to a particular country or topic, or whether the situation is more generalized.

As in the case of the individual country assessment, the overall assessment is also related to the degree that the six key topics were being considered and addressed, rather than in its outcomes. Moreover, it is important to note that the assessments are based solely on publicly available information. There may be additional information, not publicly available and therefore not included in the assessments, that could provide a more complete understanding. For this reason, the conclusions should be viewed with caution.

Results

Individual Country Assessments

Case Study 1 – USA

Detailed data and information collected on key topics are available in the USA individual report (see Annex 1). The assessment was based on such data. Annex 2 presents a summary of the score justification, main gaps, comments and some relevant sources of information. According to the available information, the USA has directly addressed all DSF/VME key topics and all of them are considered to be mostly implemented or close to being fully implemented (Figure 2 and Annex 2). Some gaps were identified (Annex 2):

- Footprint information (e.g. footprint maps) is only available for one region of the U.S.
- Lack of lists of VME species/characteristics.

- There is no criterion similar to the *FAO "structural complexity" criterion* for the identification of sensitive habitats.
- Information on the use of observer programs for VME sampling only available for some regions of the U.S. (e.g., Alaska and the West Coast).
- Some documented vulnerable areas still remain unprotected from bottom fishing impacts.
- No information on VME encounter rules, thresholds or exploratory fishery protocols for domestic bottom fisheries was found.

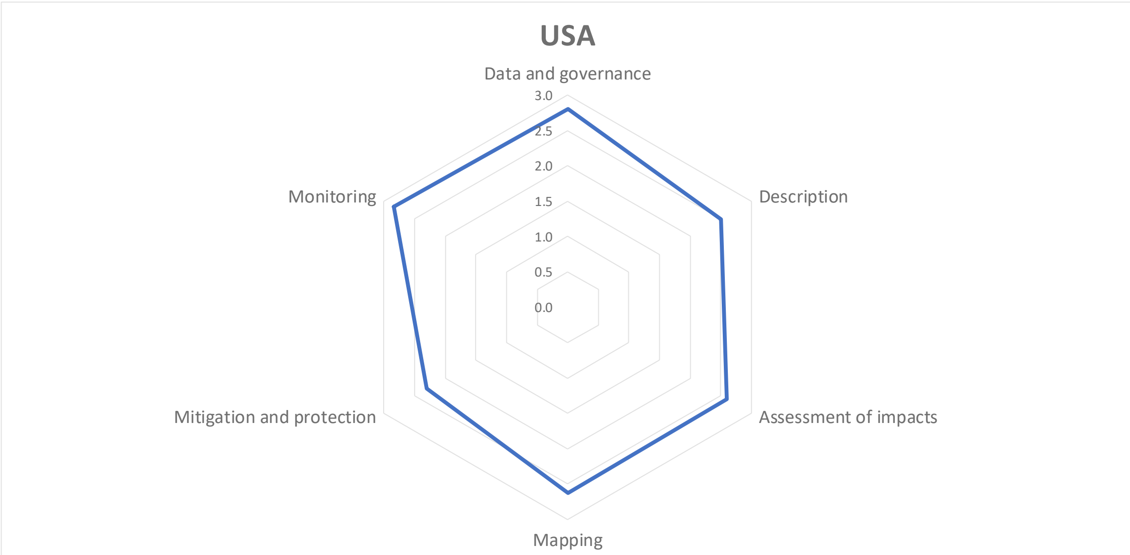

Figure 2. USA: Summary of the implementation of the DSF/VME key topics (3: Fully; 2.5: Mostly (in progress) mostly/fully; 2: Mostly or partially in progress; 1: Partially or developing; 0: No evidence).

DATA AVAILABILITY AND GOVERNANCE FRAMEWORKS

In the USA, the National Marine Fisheries Service (NMFS), also referred as NOAA Fisheries (www.fisheries.noaa.gov), is the federal government body responsible for the stewardship of living marine resources and their habitats, interactions, and ecosystems, with primary responsibility for managing marine fisheries in U.S. federal waters. Much information is publicly available in web sites and reports. More than 100 federal laws guide fisheries management, but the Magnuson–Stevens Fishery Conservation and Management Act (MSFCMA, 1976, 2006) is the primary law in this regard. The key aspects of MSFCMA are as follows: (i) Extension of the exclusive economic zone (EEZ)[49], (ii) Framework based on science, management, and a strong enforcement, (iii) Creation of eight Regional Fishery Management Councils (RFMCs), promoting co-management, stakeholder involvement and considering socio-economic aspects. RFMCs develop fishery management plans (FMPs) for approval and implementation by NOOA Fisheries; (iv) Definition of ten National Standards for management; (v) Call for attention to bycatch and to the identification, designation and conservation of essential fish habitats (EFHs); (vi) Inclusion of recreational fisheries in the management; (vii) Promotion of the MSFCMA provisions internationally and strengthen international fisheries management organizations

[49] https://oceanservice.noaa.gov/facts/eez.html

such as RFMOs. Since 1994, the High Seas Fishing Compliance Act (HSFCA) requires, among other things, that all U.S. commercial fishing vessels operating on the high seas (beyond the EEZ) possess a high seas fishing permit. The main source of data for fisheries management are (i) NOAA research surveys, fishery observers and at-sea monitors and (ii) fisheries landings. Moreover, the *Deep Sea Coral Research and Technology Program* (DSCRTP) supports resource management in fisheries and other sectors.

DESCRIPTION OF SENSITIVE SPECIES AND HABITATS

The VME terminology is not usually used in the jurisdiction of USA (this concept is generally mentioned in the context of international waters). Sensitive benthic habitats within U.S. EEZ are included under the FMPs developed by the RFMCs. For each federal managed fishery, EFH are identified, described and mapped to define the areas (waters and substrate) necessary for the spawning, breeding, feeding, and growth to maturity of target fish species. In the case of EFH for managed coral species, it includes any areas where the managed species exist. FMPs for each EFH also require the identification of Habitat Areas of Particular Concern (HAPCs). HAPCs are subsets of EFH that meets one or more of the following four criteria: (i) importance of ecological function provided by the habitat for federally managed species, (ii) area or habitat is sensitive to human induced degradation, (ii) the habitat is stressed by development, (iv) is considered rare. Seamounts, certain submarine canyons and banks, corals and associated habitats meet the criteria as HAPCs because they are especially sensitive to human-induced degradation by fishing and non-fishing activities. Moreover, they provide complex habitat for many species. Each FMP must minimize adverse effects to EFH caused by fishing. Coral areas can be also protected using the deep-sea coral discretionary provision of the MSFCMA. HAPCs and gear restrictions can be adopted via amendments to the relevant FMPs.

ASSESSMENT OF BOTTOM FISHING IMPACTS

According to FAO, the fishing fleet of the USA is quite diverse in terms of sizes and gear types varying significantly among fisheries as well as among geographic areas. Since 2011, U.S. total capture production has been quite stable despite catch fluctuations of the two main species (Alaska pollock and Gulf menhaden). Main bottom fisheries are as follows: Pacific trawl fish; Atlantic and Pacific halibut; North Atlantic trawl fish; Sablefish; Clams; Crabs; Lobsters; Scallops; Shrimps and Squids. A wide range of bottom fishing gears are used along the U.S. waters (e.g. bottom trawls, bottom gillnets, bottom longlines, dredges, pots, traps, etc.). Impacts from bottom trawl fishing are the principal matter of concern, particularly in Alaska, West coast and Northeast regions. According to NOAA Fisheries, some fishing gears have minimal impacts on bottom habitats (e.g. pots are less damaging than mobile gear, as they are stationary and contact a much smaller area of the seafloor) or rarely contacts the ocean floor (e.g. mid-water trawl). Some resources (e.g. flounders) are mainly harvested over sand and or mud habitats, more resilient to trawling than corals. In other cases, gears used (e.g. bottom trawls, dredges) have negative impacts to marine habitats. Management measures to protect sensitive habitats (e.g. deep-water corals, sponges and canyons) affected by some types of bottom gears have been implemented (e.g. area closures, gear restrictions, gear modifications), as well as measures to minimize bycatch (e.g. closed areas, bycatch excluder devices, certified reducer devices, gear modifications such as raised-footrope trawls, etc.). In many fisheries (e.g. Alaska), regulations are in place to limit the amount of incidentally caught and discarded fish. In the West Coast fisheries, the catch shares program creates incentives to reduce bycatch. In Florida, programs have been developed to removing lost and abandoned traps. The approach adopted in the U.S. to address bottom fishing impacts within national jurisdiction, is focused on the identification, designation and protection of sensitive fish habitats, rather than assessing the significant adverse impacts of bottom fisheries on VMEs, as the VME terminology is not usually used in the U.S. jurisdiction.

MAPPING OF SENSITIVE SPECIES AND HABITATS

The NOAA Office of Ocean Exploration and Research (OER) is the only federal program in the USA, dedicated to exploring the deep ocean. Created in 2001, the program mapped and explored canyons, seamounts, coral communities, seeps, vents, volcanoes and other sensitive habitats. OER is a key partner for the DSCRTP. As the major NOAA funder of deep-sea exploration and research, OER's is central to the DSCRTP mission. As a management-oriented research program, the DSCRTP complements OER's work and links it to managers' needs. The DSCRTP, which began operations in 2009, addresses fishing and other threats to deep-sea corals and sponges with the NOAA Deep-Sea Coral Data Portal. It supports new research and preserves existing information. The Portal provides access to NOAA's National Database for Deep-Sea Corals and Sponges, which contains data, images, and technical reports from research funded by the DSCRTP and its partners. The portal includes a digital map displaying more than 500,000 records and predictive habitat suitability models that allow some extrapolation to unsurveyed areas. The Database has resulted in the first comprehensive maps of coral and sponge presence. Moreover, updated maps of deep-sea coral and sponge taxa locations by U.S. region are included in the last DSCRTP biennial report to Congress. Additionally, the NOAA EFH mapper provides an interactive platform for viewing data and spatial boundaries of EFH. In 2017, a report summarizing the state of deep-sea coral and sponge ecosystems in the U.S. waters was presented by NOAA, including updated information on mapping efforts conducted in each U.S. region. In the case of Alaska and the West coast, the most comprehensive picture of deep-sea coral and sponge presence comes from bycatch in NOAA annual scientific trawl surveys and from commercial fisheries bycatch records collected by NOAA fishery observers. Moreover, NOAA collaborates with the Bureau of Ocean Energy Management (BOEM) and the U.S. Geological Survey (USGS) in the location and characterization of deep-sea coral, sponge, and chemosynthetic communities.

IMPACT MITIGATION AND PROTECTION MEASURES

The U.S. EEZ is very large area, containing more than 4 million square nautical miles of ocean[50]. In the USA, fisheries management is based on FMPs developed by the RFMCs. With regards with VMEs, RFMCs can create: (i) Coral-specific FMPs that regulate harvest of corals or sponges directly, and (ii) FMPs for other species that can lead to protection for corals from unintended fishing impacts. Deep-sea corals or sponges can therefore be protected by identifying connections between commercially or recreationally valuable fishery species and deep-sea coral or sponge habitats. In 2006, the MSFCMA, was amended to explicitly allow protection of deep-sea corals in their own right, even if its benefit to managed fish species is not known. The Deep-sea Coral Discretionary Authority allows RFMCs to adopt measures (e.g. restrict or prohibit fishing or fishing gear) to protect areas with deep-sea corals identified by NOAA's DSCRTP. In addition, there are other protection mechanisms available to RFMCs, such as federally managed National Marine Sanctuaries, U.S. Fish and Wildlife Refuges, and Marine National Monuments, that can provide protection for deep-sea

[50] https://www.fisheries.noaa.gov/insight/understanding-fisheries-management-united-states

coral and sponge habitats. Boundaries of deep-sea Sanctuaries and Monuments are accessible on the NOAA Deep-Sea Coral Data Portal and the National Marine Sanctuaries System. Moreover, federal and state Marine Protected Areas (MPAs), have been established. Boundary and classification information of MPAs are available from the NOAA's MPA Inventory geospatial database. The Pacific Islands region has the highest proportion of waters in MPAs (52%) while Alaska has the lowest (<1%), and 54% of deep-sea coral habitats (based on their current extent mapped) are contained within an MPA. RFMCs have protected between 0.8 percent to 100 percent of their regions. Since 1980s, implementation of protection evolved differently in the different RFMCs regions. In 2020, the 76% of the overall U.S. EEZ seaflor was protected from trawling. Additional information regarding the protection measures in place within the different RFMCs regions can also be found in the NOAA website.

MONITORING OF VME IMPACTS

The National Database for Deep-Sea Corals and Sponges, under the DSCRTP, displays known deep-sea coral and sponge locations submitted by researchers located across the USA and internationally. The principal sampling method used are ROVs, following by submersibles and trawls. The DSCRTP complements the federal research program focused on deep ocean exploration (OER), working closely with the RFMCs. NOAA fishery surveys and observers are also important for VME monitoring. Identification guides for deep-sea corals and sponges are available for some regions. Since 2008, NOAA submits biennial reports to the U.S. Congress summarizing the DSCRTP results on identification, monitoring and protection of deep-sea corals: (i) in the North Pacific Region there are hot-spots of coral density or bycatch. Despite the extensive EFH protections, high levels of coral bycatch are reported from fisheries in some areas; (ii) within the Western Pacific Region (U.S. Pacific Islands), seafloor-contact trawls, longlines, and gillnets are prohibited since 1983. Thus, there is little potential to impacts; (iii) The portion of federal waters of the Pacific Region off Washington, Oregon, and California that is protected from seafloor trawling nearly doubled in January 2020. Protection areas addressed most of the sites identified for relatively high coral bycatch. Data from the West Coast Groundfish Observer Program revealed coral bycatch in the trawl fishery; (iv) Since 2015, both the New England and Mid-Atlantic RFMCs have protect deep-sea coral habitat (canyons and deep slopes). Documented areas of dense coral gardens still remain unprotected from bottom fishing; (v) Since the 1980s, a number of areas have been closed to seafloor-contact fishing to protect deep-sea coral habitats in the South Atlantic and Caribbean Regions. Research on deep-sea habitats in the U.S. Caribbean to date is limited, and locations of deep-sea corals are not well-known. Risks to these habitats from fishing are likely low, as fishermen do not use the most damaging bottom fishing gears; (vi) Many areas approved for seafloor protections in the Gulf of Mexico Region had been identified as vulnerable deep-sea coral habitat. There are areas that continue to have high potential for interaction with fishing gear (deep-water coral habitats and mesophotic and shelf-edge banks). With regards to monitoring of impacts of activities other than fishing on VMEs, the BOEM’s Environmental Studies Program develops, funds, and manages scientific research specifically to inform policy decisions on the development of energy and mineral resources on the U.S. Outer Continental Shelf.

Case Study 2 - CANADA

Detailed data and information collected on key topics are available in the CANADA individual report (see Annex 1). The assessment was based on such data. Annex 2 presents a summary of the score justification, main gaps, comments and some relevant sources of information. According to the available information, Canada has directly addressed all DSF/VME key topics and all of them are considered to be mostly implemented or close to being fully implemented (Figure 3 and Annex 2). Some gaps were identified (Annex 2):

- Bottom footprint maps/fishing effort distribution maps are available only for certain regions (e.g. Maritimes, Scotian Shelf).
- DFO website/online maps could be more user friendly.
- Lists of corals and sponges are available, but no specific lists of VME species/VME features were found.
- A lower level of sponge protection in domestic waters, compared to NAFO Regulatory Area: With the exception of *Vazella pourtalesii* in a small area of the Scotian shelf, sponges are not currently protected by Canadian closures within NAFO Divisions 3LNO.
- Offshore oil and gas activities regulated by Canada in the high seas have increased in recent years, including drilling activities within closed areas established by NAFO to protect VMEs.
- Information on assessment and monitoring of impacts on VMEs from offshore oil and gas activities/mitigation measures is scarce or difficult to obtain.

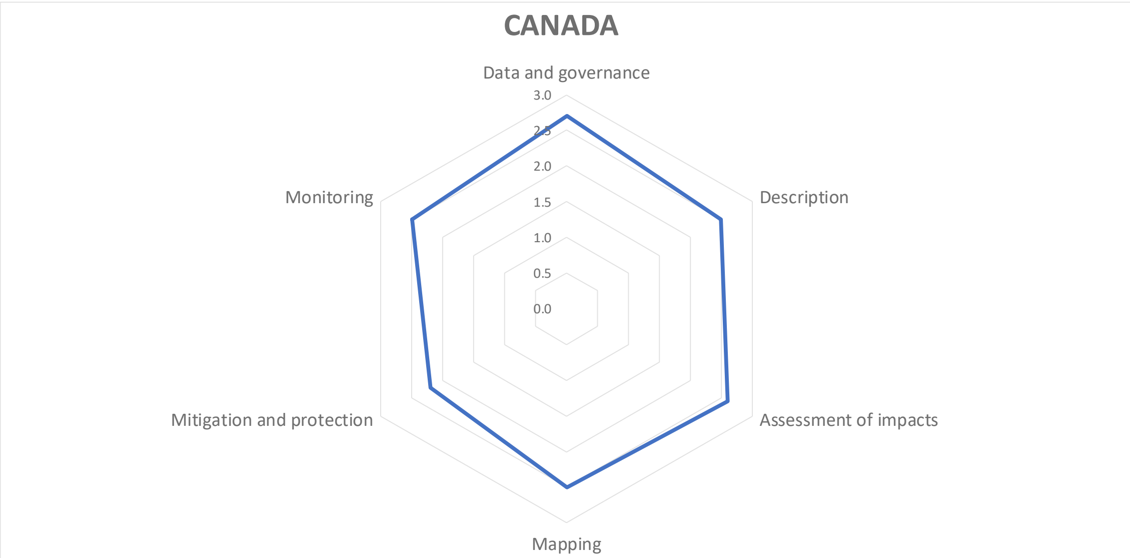

Figure 3. Case Study 2 – CANADA: Summary of the implementation of the DSF/VME key topics (3: Fully; 2.5: Mostly (in progress) mostly/fully; 2: Mostly or partially in progress; 1: Partially or developing; 0: No evidence).

DATA AVAILABILITY AND GOVERNANCE FRAMEWORKS

Fisheries in Canada are managed by Fisheries and Oceans Canada (DFO), a federal institution responsible for both domestic and international commercial fisheries (among other things), including DSF (www.dfo-mpo.gc.ca). It is organised into seven administrative regions. One of the international priorities is stated as protecting "…vulnerable marine ecosystems beyond our national waters, including seamounts and deep-sea/cold-water corals". It is made up of a number of branches, including a Science Branch that provides information to the Oceans Management Branch to help manage various aspects of their fisheries, including DSF. Regulations under which Canada's fleet operate can be found on their web site, most relevant to this study includes the Fisheries Act and Oceans act which outline the requirements for sustainable fisheries and marine protected areas respectively. The DFO also work closely with a number of RFMOs, most relevant for this study are NAFO and NPFC which manage DSFs in waters to the east and west of Canada. In 2012 the Royal Society of Canada (RSC) assessed the challenges faced by Canada in achieving sustainable fisheries and concluded that it fell behind other countries in its international obligations to sustain biodiversity. As a result of this it formed a committee to track development regarding marine biodiversity policies, identify challenges and lead implementation options.

DESCRIPTION OF SENSITIVE SPECIES AND HABITATS

Many studies have provided species richness and diversity estimates of VME taxa in Canada. A Canadian Science Advisory Secretariat (CSAS) meeting was held in 2010 to identify Sensitive Benthic Areas (SeBAs)[51] (corals and sponges) in Canadian waters. Significant concentrations of corals and sponges were identified in various locations of Eastern Canada. In NAFO waters, VMEs were identified from the broader distribution of the VME indicator taxa in the study area. In the Canadian northeast Pacific Ocean the environmental niche space and distributions of cold-water corals and sponges were modelled. Approaches for identifying VMEs are based on analysis of catches, direct analysis of visual data from cameras, and predictions from species distribution modelling (SDMs). As an example, NAFO has previously analyzed research survey catch data to identify areas with significant concentrations of VME indicators. For the NPFC, Annex 2 of CMM2019-05 and CMM2019-06 specifically identifies biological samples, visual data, and "other information that is relevant to inferring the likely presence of VMEs" to be used in defining VMEs. No specific definitions for VMEs are provided by DFO, they refer to cold water corals and sponges. The only definitions are provided by NAFO and NPFC. Although the processes towards protecting cold-water coral and/or sponge-dominated habitats have advanced differently in DFO and NAFO, the fundamental ecological features and key definitions are consistent across jurisdictions. With respect to cold-water coral and sponge-dominated habitats, the concepts of Significant Benthic Areas[52] (SiBAs) and VME are equivalents. Similarly, the notion of Serious or Irreversible Harm (SIH) used by DFO is analogous to Significant Adverse Impact (SAI) used by NAFO. Also, the functional groups used to define SiBAs and VMEs are consistent between DFO and NAFO. This consistency in principles and approaches provides a robust basis for coherent management practices at functional ecosystem scales, irrespective of legal boundaries, as well as cross applications and inferences from analyses done in both jurisdictions.

ASSESSMENT OF BOTTOM FISHING IMPACTS

In Canada, the main bottom fisheries in the Pacific are the following:

(i) Pacific and Yukon commercial fisheries. The management is integrated, according to a management plan, subject to 100% monitoring, individual

[51] Sensitive Benthic Area (SeBA) is defined as an area that is vulnerable to a proposed or ongoing fishing activity. SeBAs (not to be confused with SiBAs) are defined based on their exposure to fishing activities. Vulnerability is determined based on the level of harm that the fishing activity may have on the benthic area by degrading ecosystem functions or impairing productivity and is not addressed herein.

[52] With respect to coldwater corals and/or sponges, a Significant Benthic Area (SiBA) is a regional habitat that contains sponges (Porifera), large and small gorgonians (Alcyonacea, formerly classed as Gorgonacea) and/or sea pens (Pennatulacea) as a dominant and defining feature. These habitats are structurally complex, characterized by higher diversities and/or different benthic communities, and provide a platform for ecosystem functions/processes closely linked to these characteristics.

vessel accountability for all catch, individual transferable quotas (ITQ), and reallocation of quotas. There are approximately 250 active vessels;

(ii) Rockfish (37 species caught off the coast of British Columbia). Inshore rockfish are usually caught with hook and line gear in rocky reef habitats. Rockfish conservation strategy includes catch restrictions, monitoring, stock assessment programs, and Rockfish Conservation Areas (RCAs).

With respect to the Atlantic Ocean, the main bottom fisheries are as follows:

(i) Groundfish species in NAFO Divisions 3Ps. Several species are under moratorium. Fixed gear accounting for 74.4% of the landings. In the offshore fleet, bottom otter trawls are predominant;

(ii) Groundfish in Newfoundland and Labrador region – NAFO Subarea 2 + Divs. 3KLMNO. The fishery is primarily commercial, with recreational and indigenous components. Groundfish is harvested using fixed and mobile gear, with several stocks under moratorium.

The management of the Atlantic fisheries involves Integrated Fisheries Management Plans (IFMPs) and monitoring. Most fleets and fisheries are subject to Enterprise Allocation (EA) or Individual Quota (IQ) management regimes. Most independent surveys focus on identifying VMEs, which will ultimately be used to inform potential bottom fishing impacts. The DFO, Newfoundland Region, has undertaken stratified-random surveys since 1970's. Research vessel bottom trawl surveys are carried out annually for the assessment of fish stocks by Canada and EU/Spain/Portugal (high seas). In the eastern coast of Canada, annual research vessel trawl surveys provided distribution and diversity data to underpin the Coral and Sponge Conservation Strategy. Trawl data was used to delineate concentrations and predict distributions of VMEs applying the NAFO methodology. Most studies in the literature do not attempt to quantify Significant Adverse Impacts (SAI) on VMEs, but rather identify and define VMEs and determine whether the impacts of fishing gear to VMEs they create qualify as a SAI. Thus, actions be taken to prevent these impacts require consideration of six factors identified by FAO, the NPFC and NAFO. DFO carried out a Canadian Science Advisory peer-reviewed science meeting[53] to document the pathways of effect and benthic impact of all non-mobile fishing gear used across Canadian waters. In terms of methods and analysis of SAI assessment on VMEs, preliminary assessments are often undertaken to address (a) the intensity or severity of the impact at the specific site being affected; (b) the spatial extent of the impact relative to the availability of the habitat type affected, and; (c) the sensitivity/vulnerability of the ecosystem to the impact.

MAPPING OF SENSITIVE SPECIES AND HABITATS

While not specific to VMEs, Canada has a programme in place to coordinate cold-water coral and sponge conservation. This is managed by the Centre of Expertise (CoE) in Cold Water Corals and Sponge Reefs, established in 2008 and funded through the DFO. The Pacific Region Cold-water Coral and Sponge Conservation Strategy codifies existing and future activities and management measures for cold-water coral and sponge conservation in western Canadian waters. It helps regional

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[53] A Canadian Science Advisory Secretariat (CSAS) science advisory process to examine the impacts of trawl gears and scallop dredges on benthic habitats, populations and communities was held in March 2006. An additional science advisory process was held in January 2010 to examine the impacts of other fishing gears (excluding bottom trawls and dredges), to assemble available information on their uses and to provide scientifically-based conclusions and advice regarding their potential impacts on marine habitats and biodiversity. This science advisory report contains the conclusions and advice from that meeting. https://www.dfo-mpo.gc.ca/csas-sccs/publications/sar-as/2010/2010_003-eng.htm

partners and stakeholders understand how their existing programs and activities are aligned with other cold-water coral and sponge conservation initiatives in the region. It also aligns with the Department's Sustainable Fisheries Framework and the Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas and includes the Strait of Georgia and Howe Sound Glass Sponge Reef Conservation Areas. The Coral and Sponge Conservation Strategy for Eastern Canada has been developed to outline the current state of knowledge of corals and sponges, to provide the international and national context for coral conservation, and to highlight new and existing research and conservation efforts in eastern Canadian waters. The Strategy identifies conservation, management, and research objectives common to Central and Arctic, Quebec, Gulf, Maritimes Newfoundland and Labrador management regions, consistent with existing legislation and policy through a shared focus on ecosystem-based management. Benthic mapping has also been extensively done to develop a series of MPAs.

Data on corals and sponges in this region has primarily been collected opportunistically from three main data sources: (i) annual DFO multispecies research vessel surveys conducted by the Science Branch; (ii) fisheries observer data, collected onboard commercial fishing vessels operating within Canadian waters; and; (iii) the northern shrimp survey (DFO and industry collaboration).

These mainly rely on trawling and will be prone to bias towards certain types of sea floors. Fisheries observer data will be taken from commercial fishing vessels and biased towards areas considered "good fishing grounds", whereas survey data may be biased towards more "trawlable areas" (i.e. flatter seabeds). Non-intrusive data techniques are also employed including multibeam sonar, video footage and drop cameras, acoustic sub-bottom profiling and dedicated ROV deployments (Fisheries and Oceans Canada, 2015). Data collected from these types of surveys are used to characterise the geological basis on the occurrence of different types of coral habitat, a quantification of the coral and sponge diversity and a comparison between coral and sponge diversity in fished and unfished areas (Fisheries and Oceans Canada, 2015). Examples of this include a number of studies into the distribution of corals off the eastern coast of Canada and the biotic and abiotic features associated with them, using ROVs (e.g. Baker *et al*., 2012[54]).

Within NAFO Canada conduct an annual multi-species trawl survey within a VME closed area. Canada operates an at sea observer programme funded through the fishing industry. They do not specifically collect VME data, except when operating within an RFMO, but they do collect data on benthic bycatch. DFO, in collaboration with university, NGO and industry partners began collecting information on corals and sponges in 1998 to map out their distributions in the Maritimes. Maps of the location of significant concentrations of corals and sponges on the east coast of Canada, were produced by the DFO through quantitative analyses of research vessel trawl survey data, supplemented with other data sources where available. Sponge reef areas of the Pacific Region are available, derived from sponge data mapped by Natural Resources Canada (NRCan) and DFO. Canada does not recognize VMEs as such within its waters but instead cold-water corals and sponges. The extent of VMEs encountered by Canada within NAFO and NPFC are mapped out by the RFMO.

[54] Baker, K.D., Wareham, V.E., Snelgrove, P.V.R., Haedrick, R.l., Fifield, D.A., Edinger, E.N., and Gilkinson, K.D. (2012). Distributional patterns of deep sea coral assemblages in three submarine canyons off Newfoundland, Canada. Marine Ecology Progress Series, 445: 235-249.

IMPACT MITIGATION AND PROTECTION MEASURES

Canada[55] has an EEZ of 5,599,077 km^2, divided into thirteen bioregions and a number of Ecologically and Biologically Significant Areas. In addition, there are 34 marine refuges[56] in place (just under 5% of the EEZ area). The DFO set a goal of protecting 30% of Canada's marine and coastal areas by 2030. By the end of 2020 they had reached 13.8%. VME closures are in place in the NAFO and NPFC RFMO areas. Within Canadian waters, DFO has a policy in place for identifying and managing the impacts from fishing on SeBAs contained within their Sustainable Fisheries Framework (SFF). SeBAs are considered to be other Effective Area-Based Conservation Measures (OEABCM), or area-based measures other than MPAs, that are put in place to protect areas that meet certain criteria. SeBAs are established through first identifying SiBAs, while these are defined as VMEs, they are areas that would be considered intrinsically sensitive to fishing impacts, made up of sponges and corals, assessed using criteria based on the FAO guidelines. Areas within a SiBA likely to be exposed to proposed or ongoing fishing activities are identified as SeBAs. The criteria to identify a SiBA are taken from a number of different frameworks and cover species, habitats and communities. They are those defined under VMEs, EBSAs, Ecologically Significant Species and Significant Ecosystem Components. There are 14 MPAs designated by DFO within the Canadian EEZ (just over 6% of the EEZ). These are designated under the Oceans Act. In addition, there are a further three National Marine Conservation Areas established by the Parks Canada Agency under the National Marine Conservation Areas Act and a further one established by Environment and Climate Change Canada under the Canada Wildlife Act. An interactive map of Canada's marine protected and conserved areas, including MPAs and marine refuges, is available on-line[57]. Marine refuges and MPAs across Canadian waters protect cold-water corals and sponges, sponge reefs, seamounts, hydrothermal vents and the ecosystems they support. With the Canadian EEZ an Ecological Risk Assessment Framework (ERAF) for corals and sponges was developed under the SeBA policy by the DFO. This is a process for identifying both the level of risk associated with fishing activity and the actual impacts of different types of fishing activity on SeBas. It provides guidance on how to conduct a risk assessment for sponges and corals based on determining the risk of exposure to fishing. This is then used to provide management advice to avoid SIH to cold water coral and sponge communities. In terms of mitigation of impacts on sponges, with the exception of *Vazella pourtalesi* in a small area of the Scotian shelf, sponges are not currently protected by Canadian closures in NAFO Divisions 3LNO. This means a lower level of protection for sponges in domestic waters, compared to the greater protection that exists in international waters. In addition, there are offshore oil and gas activities (regulated by Canada), which appear to have significant spatial overlap with bottom fisheries, NAFO closures and VMEs, and have the potential to impact fisheries resources and ecosystems. These activities have increased in recent years, including drilling activities in closed areas established by NAFO to protect VMEs.

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[55] Canada's full ocean estate extend beyond 200 nm to encompass the extended continental shelf (7.1 million km^2).

[56] Fisheries area closures that meet *"other effective area-based conservation measures"* criteria are known as marine refuges. Marine refuges help protect important species and their habitats, including unique and significant aggregations of corals and sponges. They have specific conservation objectives and fishing gear restrictions. See: https://www.dfo-mpo.gc.ca/oceans/conservation/areas-zones/index-eng.html

[57] https://www.dfo-mpo.gc.ca/oceans/oecm-amcepz/refuges/index-eng.html

MONITORING OF VME IMPACTS

There is a monitoring program in place in Canada for all the 14 designating MPAs with fisheries independent surveys being conducted on a regular basis. Some of the MPAs where VMEs are thought to occur are very remote making monitoring and enforcement difficult. Funding is available though the Government as a step towards it meeting its commitments to protect 30% of Canada's oceans by 2030. The Ocean Networks Canada (ONC) and DFO have collaborated in developing remote tools for monitoring deep sea hydrothermal vents, including submersibles and permanent observatories. Underwater video and still images have been used to gather information on seamounts off eastern Canada. Data are also available in some areas from trawl surveys. Monitoring of VMEs (SiBAs) is ongoing and with regards to fisheries the impacts are monitored through the ERAF process. Within NAFO and NPFC, data on VME encounters are collected by vessels and observers. The Fish and Habitat Protection Program (FFHPP), under the DFO, was set up to conserve and protect fisheries and their aquatic ecosystems. It does this through ensuring the Fisheries Protection Program (FPP) which administers the fisheries protection provisions of the Fisheries Act, specifically an activity that may lead to "the death of a fish or any permanent alteration to, or destruction of, fish habitat". The FPP is also responsible for administering certain provisions of the Species at Risk Act and as such has responsibilities under federal environmental assessment regimes under the Canadian Environmental Assessment Act, 2012. Through this the FPP will review any proposed activity that may affect fish populations or their habitats to ensure compliance with the relevant Acts, including offshore activities such as drilling. Between 2015 and 2016 a total of 556 projects were monitored.

Case Study 3 - ARGENTINA

Detailed data and information collected on key topics are available in the individual report (see Annex 1). The assessment was based on such data. Annex 2 presents a summary of the score justification, main gaps, comments and some relevant sources of information. According to the available information, Argentina is directly addressing all key DSF/VME issues. The topic "data availability and governance framework" is considered to be mostly implemented. In this regard, a Bill on the implementation of a "strict benthic MPA" in the high seas ("Agujero Azul") is currently under discussion[58]. This is a controversial MPA, as it will cover an area of the seabed of the continental shelf, outside the EEZ, which does not affect the water column. The remaining topics are considered to be partially in progress, with several aspects mostly in progress (Figure 4 and Annex 2). Some gaps were identified (Annex 2):

- Websites/online maps could be more user friendly.
- Information on routine monitoring of VMEs was only found for certain fisheries/areas.
- A general map of the Argentine historic fishery footprint was not found. There is very little information on fishing effort in the high seas of the Patagonian Shelf (the principal source of information comes mainly from the data provided by the Spanish fleet).

[58] At the date of preparation of this report, the Bill was under review: Parliamentary processing had stalled in 2021, but the bill was subsequently debated in the Extraordinary Sessions of Congress. On July 6, 2022, the bill was finally approved by the Chamber of Deputies (https://www.hcdn.gob.ar/proyectos/proyecto.jsp?exp=5893-D-2020) and sent to the Senate for discussion (https://www.senado.gob.ar/parlamentario/Agenda/AgendaWeb/27,10,2022).

- Specific data and information on the assessment of the potential impacts of oil and gas activities on fisheries and ecosystems as well as mitigation measures are difficult to obtain.
- Specific lists of VME indicator species/features were not found.
- Regarding EEZ, no maps of VMEs other than corals were found.

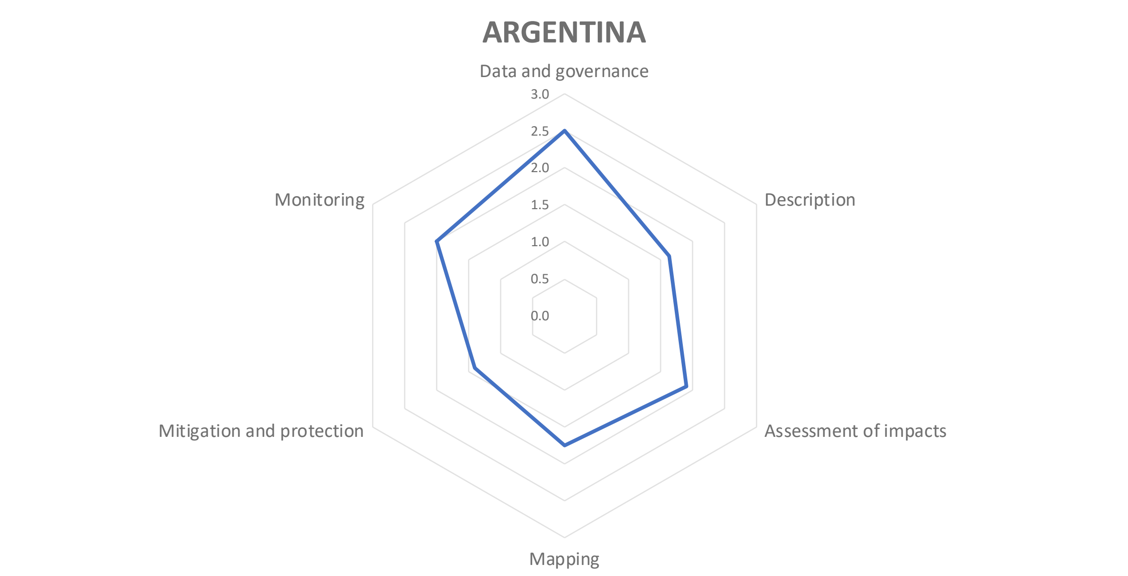

Figure 4. Case Study 3 – ARGENTINA: Summary of the implementation of the DSF/VME key topics (3: Fully; 2.5: Mostly (in progress) mostly/fully; 2: Mostly or partially in progress; 1: Partially or developing; 0: No evidence).

DATA AVAILABILITY AND GOVERNANCE FRAMEWORKS

The web sites from the Ministry of Agriculture, Livestock and Fisheries (MAGYP) (https://www.magyp.gob.ar/sitio/areas/pesca_maritima), Consejo Federal Pesquero (CFP) (https://cfp.gob.ar) and the Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP) (www.argentina.gob.ar/inidep) provide information on fisheries management and research in Argentina. The CFP is the management body that defines the national fishing and fisheries research policies, and the planning of fishing development. It is the main regulator of maritime fishing activity at national level, with a strong federal character. It was created by the Federal Fisheries Regime under the Ley Federal de Pesca Nº 24.922 (1977), as the primary law regarding research, conservation and administration of the marine living resources, including the implementation of a fishing regime. The INIDEP is the advisory body of the Government, responsible of the scientific research on marine living resources, including the assessment and development of fisheries and ecosystem conservation. In addition, the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET) is the main organization dedicated to the promotion of science and technology in Argentina (www.conicet.gov.ar), including marine research (e.g. oceanography marine geology and marine biodiversity). The VMS System makes it possible to visualise the position of fishing vessels operating in real time, through the website of the MAGYP. It has been used mainly for control and surveillance. It is now also used to map the landings of the various fleets[59] as well as the fishing activity in the areas available for oil exploration[60]. Moreover, as a part of the State policy oriented towards

[59] MAGYP (2020) Informe DPP Nº 16/2020 – Desembarques de la flota comercial argentina (2006-2019). 46pp.
[60] MAGYP (2022) Informe DPP Nº 02/2022 – Actividad de la flota comercial argentina, Cuenca Norte y Austral (2017-2020)

the Argentina sea, the Government created the "Iniciativa Pampa Azul" (www.pampazul.gob.ar). This is an interministerial initiative that articulates scientific research, technological development and innovation actions to provide scientific bases for national ocean policies (including strengthening of national sovereignty over the sea, strengthening of industries linked to the sea, economic development of the Argentina maritime regions, conservation and sustainability and implementation of MPAs). Regarding offshore oil and gas activities in the Argentine continental shelf, the competent environmental authorities are the Ministry of Environment and Sustainable Development, responsible for processing the Environmental Assessment (Ley n° 25.675 General del Ambiente) and issuing the Environmental Impact Statements of the oil and gas projects, and the Secretariat of Energy, in charge of controlling and supervising compliance with the Environmental Impact Statement and its corresponding Environmental Management Plan. In addition, some spatial information and maps of oil and gas activities are publicly available from the website of the Ministry of Economy, but specific data and information on the assessment of the potential impacts of such activities on fisheries and ecosystems as well as mitigation measures are scarce or difficult to obtain.

DESCRIPTION OF SENSITIVE SPECIES AND HABITATS

In the Patagonian shelf, Argentina has carried out samplings of epifaunal benthic communities. Both the outer continental margin and the Argentine continental slope contain deep submarine canyons with presence of VMEs. Spain carried out a series of research deep-water surveys in international waters (up to 1500 m deep) to identify VMEs and the interactions with bottom fisheries in the high seas. The inventory of benthic species of the Burdwood Bank MPA and the Namuncurá MPA was updated from the Argentine research surveys carried out in 2013. In the South Georgia Islands, information on benthic organisms was obtained from research surveys carried out on board the *RV Dr. Eduardo L. Holmberg* during 1994 and 2013, organized jointly by the INIDEP and the Argentine Antarctic Institute (IAA). VMEs were identified based on the analysis of material collected in the area during 2013[61]. During the surveys in the Shetland Islands as well as in the Antarctic Peninsula and Orkney Islands carried out from 2012 to 2014 on board the *RV Puerto Deseado* (CONICET), studies of the benthic communities were carried out based on data collected with bottom trawls and dredges. The characterization showed a predominance of corals, sponges and echinoderms in the studied sites.

ASSESSMENT OF BOTTOM FISHING IMPACTS

Fishing in Argentina is carried out almost entirely with bottom fishing gears, particularly trawls. Only a few species of pelagic fish are caught with midwater nets or purse seines, but they do not represent more than 3% of the annual catches. Other species are captured with specific fishing gear (jigs for squid, which can represent between 9% and 34% of the catches, depending on the year). Argentina's fisheries regulations related to the protection of resources and ecosystems include the Federal Fisheries Act; Regulation of Catches; Restrictions on access to fishing grounds through the establishment of temporary and spatial closures; Other measures and Non-target species measures. The Federal Fishing Regime established by Law Nº 24.922 (1997), has determined the institutions which are in charge of

[61] The characterization of an area as a VME was based on the determination of density values of Indicator Taxa greater than 10 kg every 1,200 m^2, according to the method suggested by Lockhart and Jones. Lockhart, S.J. & Jones, C.D. 2009. Detection of Vulnerable Marine Ecosystems in the southern Scotia Arc (CCAMLR Subareas 48.1 and 48.2) through research bottom trawl sampling and underwater imagery. Document CCRVMA WG-EMM-09/32.

generating policies, establishing regulations and ensuring compliance, as well as authorising access to fishing grounds and distributing resources, making the maximum development of fishing activity compatible with the rational use of its living resources. The emphasis on the federal character of the law comes from the extension of the jurisdiction of the Provinces with a maritime coastline over the territorial sea adjacent to their coasts, in line with the jurisdiction of the Nation beyond the first twelve nautical miles, within the framework established by the law, as well as the legal design of the Federal Fisheries Council (CFP). Additionally, Article 18 of the LFP establishes that the CFP will define annually the Maximum Allowable Catch (MAC) per species, based on the recommendations of INIDEP. It also establishes the annual catch quotas per vessel, per species, per fishing zone and per fleet type. Moreover, the establishment of closed areas or seasons corresponds to the CFP under the advice and recommendations of INIDEP, since it is the body whose purpose is the formulation and execution of pure and applied research programmes relating to fishing resources and their rational exploitation throughout the national territory in accordance with the fishing research policies to be formulated by the CFP itself. In addition, since 2008, Argentina has had a "National Action Plan to prevent, deter and eliminate illegal, unreported and unregulated fishing". Regarding non-target species, following the principles of the FAO Code of Conduct for Responsible Fisheries, the CFP has approved four National Plans of Action ("Planes de Acción Nacional"- PAN) to reduce interactions with Sharks, Birds, Mammals and Marine Turtles.

MAPPING OF SENSITIVE SPECIES AND HABITATS

According to Pearman *et al*., (2022)[62] the Southwest Atlantic deep sea is an undersampled region that hosts unique and globally important faunal assemblages. To date, our knowledge of these assemblages has been predominantly based on ex situ analysis of scientific trawl and fisheries bycatch specimens, limiting our ability to characterise faunal assemblages. Incidental sampling and fisheries bycatch data indicate that the Falkland Islands deep sea hosts a diversity of fauna, including vulnerable marine ecosystem (VME) indicator taxa. Benthic imagery of the Falkland Islands conservation zones (FCZs) in 2014, was annotated, with epibenthic megafauna and substrata recorded. A suite of terrain derivatives was also calculated from GEBCO bathymetry and oceanographic variables extracted from global models. Three main faunal assemblages representing two different sea pen and cup coral assemblages, and an assemblage characterised by sponges and Stylasteridae, were identified. The fauna observed are consistent with that recorded for the wider southern Patagonian Slope. Several faunal assemblages had attributes of VMEs. Faunal assemblages appear to be influenced by the interaction between topography and the Falkland Current, which, in turn, likely influences substrata and food availability. The map of corals recorded on the Argentine continental shelf, indicating the regions where high densities have been recorded (corresponding to VMEs) is available[63]. Furthermore, Spain carried out a series of surveys within the Argentine continental slope up to 1500 m depth to identify VMEs and possible interactions with fisheries in international waters in the Southwest Atlantic, following the

[62] Pearman, T.R.R.; Brewin, P.E.; Baylis, A.M.M.; Brickle, P. (2022). Deep-Sea Epibenthic Megafaunal Assemblages of the Falkland Islands, Southwest Atlantic. Diversity, 14, 637. https://doi.org/10.3390/d14080637

[63] Allega, L., Braverman, M.S., Cabreira, A.G., Campodónico, S., Colonello, J.H. et al. (2020) Estado del conocimiento biológico pesquero de los principales recursos vivos y su ambiente, con relación a la exploración hidrocarburífera en la Zona Económica Exclusiva Argentina y adyacencias. Mar del Plata Instituto Nacional de Investigación y Desarrollo INIDEP. 119p.

recommendations of the United Nations (UNGA Resolutions 59/25[64] and 61/105[65]) and the International Guidelines for the Management of Deep-Sea Fisheries in the High Seas (FAO, 2008[66]) , cold-water coral reefs were detected in this region, gardens of soft corals with a large amount of associated fauna, and fields or aggregates of sponges in deep waters that are formed mainly by porifera of two classes: Cl. Hexactinellida and Cl. Demospongiae, depth. In deep areas dominated by soft substrate, sea pens (Order Pennatulacea) were recorded.

IMPACT MITIGATION AND PROTECTION MEASURES

Argentina has an EEZ of 1,530,500 km^2 and a coastline of 6,816 km. The sector of the Argentine Continental Shelf (ACS) waters in which fishing activities are carried out has an approximate surface area of 930,000 km^2. Argentina, through the National Biodiversity Strategy and Action Plan 2015-2020, set a target of 10% protection coverage of marine and coastal areas within its maritime spaces by 2020, in accordance with Target 11 of the Strategic Plans for Biodiversity 2011-2020, adopted in 2010. There are currently 61 Coastal Marine Protected Areas (APCM) in Argentina. 26 of them include in their boundaries marine protected areas[67]. Most of them are very small (median 89 km^2) and were created as isolated and independent units, according to particular characteristics of the coast and biota that were considered unique and therefore worthy of protection. Of these, there are 21 provincial areas that protect approximately 11,500 km^2 of marine spaces within 12 miles of the Territorial Sea. Likewise, three Interjurisdictional Parks (Southern Patagonia, Isla Pingüino and Makenke) add up to approximately 3,000 km^2 of marine spaces also within the 12 nautical miles. The last of these to be incorporated is the Patagonia Azul Biosphere Reserve, which is a large area (totalling some 27,000 km^2) including 15,000 km^2 of marine area off the coast of the Province of Chubut. Moreover, there are currently three exclusively oceanic Marine Protected Areas in the Argentinean Sea. The first of these, called Namuncurá-Bank Burdwood, was created in 2013. It contributes some 28,000 km^2 to the National System of Marine Protected Areas and comprises the water column and benthic space of the underwater plateau known as Burdwood Bank, delimited by the 200-metre isobath. In 2013, the initiative called "Faros del Mar Patagónico" (FMP) was developed, consisting of an international network of NGOs created to coordinate the joint work of civil society organisations. In this initiative, a number of marine areas were identified as relevant for biodiversity conservation, particularly for endemic or threatened species. As a result of the debate in various organised workshops as part of the initiative, six areas of interest were selected to integrate the National System of Marine Protected Areas. A Bill is currently under consideration[68] that contemplates the creation of a new Benthic National Marine Reserve "Agujero Azul" which, if approved, would be the largest MPA (164,000 km^2) in the country and one of the pioneering cases in the world of the creation of this type of tool for the protection of the benthic environment. This is a very controversial measure as it covers an area of the Argentine continental shelf, in

[64] Resolución AGNU 59/25 de 17 de noviembre de 2004
[65] Resolución AGNU 61/105 de 8 de diciembre de 2006.
[66] FAO, 2008. Consulta técnica sobre las directrices Internacionales para la ordenación de las Pesquerías de aguas profundas en alta mar. Roma (Italia), 4-8 de febrero de 2008. TC: DSF/2008/Inf.3. 33pp
[67] https://www.argentina.gob.ar/sites/default/files/ambiente-sistema-nacional-areas-marinas-protegidas.pdf
[68] In July 2022, the proposal was approved by the Chamber of Deputies. In October 2022, the Senate session in which the bill was scheduled to be debated was suspended. According to the Argentine legislative system, in order to become a law of the Nation, the bill must be discussed and approved by the Senate during 2023, otherwise, it would lose parliamentary status. In this regard, in April 2023, civil society organizations urged the Senate to approve the Agujero Azul benthic MPA. https://drive.google.com/file/d/1T4V9Chr_yUa4joKoDQTCEYXS9lgAJbvd/view

international waters outside the EEZ. This MPA is located in the high seas, but will not affect the water column.

MONITORING OF VME IMPACTS

No information was found on current scientific monitoring surveys to help minimize impacts on VMEs. Data on benthic species was obtained from commercial fishing activity (e.g. scallop and prawn fisheries), collected by onboard scientific observers, as well as from research surveys (e.g. scallop assessments surveys). The "Pampa Azul" initiative has several objectives related to long-term monitoring of ecosystems and habitats[69]: (i) Characterize and evaluate the conservation status of biodiversity and ecosystems in priority geographic areas; (ii) Identify and characterize the distribution of VMEs in the Argentinean Sea; (iii) Identify those habitats essential for the life cycles of species of priority conservation interest; and (iv) Design a national system of indicators for monitoring biodiversity and socio-ecological systems.

[69] https://www.pampazul.gob.ar/redes-de-observacion/

Case Study 4 - AUSTRALIA

Detailed data and information collected on key topics are available in the individual report (see Annex 1). The assessment was based on such data. Annex 2 presents a summary of the score justification, main gaps, comments and some relevant sources of information. According to the available information, Australia has directly addressed all of DSF/VME key topics. They are considered to be in progress, mostly implemented or close to being fully implemented (Figure 5 and Annex 2). Some gaps were identified with respect to waters under national jurisdiction, except of Heard and McDonald Islands (HIMI) (Annex 2):

- There are no defined VME indicator species.
- No SAI definition.
- Lack of quantitative data available.
- Difficult to accurately map VMEs.
- There is no routine monitoring of VMEs.

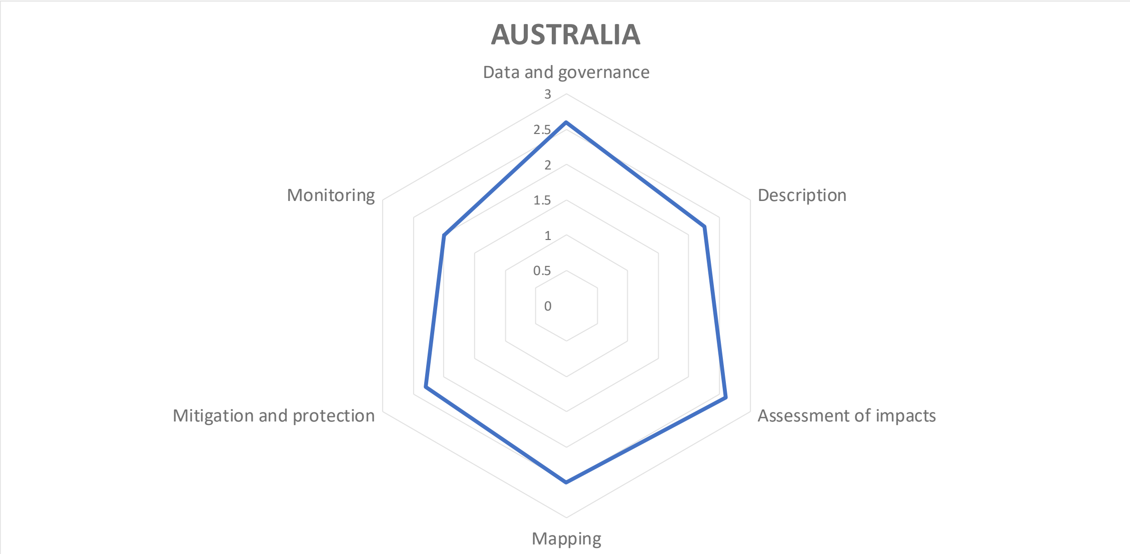

Figure 5. Case Study 4 – AUSTRALIA: Summary of the implementation of the DSF/VME key topics (3: Fully; 2.5: Mostly (in progress) mostly/fully; 2: Mostly or partially in progress; 1: Partially or developing; 0: No evidence).

DATA AVAILABILITY AND GOVERNANCE FRAMEWORKS

In Australia, the Australian Fisheries Management Authority (AFMA) is the Government agency responsible for the efficient and sustainable management of Commonwealth fish resources on behalf of the Australian community. AFMA (www.afma.gov.au) was established under and is governed by the Fisheries Administration Act 1991. Demersal fishing on the high seas by Australian vessels occurs under permits issued by the Australian Fisheries Management Authority (AFMA). High-seas permits allow Australian vessels to fish in high-seas areas outside the Australian Fishing Zone (AFZ), outside the Exclusive Economic Zones (EEZs) of other countries, and within the area of competence of either the SPRFMO or the SIOFA. AFMA has implemented a number of management measures to further promote sustainability of non-highly migratory fish stocks and to prevent significant adverse impacts to vulnerable marine ecosystems in the SPRFMO and SIOFA areas. AFMA, in consultation with the Department of Agriculture, Fisheries and Forestry (DAFF), Australian Bureau of Agricultural & Resource Economics & Sciences

(ABARES), Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) and the Department of Foreign Affairs and Trade, has developed and implemented management measures which respond to national and international commitments. In 2011, Australia completed an assessment (using available data from 1999-2009) to determine whether bottom-fishing activities by Australian vessels in the SPRFMO and SIOFA areas had significant adverse impacts on VMEs. The study concluded that the overall risk of significant adverse impacts on VMEs by Australian bottom trawl and bottom longline operations was low, and the impact caused by midwater trawling and drop-lining was negligible. In 2020, Australia and New Zealand completed a combined and cumulative bottom fishery impact assessment. The Australian Antarctic Division (AAD) leads the Australian Government's scientific programs in Antarctica and is guided by the Australian Antarctic Strategic Plan. Regulations and management of VMEs for areas under Australia's jurisdiction in this region follow the guidelines set out by CCAMLR.

DESCRIPTION OF SENSITIVE SPECIES AND HABITATS

Within waters under national jurisdiction of Australia, with the exception of Heard and McDonald Islands, there are no defined VME indicator species and data on the types and distributions of benthic habitat are generally scarce. Although no indicator species exist, risk assessments for benthic habitats are undertaken using methodology outlined in the Ecological Risk Assessment for the Effects of Fishing (ERAEF). This uses seabed imagery, where available, to classify habitats based on a SGF (sediment, geomorphology and fauna) score and the risk to each habitat then ranked according to a number of attributes. Seabed imagery used in the risk assessments is taken during surveys, for example habitat data for the assessment of the Western Deep-Water Trawl Fishery (WDWTF) otter trawl sub-fishery used data and images collected by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) during a survey in 2005. Where seabed imagery is not available an alternative methodology is used to develop an inferred list of potential habitat types that may be impacted by the fishery. Within each of the RFMOs in which it operates, Australia uses the VME indicator species adopted by the RFMO and used by all members. Research has been undertaken by the RFMOs, through its members, to identify VME taxa in their area of jurisdiction which can be used to inform management such as move-on protocols and spatial closures. This has largely been based on the criteria and species grouped developed by the FAO in their deep-sea fisheries guidelines.

ASSESSMENT OF BOTTOM FISHING IMPACTS

Australia's fishing zone covers over eight million square kilometres, making it the world's third largest. It contains around 3700 known species of fish, over 2800 species of mollusc and over 2300 species of crustaceans. Only a small proportion of these species are commercially fished. The Australian Government generally manages fisheries in waters between three and 200 nautical miles from the Australian coast. This area is referred to as the Australian Fishing Zone. State and territory entities typically manage fisheries out to three nautical miles from the coastline. Nine fisheries are managed solely by the Australian Fisheries Management Authority (AFMA) on behalf of the Australian Government. Seven fisheries are managed jointly by AFMA and regional or international partners (such as Western and Central Pacific Fisheries Commission, Commission for the Conservation of Southern Bluefin Tuna, Indian Ocean Tuna Commission, Commission for the Conservation of Antarctic Marine Living Resources, Norfolk Island Regional Council, etc). AFMA carries out Ecological Risk Assessments (ERA) for all of its major fisheries. The impact of bottom trawls on bycatch species and habitats has been assessed as part of the ERA. AFMA mitigates, or reduces, that impact through its ecological risk management (ERM) strategy. The ERM details a number of management arrangements and strategies which aim to reduce the impact of fishing on the environment, including minimum mesh sizes for otter board trawls to reduce the catch of small and juvenile fish, mitigation devices to reduce interactions with threatened, endangered and protected species and spatial closures to protect vulnerable species and habitats. AFMA reports annually on the rate of fishing gear interactions with protected species to the Department of the Environment.

MAPPING OF SENSITIVE SPECIES AND HABITATS

Since 1998, Australia, conducts stratified trawl surveys on an annual basis around Heard Island and McDonald Islands (CCAMLR Division 58.5.2). Although the primary aim is to collect data for stock assessments (abundance and biology of fish), invertebrate biodiversity and by-catch species data are also collected. Survey data and predictive modelling were used to map the distribution of seabed invertebrates (benthos) in nine regions around Australia, as part of a study into the impacts of trawling on seabed fauna (Mazor *et al*., 2017)[70]. There is a data sharing arrangement between Australia and France to conduct complementary research on the Kerguelen Plateau, including data on the ecosystem as a whole. All fishing areas within the Australian EEZ have undergone an Ecological Risk Assessment (ERA), in the case of Heard and McDonald Islands this is for both the demersal and the longline fishery. The report[71] refer to an eight-year study in which stills and Remote Operated Vehicles (ROVs) were deployed to assess the vulnerability and potential impact to benthic communities from trawls longlines or traps. Within CCAMLR Divisions 58.4.1 and 58.4.2 (East Antarctica) Australia has been working on a multi-member research programme on the exploratory research fishery for Antarctic toothfish. It includes as an objective to identify the spatial distribution of toothfish, important habitats and VMEs in order to inform spatial management approaches. To achieve this, benthic video cameras were attached to five of the vessels to cover 50% of their longline sets. Australia has also been instrumental in the proposal for designating an East Antarctica MPA within CCAMLR, which has required mapping sensitive areas using underwater cameras and ROVs. Surveys are also undertaken within the SPRFMO area using both towed video cameras and trawls. This has contributed towards the bottom fishing impact assessment with New Zealand for the SPRFMO Convention Area[72]. Moreover, deep-water fisheries within the EEZ have all been subject to ERAs that include surveys to assess the impact on the benthic environment. Vessels operating in New and Exploratory fisheries within CCAMLR (in the case of Australia Subareas 88.1 and 88.2) collect and report data on VME species according to the CCAMLR protocols. VME areas and risk areas can be publicly accessed from the CCAMLR site and CCAMLR GIS portal. Within SPRFMO and SIOFA data on VME species are also collected by observers and submitted to the Secretariat via AFMA. For other fisheries within the EEZ there are no specific VME protocols in place but observers do record benthic species. These data are submitted to AFMA and not publicly available. By law, no petroleum or greenhouse gas activity can take place before the environmental plan (EP) has been evaluated by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). The EP does not mention VMEs

[70] Mazor, T.K., Pitcher, C.R., Ellis, N., *et a*l. (2017). Trawl exposure and protection of seabed fauna at large spatial scales. Divers. Distrib. 23, 1280–1291 DOI: 10.1111/ddi.12622

[71] https://www.antarctica.gov.au/site/assets/files/36066/bottom_fishing_welsford_et_al_2014.pdf

[72] SC8-DW07 rev1. http://www.sprfmo.int/assets/2020-SC8/SC8-DW07-rev-1-Cumulative-Bottom-Fishery-Impact-Assessment-for-Australia-and-New-Zealand.pdf

specifically but does map out the general habitats (coral reef, seagrass etc.) along with a general habitat description. The EPs are available from the NOPSEMA site.

IMPACT MITIGATION AND PROTECTION MEASURES

The extent of Australia's EEZ is about 8,148,250 km^2. It includes the offshore territories but not the EEZ of the Australian Antarctic Territory, which is approximately another 2 million square kilometres. Closed areas are in place, although not specifically to protect VME species. There are no VME encounter rules within EEZ, but there are areas that are closed to trawling to protect benthos in general. Australia has a number of Marine Parks, world and heritage sites in place. Information on these are managed by the Department of the Environment and CISRO as part of the Australian Marine Spatial Information System (AMSIS). Shapefiles can be downloaded and be viewed on an interactive map[73] [74]. A number of marine parks and marine reserves have also been designated, although many of these are to protect wildlife other than the benthic environment, these can be found in the management booklets and from the SEWPaC website (www.environment.gov.au/). Australia and New Zealand are the only Member States to bottom fish in the SPRFMO area, as there were no formal guidelines from SPRFMO on VME indicators or threshold levels both countries used different bycatch weight thresholds. Australia have conducted BFIAs for their fishing activity within CCAMLR, SIOFA and SPRFMO. Within the Australian EEZ, Ecological Risk Assessment (ERA) have been undertaken for all the major fisheries. ERA protocols were developed by Hobday *et al*. in 2007 and updated in 2017. They include the Ecological Risk Assessment for the Effects of Fishing (ERAEF), which gives an assessment of risk of Commonwealth commercial fisheries to species populations, currently under review. Updates to the guide will include more detailed assessments to habitats and communities. The Australian Government is currently reviewing their exploratory fisheries policy. AFMA require all applicants for exploratory fisheries to submit an application that includes, among other information, applicants to highlight areas of significance such as "…benthic areas, breeding areas, migration paths or any other relevant information". The Southern and Eastern Scalefish and Shark Fishery operates a number of different bottom fishing gears for deep water species. Within this fishery there are a three trawl exclusion zones that have been put in place to protect benthic habitats, although only the East Coast exclusion zone is exclusively for benthos. The gear restrictions are more focussed around target and bycatch species rather than benthic impacts. In the Macquarie Island Toothfish Fishery (MSC certified fishery), there are gear limitations in place for trawl fishing (although this no longer operates, only longlines are used) and not all are related exclusively to protection of the benthos.

MONITORING OF VME IMPACTS

Within Australia's area of jurisdiction, with the exception of Heard and McDonald Islands (HIMI), there is no routine monitoring of VMEs, although benthic surveys are undertaken on an ad-hoc basis by CSIRO and other organisations. Within HIMI, Australia conducted annual surveys using camera systems as part of an eight-year monitoring programme to monitor the vulnerability of benthic habitats to impact by demersal gears. The programme ran between 2006 and 2014 and was conducted by AAD and the Fisheries Research and Development Corporation (FRDC). The surveys took place in CCAMLR waters, within the Australian EEZ around the HIMI and VME indicator species were identified using the CCAMLR VME Taxa Classification Guide.

[73] https://www.nespmarine.edu.au/australian-marine-parks-wha
[74] http://maps.ga.gov.au/interactive-maps/#/theme/amsis

The information from this was combined with effort data from the fishery, observer data and other scientific sampling of the types and abundance of benthic organisms across a range of habitat types. From this an assessment model was developed to estimate the disturbance caused by the fishery. The majority of these benthic surveys rely on the deployment of a camera system which was deployed on both trawls and longlines (the two gear types used commercially in the area). Surveys are also conducted using sleds and trawls. None are outlined within areas of national jurisdiction specific to VMEs. Impacts to the benthic habitat in general are monitored through ad-hoc benthic surveys[75] that are undertaken to characterise the seabed habitats. Monitoring of VMEs within RFMOs is still under development. Environmental plans must be submitted and reviewed by NOPSEMA prior to any offshore activities taking place, however these do not include long term monitoring plans.

Case Study 5 - NEW ZEALAND

Detailed data and information collected on key topics are available in the individual report (see Annex 1). The assessment was based on such data. Annex 2 presents a summary of the score justification, main gaps, comments and some relevant sources of information.

According to the available information, New Zealand has directly addressed all DSF/VME key topics and all of them are considered to be mostly implemented or close to being fully implemented (Figure 6 and Annex 2). However, knowledge of the VME species composition in some areas is still poor, which is a gap.

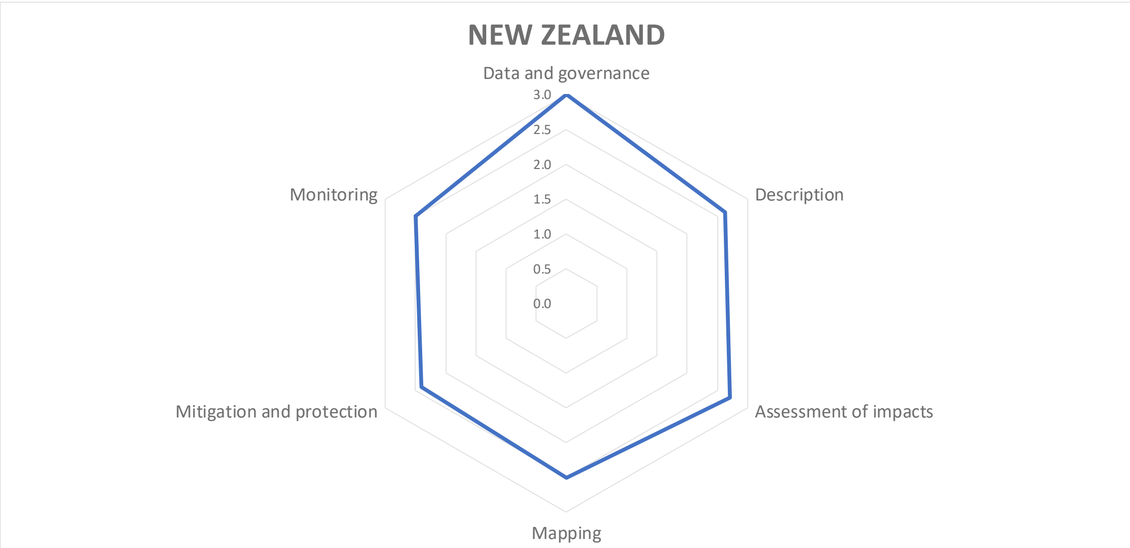

Figure 6. Case Study 5 – NEW ZEALAND: Summary of the implementation of the DSF/VME key topics (3: Fully; 2.5: Mostly (in progress) mostly/fully; 2: Mostly or partially in progress; 1: Partially or developing; 0: No evidence).

DATA AVAILABILITY AND GOVERNANCE FRAMEWORKS

The Ministry for Primary Industries (MPI) of New Zealand is structured into 5 business units and 4 functional areas (www.mpi.govt.nz). One of the 5 business units is

[75] Benthic surveys that are undertaken on an ad-hoc basis by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and other organisations.

Fisheries New Zealand (FNZ) (www.mpi.govt.nz/fishing-aquaculture). FNZ operates the country's fisheries management system, which provides New Zealanders with sustainable access to wild fisheries for tangata whenua[76], recreational and commercial fishers. FNZ monitors the sustainability of fish stocks and sets limits on commercial catches that maintain the balance between commercial and other uses. It enforces those limits and the rules associated with the system. It works with other agencies on broader marine management initiatives, including the proposed marine protected areas (MPA) reform programme which is led by the Ministry for the Environment. The Fisheries Act 1996 is the primary legislation for the management of fisheries, including the effects of fishing on the aquatic environment. The main guidance to avoid, remedy, or mitigate any adverse effect of fishing on the aquatic environment is in sections 8, 9, and 15. FNZ also administers a range of other acts on behalf of the Ministry for Primary Industries (MPI) and there are some acts administered by other agencies that lead to a requirement for FNZ to work with other government departments, especially Department of Conservation (DOC), the Ministry for the Environment (MfE) and with various territorial authorities.

DESCRIPTION OF SENSITIVE SPECIES AND HABITATS

In June 2013, the Department of Conservation of New Zealand, held an expert workshop to assess New Zealand's marine invertebrates using the New Zealand Threat Classification System (NZTCS) criteria (Townsend *et al*., 2008)[77], updating a previous listing process from 2009 (Freeman *et al*., 2009)[78]. The Conservation Services Programme (CSP) undertakes research to understand and address the effects of commercial fishing on protected species in New Zealand waters. The 2010 amendment of Schedule 7A of the Wildlife Act 1953 protects most corals in New Zealand waters, which are comprised of four main groups: stony corals (all species in the Order Scleractinia), black corals (all species in the Order Antipatharia), gorgonian corals (most species in the Order Alcyonacea), and some hydrocorals (all species in the Family Stylasteridae).

ASSESSMENT OF BOTTOM FISHING IMPACTS

New Zealand's commercial fisheries are based on the Individual Transferable Quota (ITQ) system operated under the Quota Management System (QMS). The QMS was introduced in 1986. The total allowable catch limits are based on the best available information, which includes research and reporting from the fishing industry. The management of deepwater fisheries encompasses all target stocks, bycatch stocks, and the environmental effects of fishing. All deepwater species in the QMS have been categorised into two tiers according to their commercial value and volume of catch: (i) Tier 1 fisheries are high volume and/or high value fisheries and are typically targeted. They deliver significant export revenue, which is reflected in the high quota value associated with these species; (ii) Tier 2 fisheries are typically less commercially valuable, comprise bycatch fisheries, or are only targeted periodically throughout the year. Additionally, the Tier 3 comprises those stocks that are outside

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[76] Tangata whenua (people of the land with authority in a particular place) manage their fisheries under customary fishing regulations, and the Fisheries Act 1996. https://www.mpi.govt.nz/fishing-aquaculture/maori-customary-fishing/managing-customary-fisheries/

[77] Townsend, A.J.; de Lange, P.J.; Duffy, C.A.J.; Miskelly, C.M.; Molloy, J.; Norton, D.A. 2008: New Zealand Threat Classification System manual. Department of Conservation, Wellington, New Zealand. 35 p

[78] DJ Freeman, BA Marshall, ST Ahyong, SR Wing and RA Hitchmough. 2010. Conservation status of New Zealand marine invertebrates, 2009, New Zealand Journal of Marine and Freshwater Research, 44:3, 129-148.

of the QMS[79]. Tier 1 and Tier 2 fish stocks within the EEZ, includes the use of bottom contacting trawl gears, that is bottom trawls and midwater trawls used within a metre of the seafloor. Data on catch and effort from commercial fishing are used to generate annual trawl footprints that represent the area of the seafloor contacted by trawl gear. Assessment of the annual trawl footprint is a monitoring requirement for Deepwater Fisheries Management Objective 7: *Manage deep-water and middle-depth fisheries to avoid, remedy or mitigate the impacts of deep-water fisheries on the benthic habitat*. In 2019 under the overall BEN2017-01 project objective that aimed to monitor the "footprint" of trawl fishing for deep-water species on or near the seabed. This work was the first use of the *CatchMapper tool*, developed to map the commercial catch reported by commercial fishers to forecast the quantity of displaced fishing activity. The extent of the bottom-contacting trawl footprint for the 10 fishing years was equivalent to 4.4% of the total Territorial Sea + EEZ seafloor area, 13.0% of the "fishable" seafloor area open to bottom-contacting trawling in waters shallower than 1600 m, and 11% of seafloor area in 0–1600 m depths.

MAPPING OF SENSITIVE SPECIES AND HABITATS

Since 2007, as part of the requirements of several Departments of Conservation of New Zealand, observers have recorded and collected samples of any coral taxa that (i) are protected, (ii) that strongly resemble protected coral fauna[80], or (iii) that have been proposed for protection. This instruction was to ensure legal obligations of the Wildlife Act (1953) could be met. Observers photograph coral specimens at sea and all samples, or a sub-sample of the colony, are returned to the National Institute of Water and Atmospheric Research (NIWA) (frozen) for identification and curation. Corals are identified to the lowest possible taxonomic level and resulting data are entered into the Ministry of Fisheries (MFish) Centralised Observer Database that is maintained by NIWA. The 2007–2010 projects focused on the main deep-water fisheries. Any coral samples retained from these projects are held under stewardship at NIWA and species identification information is also loaded into the NIWA Invertebrate Collection (NIC) Specify database. Government observers on commercial fishing vessels follow standardised methods to assess each trawl tow or longline set for the presence of invertebrates, including corals, recording presence and weight data. Tracey *et al.* (2011)[81] analysed the distribution of nine groups of protected corals based on bycatch records from observed trawl effort for 2007-10. Maps of the distributions of the main coral groups, based on the observed trawl data, are available. A range of statistical modelling methods to predict habitat suitability and species distributions in unsampled regions have been developed in recent years, many of which take advantage of the processing power of modern computers and machine learning algorithms. Such models have been used to predict the distribution of fish and benthic invertebrate taxa over broad regions of the EEZ and beyond into the wider Pacific. The predictive habitat modelling studies were commissioned by several government agencies and most have focused on protected corals and VME indicator taxa. A specific project was developed in 2012-15, aimed (i) to produce

[79] Tier 3 species are those caught as bycatch that are not managed through the QMS. https://www.mpi.govt.nz/dmsdocument/39770-Annual-Review-Report-for-Deepwater-Fisheries-2018-19.

[80] A measure of accuracy of the observer coral identification is assessed by comparing the at-sea coral identifications of returned samples with expert identifications made later in the laboratory. Distribution of protected corals in relation to fishing effort and assessment of accuracy of observer identification. 2011. NIWA.

[81] Tracey, D.; Baird, S.J.; Sanders, B.M.; Smith, M.H. 2011. Distribution of protected corals in relation to fishing effort and assessment of accuracy of observer identification. NIWA Client Report No: WLG2011-33 prepared for Department of Conservation, Wellington. 74 p.

such models for VMEs in the area adjacent to New Zealand's[82] EEZ (SPRFMO area), and (ii) to evaluate their effectiveness for potential management and conservation scenarios.

IMPACT MITIGATION AND PROTECTION MEASURES

New Zealand has a range of marine protected areas in place within the Territorial Sea, some of which provide protection of coral species. Corals are identified as one potential component of biogenic habitats, to be represented within a network of marine protected areas. As at September 2019, there are 44 marine reserves implemented under the Marine Reserves Act 1971 and 19 "Type 2" marine protected areas implemented under other legislation. Marine reserves provide the highest level of protection by prohibiting activities that may involve the take or disturbance of marine life. Type 2 MPAs are managed areas that meet a defined protection standard under New Zealand's MPA Policy. These protected areas range in latitudinal extent from the subtropical Kermadec Islands Marine Reserve in the north, to subantarctic Moutere Ihupuku/ Campbell Island Marine Reserve in the south. A wide range of other spatial restrictions apply that provide protection against some but not all of the disturbance agents specified in the marine protected areas protection standard. While some of these protected areas and other spatial closures are relatively small and confined to nearshore habitats, some are large and extend across habitats within the Territorial Sea and likely include at least some species of protected corals. For example, the spatial closure in Spirits Bay implemented under the Fisheries Act 1996 contains at least 29 species of corals and gorgonians. Current spatial measures to protect corals from the effects of fishing in the EEZ, have been put in place using the Fisheries Act 1996. In 2001 all trawling methods were prohibited in 17 seamounts. In 2007, in response to a fishing industry proposal, an additional 17 Benthic Protection Areas (BPAs) were closed to dredging and placed tight restrictions on trawling. The purpose of the BPAs and seamount closures was to protect benthic (seafloor) biodiversity. BPAs and Seamount closures together cover 28% of known underwater topographic features in the EEZ, 52% of known seamounts with an elevation of >1000 m, and 88% of known active hydrothermal vents.

MONITORING OF VME IMPACTS

In New Zealand, for over a decade, Government Fisheries Observers (referred to as observers throughout) placed aboard fishing vessels have been documenting fishery impacts as the occurrence of non-target species (bycatch) in commercial catch. Observer documentation includes sampling protected coral bycatch and depositing voucher specimens within the NIWA Invertebrate Collection (NIC). Observer digital images and voucher material are examined by taxonomists and other expert identifiers. This identified bycatch component has been used as an estimate of fisheries impacts, both in terms of biomass and biodiversity. The Conservation Services Programme (CSP) monitors the impact of commercial fishing on protected species, studies species populations and looks at ways to mitigate bycatch. Protected marine species include all marine mammals and reptiles; sea birds (except black backed gulls); seven species of fish; all black corals, gorgonian corals, stony corals and hydrocorals. The Department of Conservation carries out benthic surveys[83] to evaluate the diversity of benthic marine areas using video cameras.

[82] https://www.un.org/depts/los/bfw/New%20Zealand_2022.pdf
[83] Within the ocean survey 20/20 programme, the Department of Conservation, NIWA and the Ministry of Fisheries carried out benthic surveys to characterise the seabed habitat.

Overall Assessment

Figure 7 displays the overall assessment of the 6 key topics across the 5 selected countries with the y-axis representing the assessment score (ranging from 0-no evidence to 3-fully). Each bar on the graph represents the **assessment average score** for the country, being the bars grouped according to the key topic being assessed. This allows for an easy comparison of the assessment scores across the countries and key topics, illustrating the degree of implementation that each country has achieved for the key topic, and where there are gaps and therefore room for improvement.

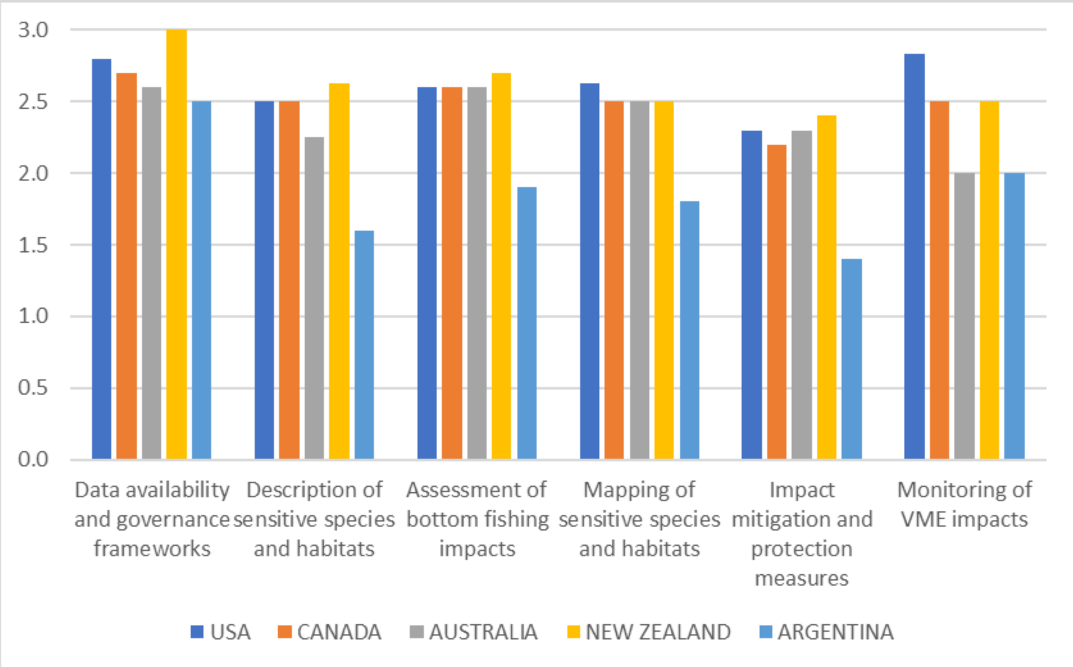

Figure 7. Overall assessment for the 6 key topics across all countries (3: Fully; 2.5: Mostly (in progress) mostly/fully; 2: Mostly or partially in progress; 1: Partially or developing; 0: No evidence).

It is essential to exercise caution when interpreting **these outcomes as they rely only on publicly available information for each country** and therefore, **interpretation of the results must be approached very carefully** and with a **critical and thoughtful mindset**, recognizing the potential limitations and uncertainties associated with the analysis.

Overall, Figure 7 provides a useful snapshot of the state of DSF/VME conservation efforts across the selected countries and the specified key topics. According to the publicly available information, all the reviewed countries have addressed the "**data availability and governance frameworks**" key topic, being considered to be mostly (in progress) implemented to fully implemented. With regard to the "**description of sensitive species and habitats**" all countries, except Argentina, were found to have a good degree of implementation having between mostly or partially in progress and mostly (in progress) mostly/fully average scores. The relatively low level of implementation found for Argentina could be explained by the fact that no available information on biodiversity indicators was found. Moreover, the specific definition of VME concept or specific list of VME indicator species/features were also not found in the publicly available information that was reviewed for this country. The degree of implementation of the "**assessment of bottom fishing impacts**" key topic was high for almost all the countries, being the average above the mostly (in progress) mostly/fully score. The main gap on this topic for Argentina was that available information about fishing fleets operating in the high seas is scarce and with very limited access. Besides, no available information on the description of methods for assessing SAIs on VMEs/sensitive species and habitats was found for this country. The bar graph also shows that the level of implementation of the "**mapping of sensitive species and habitats**" key topic was in average "mostly (in progress) mostly/fully" for Canada, Australia and New Zealand. The USA has a higher level of implementation for this topic than the rest of the countries while the review of Argentina showed a gap on scientific observer programs implemented to sample VME indicator species. No available information was found regarding habitat suitability models/species distribution models developed to map VMEs/sensitive species and habitats. All the countries are below the 2.5 (Mostly (in progress) mostly/fully) average score in terms of the "**impact mitigation and protection measures**" topic, either because no information has been found available to answer in detail the questions or because the impact mitigation measures are still in the process of developing indicating that there is room for improvement, especially in the case of Argentina. Finally, the level of implementation of the "**monitoring of VME impacts**" topic was good for all countries, with average score values between 2 (Mostly or partially in progress) and 3 (Fully).

Conclusions

It is essential to exercise caution when interpreting the outcomes from Task 1, as they rely only on publicly available information for each country and therefore, interpretation of the results must be approached very carefully and with a critical and thoughtful mindset, recognizing the potential limitations and uncertainties associated with the present analysis.

The Individual Country Reports contain a useful summary of publicly available information on the work undertaken by five relevant countries in support of VME protection and the identification of mitigation measures for the impacts of bottom fishing and, where appropriate, other human activities. This information provided an overview of how each country (each government) is addressing the 6 key topics (including the main gaps), particularly in waters under national jurisdiction. It also expands on the knowledge of the state of play obtained under the previous SC08 study, which focused on approaches developed in the high seas by intergovernmental organizations (RFMOs/RFBs).

The Overall Assessment conducted provides a more comprehensive and nuanced understanding than looking at the 6 key topics in isolation. It also provides a better understanding of how different countries deal with DSF management and VMEs conservation efforts. This can be useful for support management decisions. This assessment showed that all countries reviewed have implemented some form of governance and data collection frameworks for DSF and VMEs, with specific regulations and bodies for management, research and enforcement, and that most have described sensitive species and habitats in some way. Moreover, some countries have made significant efforts towards co-management, involving a variety of stakeholders. The assessment of bottom fishing impacts has in general a good degree of implementation for almost all countries (addressing, in some cases, the issue of the impacts of activities other than fishing), just like the mapping of sensitive species and habitats. Sometimes the approach adopted is broader and focuses more on the identification, designation and protection of essential fish habitats, or in the assessments of risk for benthic habitats, rather than assessing SAIs on corals and sponges. There is room for improvement in impact mitigation and protection measures, as some documented vulnerable areas still remain unprotected, but in general, progress is being made in this area. Most countries have successfully implemented some kind of monitoring of VME impacts, or such implementation is still partially in progress, or is planned. Finally, the differences between countries and the gaps identified are explained either by the different development of management frameworks, or by the availability and accessibility of information or the degree of detail of the information available.

TASK 2 - Critical review of FAO 2008 DSF guidelines and compilation and development of best practices and recommendations on key aspects related to the conservation of VMEs and management of DSF.

Objectives

The aim of this task is to conduct a critical review of FAO 2008 DSF guidelines and to compile and develop best practices and recommendations on key aspects related to the conservation of VMEs and management of DSF in the high seas. It is especially important to identify the best available scientific knowledge and practices, but also any specific concerns raised in academic literature or by civil society that have emerged since the development of the guidelines in this task.

Methodology

This task involved a critical review of 2008 DSF FAO Guidelines (FAO, 2009[84]) with the purpose of: i) identifying the possible implementation issues that stem from the interpretation of the Guidelines, ii) identifying the gaps in scientific knowledge that could hamper operationalization of the Guidelines and iii) proposing mitigation measures for those issues/gaps identified. Moreover, the review includes a compilation and development of best practices and recommendations on key aspects related to the conservation of VMEs and management of DSF in the high seas.

This task is mainly a desk-based research, including interviews (i.e., videoconferences, due to the COVID-19 situation) with the relevant scientists and managers involved in VMEs science and policy making, when possible. The review involved a revision of readily available scientific literature, reports (e.g. FAO reports from ABNJ Deep Seas Project), grey literature and databases (e.g. FAO VME database) related to the implementation of the Guidelines.

In particular, the review considered two sub-tasks:

<u>Sub-task 2.1. Review the 2008 DSF FAO guidelines:</u>

RFMO/Fishing areas considered within this task are: NEAFC, SPRFMO, SIOFA, NAFO, FAO Area 41, GFCM, SEAFO, NPFC, CCAMLR, WECAF and CECAF.

Specific templates were prepared and distributed among partners in order to collect information regarding: (i) Characteristics of the DSFs in the RFMO/Fishing area; (ii) Definitions and interpretation of key concepts (e.g., VMEs and SAIs) used in the RFMO/Fishing area; (iii) Criteria/guidelines used for assessing SAIs; (iv) Identification and assessment of VMEs; (v) VME indicator species and threshold levels; (vi) Characteristics of implemented data collection programs (e.g., type of data, resolution of the data, etc.) and reporting systems; (vii) Costs of implementation of the collection program; (viii) Frameworks and measures to prevent SAI including identification of areas known or likely to contain VMEs; (ix) Monitoring, control and surveillance frameworks in place; (x) Reported issues or challenges regarding the implementation of measures related to the FAO Guidelines and; (xi) Strengths and weaknesses of the approach followed by the RFMO/Fishing area.

[84] FAO (2009) International guidelines for the management of deep-sea fisheries in the high seas. Rome: Food and Agriculture Organization of the United Nations, 73 pp. http://www.fao.org/3/i0816t/i0816t.pdf

This information was used as the basis for the critical review. The main elements of the critical review are: i) the identification of the possible implementation issues that stem from the interpretation of the Guidelines, ii) the identification of the gaps in scientific knowledge that could hamper operationalization of the Guidelines and iii) a proposal of mitigation measures for those issues/gaps identified. For each of the RFMOs, we determined to which extent the FAO Guidelines have been considered in the measures that have been implemented to protect VMEs and to assess SAIs.

Sub-task 2.2. Compilation of best practices:

The objective of this subtask was to prepare a compilation of best practices regarding the identification, monitoring and conservation of VMEs. Specific templates were prepared and distributed among partners in order to gather information from the different RFMOs regarding the next issues: (i) Criteria for identification of existing and potential VMEs; (ii) VMEs indicator taxa; (iii) Approaches and methods for the identification and mapping of VMEs; (iv) Monitoring of VMEs; (v) Assessment of all of the six FAO criteria for SAI assessment for different gears and development of bottom fishing impact assessments; (vi) Minimization of fisheries impacts. The information in these templates was reviewed in order to identify best practices regarding the identification, monitoring and conservation of VMEs.

Once sub-tasks 1 and 2 were completed, the findings were integrated in a report (**Deliverable 1 - D1**[85]). The conclusions of this report were discussed among the partners and relevant external experts (e.g., scientists, managers, etc.) via a **Virtual Workshop** (see below). This Workshop was proposed by the Consortium and is outside of the contract demands. The Workshop took advantage of the exchange with a community of experts to further identify and discuss around barriers regarding the implementation of the FAO Guidelines and best practices related to the conservation of VMEs and management of DSF. After the Workshop, the **Deliverable 1** was revised to incorporate the findings and conclusions derived from the Workshop. The **Virtual Workshop** was carried out on February 28th 2022 with the objective of bringing together a group of relevant experts and improve the outcomes of the work carried out by the partners in Task 2. The experts that participated belonged to RFMOs such as the Northwest Atlantic Fisheries Organisation (NAFO), international NGOs such as the Deep Sea Conservation Coalition (DSCC) and the Pew Charitable Trusts and stakeholder organizations such as the Long-distance Fisheries Advisory Council (LDAC). Prior to the workshop, the consortium prepared a brief document containing a compilation of the main issues and good practices regarding VMEs conservation in deep sea fisheries in the high seas. This document was presented and discussed in the workshop, and the main outputs of this workshop were incorporated in Deliverable 1. A report of the workshop was also prepared and was submitted as an annex to Deliverable 1. This document includes a summary of the discussions and main conclusions reached in the workshop.

The main findings from these sub-tasks, as extracted from D1, are presented below, in the subsection titled ***"Results; Deliverable 1 (D1): Summary of findings and key information"***. In addition, the D1 document is included in the Annex 3 of the present report.

[85] Deliverable 1 (D1): Compilation of best practices guidance on key aspects related to the conservation of VMEs and management of DSF. D1 contains the review of the implementation of the FAO Guidelines in the high seas (Task 2). See Annex 3 of the present report.

Results

Deliverable 1 (D1): Summary of findings and key information

Deep-sea fisheries operate globally throughout the world's oceans, chiefly targeting stocks on the upper and mid-continental slope and offshore seamounts. Fishing in the deep sea not only harvests target species but can also cause unintended environmental harm, mostly from operating heavy bottom trawls and, to a lesser extent, bottom longlines. Bottom trawling over hard seabed (common on seamounts) routinely removes most of the benthic fauna (Clark *et al*., 2016[86]).

The FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas were developed for fisheries exploiting deep-sea fish stocks, in a targeted or incidental manner, in areas beyond national jurisdiction (ABNJ), including fisheries with the potential to have significant adverse impacts on vulnerable marine ecosystems (VMEs). The role of the Guidelines is to provide tools, including guidance on their application, to facilitate and encourage the efforts of States and Regional Fisheries Management Organisations (RFMOs) towards sustainable use of marine living resources exploited by deep-sea fisheries, the prevention of significant adverse impacts on deep-sea VMEs and the protection of marine biodiversity that these ecosystems contain. The Guidelines were developed with a view to assisting states and RFMOs with the implementation of the United Nations General Assembly (UNGA) Resolution 61/105 of 2006, concerning responsible DSF in the marine ecosystems of the high seas.

In this deliverable, a critical assessment of the implementation of FAO Guidelines in the high seas was carried out, considering RFMOs and RFBs with competence in the high seas. The main findings of the assessment were:

Definitions and interpretation of key concepts. The great majority of RFMOs/RFBs refer to the concept of VME established in the FAO Guidelines. However, from a practical point of view, the definition of what constitutes a VME must be further developed to create operational definitions, in order to consistently identify VMEs. The lack of operational definitions in many of the RFMOs/RFB is one of the main issues that have been identified in this review. Also, definition of VMEs should take into account societal issues, broader biodiversity (e.g., BBJN[87]) considerations and ecosystem services. The main ecosystem services that have been identified for VMEs are related to supporting services (e.g., essential fish habitat), provisioning services (e.g., chemical compounds for pharmaceutical applications), regulating services (e.g., sequestering CO_2 from atmosphere) and cultural services (e.g., non-material benefits such as recreation, inspiration and aesthetic pleasure).

VME indicator taxa. In some RFMOs, the lists of VME indicators include few taxa and more work is needed. Also, expert reviewers often indicate a lack of information to evaluate candidate VME indicators against FAO criteria. It is necessary to carry out research to fill the gaps regarding biological information of benthic organisms and their distribution, in order to allow their evaluation against FAO criteria.

Identification of VMEs. Direct observations of VMEs (e.g., using underwater imagery) are only available for a small fraction of the seabed. This is mainly because research surveys are costly and, logistically, it can be difficult to conduct them because of the remote location of the seamounts and other VME habitats. Because

[86] Clark, M.R. et al., 2016. The impacts of deep-sea fisheries on benthic communities: a review. ICES Journal of Marine Science, Volume 73: i51–i69. https://doi.org/10.1093/icesjms/fsv123
[87] Biodiversity Beyond National Jurisdiction

of this, other approaches to identify VMEs are needed (e.g., species distribution models or multi-criteria assessments). However, not all of the RFMOs can apply repeatable, quantitative approaches because there are not enough data (e.g., SEAFO, CECAF, NPFC, SIOFA, WECAFC). Also, sampling carried out in research surveys using bottom trawls is destructive to VMEs[88], so there is a need to develop alternative methods to identify and monitor VMEs (e.g., explore the possibility of using environmental DNA for this purposes).

Assessment of SAI. Not all RFMOs have completed impact assessments of bottom fishing activities. In addition to this, some of the impact assessments may have not been carried out according to the Guidelines and UNGA Resolutions (e.g., SPRFMO, as criticized by the DSCC). Also, there is a need to discuss what threshold would be appropriate for the protection of VMEs without causing SAI, because there is no set threshold in the Guidelines. Such a threshold would help to operationalize VME protection according to the Guidelines, and it is important because it may not be realistic to be able to protect 100% of VMEs.

Measures to protect VMEs. Some RFMOs have not implemented closure areas to specifically protect VMEs (e.g., SPRFMO, GFCM) as required under the UNGA resolutions. This may be related to the difficulty of identifying and delineating area closures especially when there is still a lack of empirical data on the distribution of VMEs within the high seas. In these cases, spatial management is often informed by model predictions of the spatial distribution of VME indicator taxa. However, in any case, the lack of data should not prevent RFMOs from applying the precautionary approach in line with the UNGA provisions. While area closures can offer protection from direct impacts of bottom-contact fishing gears, the long-term viability of the protected populations will depend on identifying and protecting sources of recruitment and connectivity pathways (Wang *et al*., 2020[89] and references therein). Connectivity of closed areas has not been considered in most RFMOs. Climate change should be also considered, because it might lead to shifts in VME distributions by changing or reducing suitable habitat for VME species. Understanding how climate change can affect the distribution of deep-sea species is critically important for developing appropriate area closures and other measures. Other aspects that need to be given more attention are: the inclusion of buffer zones to protect VMEs from significant adverse impacts and restoration of VMEs in previously fished areas.

[88] This is an issue of current concern in RFMOs such as NAFO. In June 2023, NAFO Scientific Council (SC) concluded that while scientific bottom contacting trawl surveys do impact VMEs, the available evidence does not support a blanket exclusion of research surveys from all protected areas. Impacts from research surveys are not generally considered to cause long-term harm to VMEs due to their small footprint and long recurrence interval. The review of excluding closed areas from the surveys indicated that survey indices for some stocks would be impacted making them unreliable for scientific advice. These surveys also play an important role in monitoring conservation objectives of the protected areas. SC recommended that the surveys can operate inside the closed areas in the NAFO Regulatory Area, but must make every effort to minimize impacts of the sampling and maximize the collection of data in the hauls made in those vulnerable areas. Regardless of the levels of impact, mitigation measures must still be considered to minimize harm while maintaining the integrity of the survey design (e.g. moving sets outside the VME closed areas if possible, avoiding areas of particularly high density of VMEs within the closed areas, shortening the survey time within the closed areas and/or reducing the number of sets in the strata within the closed areas). For additional information, see:
https://www.nafo.int/Portals/0/PDFs/sc/2022/scr22-034.pdf
https://www.nafo.int/Portals/0/PDFs/sc/2022/scr22-032REV3.pdf

[89] Wang, S., Kenchington, E.L., Wang, Z. et al. (2020). 3-D ocean particle tracking modeling reveals extensive vertical movement and downstream interdependence of closed areas in the northwest Atlantic. Scientific Reports 10, 21421. https://doi.org/10.1038/s41598-020-76617-x

Regarding encounter protocols, some RFMOs have not established encounter thresholds/protocols (e.g., GFCM). Encounter thresholds that trigger move-on rules should ideally be specific to area, gear type and taxon, and based on historic bycatch levels and catchability estimates (Ardron *et al.,* 2014[90]). However, in many occasions the historic data of bycatch levels are not available and catchability has not been estimated, so the set encounter thresholds may not be appropriate. Because of this, there is a need of revising encounter thresholds as new data becomes available.

Data collection. Accurate identification of some VME indicator taxa can be difficult. Because of this, identification guides and training of observers are necessary. Some RFMOs have prepared ID Guides (e.g., CCAMLR, NAFO, SEAFO, SIOFA, and SPRFMO) but not all have developed such guides. Also, data for modelling may not have enough quality or resolution. For example, models developed using data with low taxonomic resolution data may mix species with very different life-histories and environmental requirements, resulting in overly broad predicted distributions and potentially increased model uncertainty (Winship *et al.,* 2020)[91].

Monitoring, control and surveillance (MCS). Adequate MCS ensure that conservation and management measures related to VMEs are implemented. It also addresses issues such as Illegal, Unreported and Unregulated fishing (IUU), that may affect VMEs directly because IUU fishing often uses illegal fishing methods (such as bottom trawling in forbidden areas), which can seriously damage the seabed environment and its diversity. Moreover, there is the problem that, in order to avoid inspection, illegal fishing gear is abandoned directly into the sea, causing a large number of ghost fishing gear that can damage marine ecosystems, including VMEs. Currently, IUU fishing remains a constant threat for all of the deep-sea RFMOs. Also, there is room for improvement regarding cooperation and information sharing among RFMOs.

Finally, Deliverable 1 includes a section of **good practice and recommendations** to improve identification, monitoring and conservation of VMEs. These recommendations can be summarized as follows:

Definitions and key concepts.

- Create operational definitions for key concepts (VME, VME indicator, significant concentration or threshold of VME taxa indicating the presence of VME, VME elements and features, etc.), because this is necessary to consistently identify VMEs.
- Evaluate the appropriate spatial scale of the ecosystem, that is, to determine the real extension of the VMEs considering not only habitat structure or the biogenic structure of VMEs but including also information on rare or endangered species, life history characteristics of individual species, the connectivity among different areas, and the functional roles of these VME associated species in the ecosystems.

[90] Ardron et al. (2014). 'A systematic approach towards the identification and protection of vulnerable marine ecosystems'. Marine Policy Vol. 49: 146-154. https://doi.org/10.1016/j.marpol.2013.11.017
[91] Winship, A.J. et al., (2020). 'Good practices for species distribution modeling of deep-sea corals and sponges for resource management: data collection, analysis, validation, and communication'. Frontiers in Marine Science, 7, p.303.

VME indicators.

- Create lists of regional VME indicator taxa using the FAO criteria (individually or in combination) and update those lists as new information becomes available.
- Carry out research to fill the gaps regarding biological information of benthic organisms and their distribution because expert reviewers often indicate a lack of information to evaluate a FAO criterion.

Approaches to the identification of VMEs.

- Ideally, VMEs should be identified using direct observations, from high quality underwater imagery as this allows accurate and quantitative description of community composition and associated fauna, determination of the extent of the associated habitat, and the damage caused by particular fishing gears. This type of data collection could be incorporated in many research surveys and this possibility shall be explored.
- Research of other non-destructive sampling methods, such as environmental DNA shall be promoted, because there are still many gaps that prevent the implementation of this modern methodology.
- Bottom trawl fisheries research surveys should avoid all areas[92] where VMEs are known or are likely to occur, particularly in areas where bottom fishing is prohibited. To this regard, established surveys could try to develop sampling plans that avoid locations where VMEs are known.
- If bycatch data of VME taxa are available or likely to become available, quantitative (or at least semi-quantitative) and reproducible approaches shall be considered for the identification of VMEs (e.g., the Kernel Density Estimate (KDE), Species distribution models/Habitat suitability models, Multi-criteria Assessment MCA).
- Collection of absence data (locations where VME taxa are not present) shall be encouraged, because they are fundamental to fully evaluate the occurrence of VME habitats and indicators, and, specifically, to support mapping of benthic habitats.

Assessment of SAIs.

- Quantitative impact assessments of bottom fishing on benthic habitats and taxa indicative of VMEs should be carried out.
- The question of what are appropriate protection levels for VMEs should be discussed, because there is no set threshold in the Guidelines. Such a threshold would help to operationalize VME protection according to the Guidelines, and it is important because in reality, it may be reasonable to assume that a fraction of VMEs can be lost without incurring SAIs.

[92] This is an issue of current concern in RFMOs such as NAFO. In June 2023, the NAFO Scientific Council (SC) discussed this issue, based on the work done during the last NAFO Working Group on Scientific Ecosystem Assessment (WG-ESA), refuting its main conclusions. Earlier, in November 2022, the WG-ESA had reviewed all available analyses from relevant Canadian and EU surveys on the impacts of excluding bottom-trawl surveys from VME closed areas, as well as the impacts these surveys may have on these VMEs. Based on this review, WG-ESA concluded that the evidence does not support a blanket exclusion of research surveys from all protected areas. Impacts from NAFO research surveys are not generally considered to cause long-term harm to VMEs as the recurrence time for the surveys is expected to allow sufficient time for VMEs to recover. Moreover, WG-ESA discussed a potential guidance framework to assist survey planning and design to mitigate impacts on VMEs. For additional information, see: https://www.nafo.int/Portals/0/PDFs/sc/2022/scs22-25.pdf

- Assess SAIs by bottom fisheries on relevant VME indicator taxa as the VME indicator taxa lists are updated, that is, consider new identified taxa in SAIs assessments.

Measures to avoid SAIs.

- Closing areas to bottom contact gear is the only certain method for avoiding significant adverse impacts on VMEs. The effectiveness of existing area closures can be improved by using explicit buffer zones and by considering the connectivity among the areas closed to protect VMEs.
- Give attention to the restoration of impacted VMEs. RFMOs should consider that allowing continued bottom-contact fishing at sites that have already experienced heavy trawling may cause damage to remnant VME populations. If these remnant populations are large enough to be reproductively viable, then they are likely to play a critical role in the recovery process as a source of propagules for heavily disturbed areas on seamounts.
- Refine the current thresholds on the basis of new scientific information, including bycatch levels and catchability estimates, and use taxon-specific and gear-specific thresholds. Data-informed approaches to establish meaningful encounter thresholds shall be promoted.
- Reporting of sub-threshold encounters may help improving the information collected regarding VMEs.
- Regarding move-on rules, further refining the move-on distance shall be considered in relation to the size and distribution of observed VME patches, as well as the size of fishable seamounts.
- Regarding the areas provisionally closed because thresholds have been exceeded (but also for areas closed on the basis of other evidence, such as data from surveys), it is necessary to carry out an assessment of the available evidence by a relevant scientific advisory body before re-opening can be considered.
- Consider the recommendations from the FAO/NPFC Workshop held in 2018, such as:
    - Assess and monitor the recovery of VME sites and protect recovering sites in addition to pristine VME sites
    - Develop a standardized approach and metrics to assess the cumulative impact of all bottom fisheries on VMEs through time.
    - Develop measurable objectives for determining the occurrence of SAIs, for example, NAFO has established a 60% biomass threshold as the desirable protection level for VMEs in its regulatory area.

Data collection programs.

- Continue work on the identification guides for VME indicators (those RFMOs that have not elaborated guides, such as NEAFC).
- Consolidate all available data including bycatch, scientific surveys, fisheries independent surveys, historical literature, the fishing industry, and potentially relevant information from within EEZs, to get more detailed information about interactions between VMEs and bottom fisheries.
- Data collection programs regarding VME taxa should at least include comprehensive descriptions of the location (including depth, latitude and

longitude); records of presence and absence; abundance, biomass, or density (abundance or biomass per unit area) with a measure of effort for each sampling unit (e.g., area surveyed).

- Sampling programs should record biological data at the highest taxonomic resolution possible.
- Consider conducting standardized training programs for observers and development of the regional observer programs.

Monitoring, control and surveillance (MCS).

- The implementation of Memorandums of Understanding across the RFMOs shall be promoted because this allows for harmonization and integration of MCS and facilitate greater cooperation and exchange of information. A less formal mechanism for the cooperation and exchange of information between the secretariats of the deep-sea RFMOs may also be very beneficial. Opportunities should be explored for the secretariats to collaborate on activities and projects including those related to data management, capacity building and testing new technologies.

Conclusions

From the critical review carried out in this task, it is clear that many aspects related to the protection of VMEs need to be improved, starting necessarily with creating operational definitions of key concepts (such as VME and VME geomorphological elements) and determining acceptable thresholds of protection level for VMEs, as it may not be realistic to be able to protect 100% of VMEs. The lack of biological and distribution information of VME indicator taxa, which also prevents evaluating their vulnerability using FAO criteria, was identified as an important issue. This can be overcome by carrying out further research of the species that form VMEs. Then, it is evident that identifying VMEs remains a difficult task. Direct observations from research surveys are only available for a small portion of the seabed, so RFMOs must rely on indirect approaches (such as species distribution models) to identify VMEs, with a higher associated uncertainty. And even such approaches are not within the reach of many RFMOs because there are simply not enough data regarding the distribution of VME taxa to apply them. Nevertheless, it must be emphasized that this situation does not justify the lack of action or implementation of measures to protect VMEs, and that a precautionary approach must be applied. Regarding the measures to protect VMEs, the majority of the RFMOs with competence over bottom fisheries on the high seas have adopted regulations to prevent significant adverse impacts on VMEs through area-based management approaches. This includes areas closed to bottom fishing designated to protect VMEs. Although such area closures can offer protection from direct impacts of bottom-contact fishing gears, the long-term viability of the protected VMEs will depend on understanding the wider context of VME functioning (for example, identifying sources of recruitment and taking into account the connectivity among different areas). In addition, climate change should be also considered, because it might lead to shifts in VME distributions by changing or reducing suitable habitat for VME species. Thus, understanding how climate change can affect the distribution of deep-sea species is critically important for developing appropriate area closures (or adapting the existing ones) and other measures. Finally, the restoration of damaged VMEs must be given more attention, as there is evidence that this can be achieved, at least to some degree, through long-term protection of heavily trawled areas.

TASK 3 – Overview and critical analysis of existing by-catch mitigation and management approaches in DSF, and development of recommendations for improving by-catch management in DSF.

Objectives

The objective of Task 3 is to conduct an overview and critical analysis of existing by-catch mitigation and management approaches in DSF, and development of recommendations for improving by-catch management in DSF, considering only FAO Area 41 (SW Atlantic), NAFO, NEAFC, SEAFO, SIOFA, SPRFMO, GFCM and CCAMLR.

Methodology

This task involves a critical analysis of the current practices and measures implemented to reduce and manage by-catch in DSF, with the purpose of developing a series of recommendations to improve by-catch management.

This task is mainly a desk-based research, including interviews (i.e., videoconferences, due to the COVID-19 situation) with the relevant scientists and managers involved in by-catch management in DSF, when possible. The review involves a revision of readily available scientific literature, reports (e.g., FAO reports from ABNJ Deep Seas Project[93] or the reports of the UN/FAO MED bycatch Project[94]) and grey literature related to by-catch mitigation and management approaches in DSF. Regarding FAO Area 41 (SW Atlantic) the absence of a competent RFMO in the area posed difficulties to identify current practices and implemented measures because these are determined by individual Flag States and might not be easily accessible. Nevertheless, an effort was made to obtain as much information as possible for this fishing area. For this, the Deep Sea Conservation Coalition[95] was considered as it can facilitate access to such information.

Considering the information collected under the SC08 study and the possible relevant recent developments, the following sub-tasks were carried out:

Sub-task 3.1 – Effectiveness of by-catch management

Sub-task 3.2 – Areas with gaps/improvements needed

Sub-task 3.3 – Recommendations for by-catch avoidance and management

The main findings from these sub-tasks, as extracted from D2 "Guidelines for improving by-catch management in DSF", are presented below, in the subsection titled ***"Results; Deliverable 2[96] (D2): Summary of findings and key information"***. Following CINEA suggestions, D2 included a specific section, called

[93] The project "Sustainable fisheries management and biodiversity conservation of deep-sea living marine resources and ecosystems in areas beyond national jurisdiction" (ABNJ Deep Seas Project) is a joint project from FAO and United Nations Environment Programme (UNEP). It works with regional fisheries bodies, other multi-sectoral organizations, the fishing industry and governments towards the sustainable use and efficient conservation of deep-sea biodiversity. Available at: https://www.abnjdeepseasproject.com/en.

[94] The project "Understanding Mediterranean multitaxa bycatch of vulnerable species and testing mitigation – a collaborative approach" (Medbycatch project) is carried out by a partnership involving GFCM, FAO, UN Environment MAP, IUCN-MED and other organisms such as ACCOBAMS, Birdlife international and MEDASSET. More information available at: http://www.fao.org/gfcm/activities/environment-and-conservation/med-bycatch-project/en/

[95] The Deep Sea Conservation Coalition is made up of more than 80 non-government organizations, fishers organizations and law and policy institutes working together to protect vulnerable deep-sea ecosystems. http://www.savethehighseas.org/

[96] Deliverable 2 (D2): Guidelines for improving by-catch management in DSF (Task 3). See Annex 4 of the present report.

"Critical assessment of identified measures", where the main bycatch avoidance and mitigation measures are discussed for each group (i.e., Sharks and rays, marine mammals, seabirds and benthic organisms related to VMEs). Moreover, for each measure an **overview**, its **pros** and **cons** and the available evidence on its **effectiveness** are included. In addition, the D2 document is presented in the Annex 4 of the present report.

Results

Deliverable 2 (D2): Summary of findings and key information

The first section of this deliverable presents an assessment of the existing bycatch management approaches in the reviewed RFMOs. For this assessment, bycatch avoidance and management approaches were identified and described for each of the considered RFMOs. Once this information had been gathered, a comparative analysis of the implementation of bycatch mitigation measures across RFMOs was carried out. This facilitated the identification of the main measures taken in the different RFMOs to avoid and mitigate bycatch. In addition, this analysis allowed to evaluate the performance of the different RFMOs considered in this review, by using a modification of the "Bycatch mitigation effort Score"[97]. Using this metric, RFMOs were assessed for their efforts in addressing bycatch of 4 different groups: 1) Sharks and rays, 2) Marine mammals, 3) Seabirds and 4) Benthic organisms related to VMEs.

The implementation level of measures to avoid bycatch is different across the RFMOs. Some, such as CCAMLR, are very advanced while other RFMOs are still working on the implementation of measures to avoid and mitigate bycatch. For sharks and rays, the mitigation measures in use are: bycatch limits (e.g., CCAMLR, NEAFC, NAFO and SPRFMO), move-on rules (e.g., CCAMLR and SPRFMO) and live release of bycaught specimens (i.e., CCAMLR, NAFO and NEAFC). For marine mammals, the main measures implemented so far are: exclusion devices (e.g., CCAMLR), live release of bycaught specimens, prohibition of offal and discards during net shooting and hauling (e.g., CCAMLR) and mitigation of depredation (e.g., minimization of net exposure and avoidance of net maintenance in the water in CCAMLR and avoidance of hauling longlines in the presence of cetaceans in SIOFA). For seabirds, plenty of measures have been implemented: bycatch limits (CCAMLR), bycatch thresholds to revert to night setting (CCAMLR, SIOFA), live release (CCAMLR, SIOFA, SPRFMO), prohibition of net monitoring cables on trawl gears (CCAMLR), use of scaring lines and bird exclusion devices (GFCM, SIOFA, SPRFMO), minimization of illumination directed out from the vessel and night setting (CCAMLR, GFCM, SIOFA, SPRFMO), prohibition of offal and discards during net shooting and hauling (CCAMLR, GFCM, SPRFMO), adoption of gear configurations that minimize encounters (CCAMLR, SIOFA, SPRFMO) and mitigation of depredation (e.g., minimization of net exposure, avoidance of net maintenance in the water (CCAMLR). For benthic organisms related to VMEs, area closures (All RFMOs) and move-on rules (All RFMOs except GFCM) have been implemented to protect them.

The second section presents a critical assessment of the implemented measures. This assessment included the pros and cons of each measure. Also, based on the available information (e.g., evidence in literature, pilot studies or case studies), the effectiveness of these measures was discussed. Below is a summary of the results of this critical assessment, for each group of species:

[97] Developed by Elliott (2020) in 'A Review of Regional Fisheries Management Organization Efforts in Addressing Cetacean Bycatch: Report to the International Whaling Commission. CC/68A/06.4.2/01Rev1'.

Sharks and rays. **Bycatch limits** are widely used as bycatch mitigation measure. These limits allow for the regulation of the impacts upon a threatened species such that they do not endanger the continued survival of the species or population. Bycatch limits for some species of sharks and rays have been set in CCAMLR, NAFO, NEAFC and SPRFMO. CCAMLR, NAFO and SPRFMO have also adopted move-on rules related to sharks and rays. In setting effective bycatch limits, a good knowledge of the population being affected by bycatch is needed, which is generally not the case for sharks and rays. Therefore, it is difficult to determine meaningful bycatch limits for these species. In addition to that, setting effective bycatch limits requires a good characterization of the fishery and sufficient and accurate bycatch data, which is often not available. Theoretically, bycatch limits should be effective measures to limit the damage done to fish populations, but there is little evidence of its actual effectiveness in practice. **Move-on rules** related to sharks and rays have also been adopted by CCAMLR, NAFO and SPRFMO. One of the main concerns regarding move-on rules is potential displacement of effort to other areas, which would reduce or eliminate the supposed benefits of this measure. Therefore, bycatch levels and its distribution must be monitored to determine if move-on rules are being effective in reducing bycatch, and not only re-distributing the problem. Regarding their effectiveness, RFMOs have not carried out many studies to determine if move on-rules are achieving their objective of protecting bycaught species and avoiding local depletion. CCAMLR, for example, reviewed the implementation of the bycatch limits and move-on rules in fisheries between 2010 and 2018 and concluded that they were being effective according to the available information. However, they also acknowledged that bycatch limits had been based on a ratio of bycatch to target species that was derived from historical data and it was unclear whether this was still the best option to set bycatch limits. They also noted that alternative methods for setting bycatch limits may need to be developed and evaluated. CCAMLR, NAFO and NEAFC consider **live release** of elasmobranchs in their conservation measures. This measure is potentially effective in reducing the impacts of bycatch on many sharks and rays' species by reducing mortality. Some elasmobranchs are considered to have high survival rates, including lesser-spotted dogfish, thornback ray and blue shark. Also, some studies in CCAMLR have determined that survival rates for skates are high. However, post-release mortality is high for other species, such as thresher sharks and hammerhead sharks. For deep-water sharks (e.g., *Somniosus spp*.), even if there is no evident damage at the moment of release, there may be negative effects to their tissues (e.g., gas embolism disease) that produce the eventual death of the released animals. In practice, there is uncertainty of the real benefits of applying this measure for many species of sharks and rays due to a lack of post-release survivorship studies (e.g., tagging studies), so more research is needed.

Marine mammals. For marine mammals, **exclusion devices** that allow bycaught animal escaping fishing nets are potentially effective in reducing bycatch mortality (mainly for small cetaceans such as dolphins and pinnipeds). For example, top-opening, hard-grid exclusion devices have effectively reduced pinniped bycatch in a number of trawl fisheries. However, this measure has shown limited success in reducing cetacean bycatch (Hamilton and Baker, 2019 and references therein[98]). **Live release** has also been considered for bycaught marine mammals, for example, when entanglements in fishing gear occur. Although this measure is potentially effective in reducing bycatch mortality of marine mammals, there is a generalised

[98] Hamilton, S. and Baker, B. (2019). Technical mitigation to reduce marine mammal bycatch and entanglement in commercial fishing gear: lessons learnt and future directions. Rev Fish Biol Fisheries (2019) 29:223–247. Available at: https://doi.org/10.1007/s11160-019-09550-6

lack of information on the post-release health and survival of marine mammals that are injured, retain or ingest hooks, or remain entangled in gear. Thus, the actual effectiveness of this measure is not known and needs to be assessed through research. For example, carrying out surveys using photo-identification of tagging studies (e.g., telemetry) or using satellite-linked tracking of released animals could be very useful. Some of the RFMOs have also implemented some measures to **mitigate depredation**, which refers to the interactions between marine mammals and fishing operations that to occur when marine mammals actively seek to prey on fish captured in fishing gears. Such measures include, for instance, minimization of net exposure and avoidance of net maintenance in the water (implemented in CCAMLR) and avoidance of hauling longlines in the presence of cetaceans (implemented in SIOFA). These measures are also effective for reducing depredation by seabirds. Another measure implemented in the last decade to mitigate depredation in longline fisheries is the Chilean longlining system (trotline with nets). At present, the Chilean longlining system has shown great potential as a deterrent to cetacean depredation of target catch and as a means of seabird bycatch mitigation (FAO, 2021[99]). However, continued monitoring is required to observe the interactions between the Chilean system gear and cetaceans because over time, cetaceans could become habituated to the net shrouds and resume fish depredation. **Spatial closures** have also been considered to reduce interactions between marine mammals and fishing gear in areas where they both occur. Spatial closures for marine mammals have not been implemented in any of the RFMOs considered in this study. This measure could be considered by RFMOs, but most of them still lack appropriate knowledge on the abundance and temporal-spatial distribution of marine mammals which is necessary to establish spatial closures. For many cetacean species, **acoustic deterrents** (i.e., pingers) have been shown to be effective in reducing bycatch or causing area avoidance (e.g., harbour porpoise, striped dolphin, franciscana dolphin and several species of beaked whales). **Acoustic deterrents** are mainly used in gillnet fisheries, which are banned in many of the reviewed RFMOs in this document (CCAMLR, NEAFC, SEAFO and SPRFMO). However, this measure can be considered for other RFMOs, such as GFCM. For example, in the GFCM area of application, it seems pingers could have a positive effect on reducing the bycatch of Black Sea harbour porpoises in the Black Sea turbot gillnet fishery and for other cetacean species (Carpentieri *et al.*, 2021[100]). Nevertheless, acoustic deterrents seem to be ineffective for some species that are actually attracted to pinger sounds (e.g., bottlenose dolphin).

Seabirds. **Bycatch limits** for seabirds have been only established by CCAMLR. **Bycatch thresholds to revert to night settings** have been established in CCAMLR and SIOFA. No information on the effectiveness of this specific measure was found, because it is applied together with other measures in this fishery (CM 25-03 that sets out technical measures to minimize bird bycatch regarding net monitoring cables, vessel lighting, discarding of offal, net cleaning, net sinking and streamer lines). However, in the case the bycatch limits were reached, it would be effective in preventing further damage to the seabird populations. Setting longlines at night is effective at reducing incidental mortality of seabirds because the majority of

[99] FAO (2021). 'Fishing operations. Guidelines to prevent and reduce bycatch of marine mammals in capture fisheries'. FAO Technical Guidelines for Responsible Fisheries No.1, Suppl. 4. Rome. https://doi.org/10.4060/cb2887en

[100] Carpentieri, P., Nastasi, A., Sessa, M. & Srour, A., eds. (2021). 'Incidental catch of vulnerable species in Mediterranean and Black Sea fisheries – A review'. Studies and Reviews No. 101 (General Fisheries Commission for the Mediterranean). Rome, FAO. https://doi.org/10.4060/cb5405en

vulnerable seabirds are diurnal foragers (ACAP, 2021a[101]). The effectiveness of **night setting** is well documented in regional studies and has recently been confirmed on a large and temporal scale in a recent study (Jiménez et al. 2020 and references therein[102]). This measure produces the best mitigation scenario in combination with the use of line weighting regimes (in longlines) and bird scaring lines. Also, to maximize effectiveness, deck lighting should be kept at the minimum level appropriate for crew safety and directed inboard so the line is not illuminated as it leaves the vessel (ACAP, 2021a). **Live release** may reduce incidental mortality of seabirds and lessen the negative impacts of fishing on their populations. This measure has been implemented by some of the RFMOs, like CCAMLR, SIOFA and SPRFMO. As with elasmobranchs and marine mammals, bycaught animals are often injured, retain or ingest hooks, or remain entangled in gear and this affects their post-release survival. Post release survival seems to vary among different species. For example, wandering albatrosses appear to survive less after being released (Philips and Wood, 2020[103]). Nevertheless, studies regarding post-release survival for bycaught seabirds are scarce and more research is needed to determine the effectiveness of live-release for different seabird species. In trawl fisheries, high levels of seabird mortality have been associated with collisions with **warp cables and net monitoring cables** (also knowns as netsonde or third-wire). Because of this, the use of this equipment is currently banned in several regions (e.g., New Zealand and CCAMLR). This measure directly eliminates the risk of birds colliding with these types of cables. Where such a measure cannot be implemented, ACAP (2021b[104]) recommends: i) deploying bird scaring lines specifically positioned to deter birds away from net monitoring cables while fishing; and ii) installing a snatch block at the stern of a vessel to draw the net monitoring cable close to the water to reduce its aerial extent. **Scaring lines and bird exclusion devices** are both considered effective methods to reduce interactions of seabirds with fishing gears (ACAP, 2021a and references therein). Effectiveness is increased when used in combination with other measures – e.g., night setting, appropriate weighting of line and offal management. Discharge of offal and discards is the most important factor attracting seabirds to the stern of trawl vessels, where they are at risk of cable and net interactions (ACAP, 2021b). **Managing offal discharge and discards** while fishing gear is deployed has been shown to reduce seabird attendance of vessels and consequent risk of interactions and bycatch. In CCAMLR demersal fisheries, discharge of offal is prohibited during line setting. During line hauling, storage of waste is encouraged, and if discharged must be discharged on the opposite side of the vessel to the hauling bay. A system to remove fish hooks from offal and fish heads prior to discharge is required. Similar requirements are prescribed by other demersal longline fisheries (e.g. Falkland Islands (Islas Malvinas), South Africa and New Zealand (ACAP, 2021a). The following offal and discard management measures, in order of their effectiveness in reducing bird attendance, are recommended by ACAP (2021a

[101] ACAP (2021a). ACAP Review of Mitigation Measures and Best Practice Advice for Reducing the Impact of Demersal Longline Fisheries on Seabirds. In: ACAP - Twelfth Meeting of the Advisory Committee. Available at: https://www.acap.aq/resources/bycatch-mitigation/mitigation-advice/3950-acap-2021-demersal-longlines-mitigation-review-bpa/file

[102] Jiménez et al. (2020). 'Towards mitigation of seabird bycatch: Large-scale effectiveness of night setting and Tori lines across multiple pelagic longline fleets'. Biological Conservation, 247, 108642

[103] Phillips, R.A. and Wood, A.G. (2020) Variation in live-capture rates of albatrosses and petrels in fisheries, post-release survival and implications for management. Biological Conservation 247, 108641.

[104] ACAP (2021b). ACAP Review of Mitigation Measures and Best Practice Advice for Reducing the Impact of Pelagic and Demersal Trawl Fisheries on Seabirds. In: ACAP - Twelfth Meeting of the Advisory Committee. Available at: https://www.acap.aq/resources/bycatch-mitigation/mitigation-advice/3949-acap-2021-trawl-mitigation-review-and-bpa/file

and 2021b): (1) Retention of waste: no discharge during fishing trips should occur and if this is not possible (e.g., lack of storage space in the vessel), no discharge should occur during fishing activity (when cables or net are in the water); (2) Mealing waste: converting offal into fish meal, and retaining all waste material with any discharge restricted to liquid discharge; (3) Batching waste: waste should be stored temporarily for two hours or longer before strategically discharging it in batches and (4) Mincing of waste: reduce waste to smaller particles (currently only recommended as a mitigation for bycatch of large albatrosses). Repeated studies have shown that in the absence of offal discharge/fish discards seabird interactions and mortality levels are negligible. As with cetaceans, another measure to **mitigate depredation** in longline fisheries is the Chilean longlining system (trotline with nets). At present, the **Chilean longlining system** has shown great potential as a means of seabird bycatch mitigation (FAO, 2021[105]). Finally, **area and seasonal closures** can also help reducing bycatch of seabirds. Seabird mortality rates are generally higher close to breeding colonies during the breeding seasons. Because of this, seasonal fishing closure is regarded as a fundamental factor in reducing seabird bycatch in CCAMLR fisheries. This measure is applied in some high-risk areas such as South Georgia. There is, however, a risk that area or seasonal closures may displace fishing effort leading to increased mortality in other areas.

Benthic organisms related to VMEs. **Area closures** are used by RFMOs as the main measure to protect VMEs. The value and effectiveness of such closures is well-evidenced in the literature on marine protected areas, and studies have confirmed these benefits in the context of bottom fisheries closures in the high seas (Wright et al. 2015 and references therein[106]). However, this measure's effectiveness depends on the correct identification and definition of the area occupied by a VME. As was mentioned above, there is still a lack of empirical data (e.g., from research surveys) on the distribution of VMEs and identification of VMEs relies many times on the results of distribution models. The effectiveness of area closures can be improved by using explicit buffer zones. Another important aspect to be considered for the effectiveness of closures is determining the connectivity among the areas closed to protect VMEs. **Move-on rules** provide an immediate response that prevents further damage to possible VMEs encountered during fishing operations. In addition, move-on rules can serve as a safeguard to the main management measures (e.g., area closures) in case these happen to be extremely flawed. In general, there are concerns about the effectiveness of encounter protocols, and it is generally agreed that spatial restrictions and closures are more effective at protecting VMEs. However, encounter protocols still play an important role in areas that have not been fully mapped for the presence of VMEs. Because of this, move-on rules should be considered to be temporary measures: they can provide precautionary protection for areas showing evidence of VMEs and serve as an imperfect interim data collection measure, until objectively planned spatial closures can be implemented to protect VMEs. Ideally, **non-destructive sampling** should be used for detection and monitoring of VMEs instead of trawl-based surveys[107]. There are a few options that could be considered to carry out non-destructive sampling. For example, underwater imagery can be used to obtain information on the location and characteristics of potential VMEs, as has been done in surveys using remote operated vehicles (ROVs) or towed cameras.

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[105] FAO. 2021. 'Fishing operations. Guidelines to prevent and reduce bycatch of marine mammals in capture fisheries'. FAO Technical Guidelines for Responsible Fisheries No.1, Suppl. 4. Rome. https://doi.org/10.4060/cb2887en

[106] Wright *et al.* (2015). Advancing marine biodiversity protection through regional fisheries management: A review of bottom fisheries closures in areas beyond national jurisdiction. Marine Policy 61: 134–148

[107] This is currently a controversial issue of concern in RFMOs such as NAFO. See details in Task 2.

Another option to survey potential VMEs is using environmental DNA (eDNA). eDNA refers to DNA that is collected from an environmental sample (e.g., water or sediments) instead of directly collecting it from an organism. Nevertheless, there are still few studies using eDNA to detect VME species and specific pilot studies in different areas with diverse bathymetry and hydrographic conditions must be carried out to test the utility of eDNA for these purposes. And what is more, the method still needs to be fine-tuned to be able to overcome present difficulties, such as the lack of a unified protocol for sampling and interpreting DNA data.

Remaining challenges/issues are presented in the third section of the document. Finally, a series of **recommendations to improve bycatch management** are presented. These recommendations, for the different groups, can be summarized as follows:

- **Sharks and rays.** It is recommended that the technical effectiveness of mitigation measures for elasmobranch bycatch is investigated by RFMOs, considering the particular characteristics in each of the fisheries. Some of the measures to be considered are: (1) spatio-temporal closures; (2) net restrictions; (3) bycatch exclusion devices; (4) use of shark deterrents and (4) live release of specimens on board or from the net.

- **Marine mammals**. It is recommended that further research is carried out to determine the distribution of marine mammals in the RFMOs (including at different periods in the year), their biology and ecology, the fisheries that interact with them and bycatch rates. This is crucial to de able to implement conservation measures for marine mammals. Recently, FAO has elaborated Guidelines to prevent and reduce bycatch of marine mammals in capture fisheries (FAO, 2021[108]). It is recommended that RFMOs take advantage of the Guidelines to improve their conservation and management measures accordingly.

- **Seabirds**. There are several published guidelines and recommendations that can be used as a basis to improve seabird bycatch and conservation measures. These guidelines have been elaborated by FAO and various organisms dedicated to seabird conservation, for example the Agreement on the Conservation of Albatrosses and Petrels (ACAP). It is recommended that RFMOs dedicate attention to these publications. Recommended measures in the guidelines are identified depending on the type of fishing gear used. For trawl fisheries, the best measures for reducing seabird net entanglements are effective fish waste management combined with operational measures, such as cleaning the net prior to shooting and reducing the time the net is on the surface at shooting and hauling. Available evidence suggests that a no-discharge policy would virtually eliminate seabird mortality, and that strategic management of offal discharge is probably the most critical mitigation measure. For longline fisheries, using a combination of measures such as line-weighting, bird scaring lines and night setting has shown to be effective for reducing bycatch of seabirds. Therefore, these measures shall be considered by those RFMOs that have not implemented them[109].

[108] FAO (2021) 'Fishing operations. Guidelines to prevent and reduce bycatch of marine mammals in capture fisheries'. FAO Technical Guidelines for Responsible Fisheries No.1, Suppl. 4. Rome. https://doi.org/10.4060/cb2887en

[109] NAFO, NEAFC and NPFC have not yet implemented measures to avoid and reduce bycatch of seabirds. GFCM is working towards implementing such measures. GFCM/35/2011/3 establishes that contracting parties should develop mechanisms to ensure that incidental bycatch of seabirds in fishing activities is monitored, recorded and kept to the lowest level as possible, but no specific measures are enforced in GFCM/35/2011/3. However, Recommendation GFCM/44/2021/13 complements the previous

- **Benthic organisms related to VMEs**. Area closures are a well-established measure to protect VMEs, and are also required under the UNGA resolutions. Therefore, efforts should continue to identify areas were VMEs are present or are likely to occur. For areas closures already established, the possibility of improving the effectiveness of these closures shall be explored. For example, by determining buffer zones and taking into account the connectivity of the populations among different closures. Encounter thresholds still play an important role in areas that have not been fully mapped for the presence of VMEs and it is recommended that at least, a data-informed approach should be used for establishing such thresholds. Non-destructive sampling using eDNA seems to be a promising method for detecting and monitoring VMEs, and it is recommended to carry out specific research on this methodology.

Conclusions

The review of existing bycatch mitigation and management approaches in DSF allowed us understanding the current state of the protection of bycaught species in different RFMOs. Current conservation measures were critically assessed, which allowed us identifying their advantages and limitations, and effectiveness according to existing evidence. From this study, it is clear that RFMOs are advancing at different paces. Perhaps the biggest issue that remains, and that slows down bycatch mitigation efforts, is the generalised lack of data that still exists in many RFMOs regarding the interactions of vulnerable species with fisheries, that can end up as bycatch. This is especially evident for elasmobranchs, marine mammals and seabirds. As GFCM well acknowledges, the lack of data on the occurrence and level of bycatch hinders the ability to manage and apply rules on fishing vessel activities. Even where data exists, the lack of statistically robust and harmonized sampling designs limits its value and, for example, prevents comparisons between different fishing fleets and areas. Therefore, actions shall be implemented (or continued) to achieve adequate monitoring programs and frameworks that can provide sound bycatch data collection are urgently required. Once this data becomes available, better measures can be designed to protect bycaught species in DSF.

Recommendation and establishes a series of measures that shall be evaluated by CPCs to determine their effectiveness, with the purpose of improving protection of seabirds.

TASK 4 – Criteria for the establishment of footprints and historical fishing, and the development of a framework for exploratory fisheries and scientific surveys.

Objectives

The objective of this task is focused on the review of the existing criteria/methods for characterisation of fishing footprint in DSF in relevant RFMOs (NAFO, NEAFC, SEAFO, GFCM, NPFC, SPRFMO, SIOFA and CCAMLR), as well as in FAO Area 41. Furthermore, a framework for exploratory fisheries and scientific surveys was developed.

Methodology

This task is mainly a desk-based research that compiled relevant information to address the following three specific sub-tasks:

<u>Sub-task 4.1 – Criteria and methodologies for fishing footprints</u>

During the first stage of this review, a template to obtain information for each RFMO/Fishing area (NEAFC, SPRFMO, SIOFA, NAFO, FAO Area 41, GFCM, SEAFO, NPFC and CCAMLR) was prepared by IEO and circulated among partners in order to collect information related to the following issues: (i) Diversity of fishing fleets, their practices and strategies; (ii) Operative/technical characteristics of the fishing gear (mobile vs. static); (iii) Definition of spatial footprint for a typical fishing gear deployment event; (iv) Time frame used for each RFMO/ FAO Area 41 to calculate the fishing footprint; (v) Spatial resolution of the data used to calculate the footprint; (vi) Availability of data and coverage; (vii) Quality of data (missing VMS pings; irregularities in the data transmission); (viii) Effort units that are being used and; (ix) Other issues to consider in order to describe the criteria and methodologies conducted in this RFMO with regards to the fishing footprint definition/establishment. This sub-task produced the **Deliverable 3 (D3[110])** which included improvements based on the feedback from DG MARE. In line with this, additional sections were included in order to expand the information collected: (i) Identify the link between the fishing techniques/gears and the specific challenges/issues related to the definition of the fishing footprint (e.g. specific methodologies for different fishing techniques/gears, data needs, specific data analysis, etc.); (ii) Identify strengths and weaknesses of the methodologies used for establishment of historical and cumulative fishing footprint and; (iii) Suggest/propose recommendations (e.g. specific methodologies for different fishing techniques/gears, data needs, specific data analysis, etc.) that could be considered as guidelines for future EU proposals regarding the definition of footprint. Moreover, following CINEA suggestions, additional information was collected to compile general considerations and recommendations applicable to the different RFMOs and FAO Area 41, as well as information on the concept of "fishing footprint" in the RFMOs.

The main findings from this sub-task, as extracted from D3, are presented below, in the subsection titled ***"Results; Deliverable 3 (D3): Summary of findings and key information"***. In addition, the D3 document is included in the Annex 5 of the present report.

[110] Deliverable 3 (D3): Review of existing and recommended criteria and methodologies for the establishment of historical and cumulative fishing footprints (Task 4 – Sub-task 4.1). See Annex 5 of the present report.

Sub-task 4.2 – Approaches for "*exploratory fisheries*" and options

Templates to obtain information for each RFMO/Fishing area were prepared by IEO and circulated among partners. Information regarding the following aspects was collected:

a. Legal framework and implications.
b. Definition/meaning of the concept "*exploratory fisheries*".
c. Description of the "*exploratory fisheries*" process and steps.
d. Existence of a preliminary assessment, or bottom fishing impact assessment (BFIA): description of the content.
e. Review of conservation and management measures to prevent SAIs.
f. Exploratory fisheries monitoring.
g. Experience with exploratory fishery protocols.
h. Strengths and weaknesses of the exploratory fishery protocols
i. Recommendations.
j. Other issues that could be useful for providing options for a framework for "*exploratory fisheries*".
- References

Main topics of the exploratory fisheries approaches were summarized. This exercise allowed us to explore the potential elements needed for developing a framework for exploratory fisheries.

The main findings from this sub-task, as extracted from Annex 6, are presented below, in the subsection titled ***"Results; Annex 6[111]: Summary of findings and key information"***. In addition, the Annex 6 is included in the present report.

Sub-task 4.3 – Framework for research activities not related to fisheries

Information on the existing procedures for conducting research in the RFMOs was compiled and summarized. As a previous step, templates to obtain complementary information for each RFMO were prepared by IEO and then circulated among partners. Information regarding the following aspects was collected:

a. Relevant research projects.
b. Relevant research programmes.
c. Surveys at the sea.
d. Identify strengths and weaknesses of the scientific research projects/relevant programmes.
e. Experience with data sharing and potential integration of new data in the RFMO advisory cycle, and remarkable consequences, if any
f. Potential adverse impacts of scientific research activities and mitigation measures. Alternative methods.
g. Other issues/recommendations that could be useful for providing options for the development of a framework for scientific research activities (not related to fisheries).
- References.

Key findings and lessons learned from the RFMOs were summarized. This exercise allowed us to explore the potential elements needed for developing a framework for scientific research.

[111] Annex 6 (Sub-task 4.2) - Approaches for "exploratory fisheries" and options.

The main findings from this sub-task, as extracted from Annex 7, are presented below, in the subsection titled ***"Results; Annex 7[112]: Summary of findings and key information"***. In addition, the Annex 7 is included in the present report.

Results

Sub-task 4.1 - Deliverable 3 (D3): Summary of findings and key information

Deliverable 3 (see Annex 5) carries out a review of information related to fishing footprint from relevant RFMOs (NAFO, NEAFC, SEAFO, GFCM, NPFC, SPRFMO, SIOFA and CCAMLR) as well as FAO Area 41 (Southwest Atlantic Ocean). This review takes into account the difficulties and limitations to define bottom fishing footprints in Deep Sea Fisheries. An important finding is that, despite the relevance of the concept of "*fishing footprint*" in the context of DSF management, this concept is not specifically defined in the FAO Guidelines as a *"key concept"*. Nevertheless, in most of the RFMOs the terms *"fishing footprint*", "*bottom fishing footprint*", "*existing bottom fishing areas*", "*existing deep-sea bottom fishing areas*" generally refer to the same concept (i.e. those locations in which some level of bottom fishing activity has previously been conducted in a reference period). As is widely recognized, the determination of the historical bottom fishing footprint, and the resulting establishment of areas where such fishing has not taken place, is crucial for the adequate management of DSF, and in particular for the adoption and implementation of appropriate management measures for the protection of VMEs from the impacts of bottom fishing gears, including through the adoption of encounter and/or exploratory fishing protocols. Therefore, a section on the concept of "fishing footprint" within the different RFMOs is included in Deliverable 3 (see Table 1) as a necessary starting point. The footprint definition is still under development within some RFMOs (e.g. NPFC, GFCM).

Table 1. Overview of the concept "fishing footprint/existing bottom fishing areas" in the RFMOs.

Atlantic Ocean and adjacent waters	NAFO[113]	*"<u>Footprint</u>"*, otherwise known as *"<u>Existing bottom fishing areas</u>"*, means that portion of the Regulatory Area where bottom fishing has historically occurred (based on information concerning the period 1987-2007)[114], and is defined by the coordinates shown in Table 4 and illustrated in Figure 2 of NAFO CEM.
	NEAFC[115]	*"<u>Existing bottom fishing areas</u>"* means the portion of the Regulatory Area where bottom fishing has historically occurred, based on information concerning the period 1987-2007 (Article 4). Areas where the NEAFC Commission decides to authorise new bottom fishing based upon the exploratory fisheries conducted in the previous two years are also defined as "existing bottom fishing areas".
	SEAFO[116]	*"<u>Existing bottom fishing areas</u>"* means the portion of the Convention Area where bottom fishing occurred in the period 1987-July 2011. Areas where new bottom fishing activities are authorised shall be defined as "existing bottom fishing areas" pursuant to Article 4.
	GFCM[117]	*"<u>Existing deep-sea bottom fishing areas</u>"*, means that portion of the GFCM area of application where deep-sea bottom fishing has occurred up to and including 2019.

[112] Annex 7 (Sub-task 4.3) - Framework for research activities not related to fisheries.
[113] NAFO Conservation and Enforcement Measures (CEM) 2021.
[114] NAFO Secretariat (2009) https://www.nafo.int/Portals/0/PDFs/fc/2009/fcdoc09-20.pdf
[115] NEAFC Recommendation 10:2021. Recommendation to amend Recommendation 19:2014 on the Protection of Vulnerable Marine Ecosystems in the NEAFC Regulatory Area, as amended.
[116] SEAFO Conservation Measure 30/15 on Bottom Fishing Activities and Vulnerable Marine Ecosystems in the SEAFO Convention Area (Adopted 03/12/2015).
[117] GFCM-WGVME (2017) Scientific Advisory Committee on Fisheries (SAC). Report of the first meeting of the Working Group on Vulnerable Marine Ecosystems. Malaga, Spain, 3-5 April 2017.

Pacific Ocean	NPFC[118]	Under CMM 2021-05 and CMM 2019-06, members are required to submit to the Scientific Committee (SC) an estimate of their impacts on VMEs and the footprint is assessed according to the standards laid out in the Annex 2 *'Science-based Standards and Criteria for Identification of VMEs and Assessment of Significant Adverse Impacts on VMEs and Marine Species'*. Member states submit the required data the on an annual basis which are reviewed by the Scientific Committee.
	SPRFMO[119]	Area of the sea floor potentially contacted by bottom fishing gear. It was constructed from reported demersal and midwater trawling, and bottom longlining fishing effort records from 1989 to 2019[120].
Indian Ocean	SIOFA[121]	*"SIOFA bottom fishing footprint"* means a map of the spatial extent of historical bottom fishing in the Agreement Area, for all vessels flagged to all Contracting Parties, Cooperating Non-contracting Party (CNCPs) and Participating fishing entities (PFEs) over a period to be defined by the Meeting of the Parties. The SC agreed that the maps will include all grid squares in which fishing effort has been recorded between 2000 and 2015[122].
Southern Ocean	CCAMLR[123]	*"Fishing footprint"* is the area of the seafloor within which fishing gear interacts with benthic organisms. Fishing footprint may be expressed per unit of fishing effort for a particular gear configuration (e.g. for longlines, km^2 seabed contacted per km of longline deployed), or as a cumulative footprint when calculated and summed for all fishing gear deployments in a defined period and area. This areal measure does not incorporate the level of impact within the footprint. This defines both the fishing footprint from an individual fishing event and the cumulative footprint.

Moreover, as part of the review conducted on the current evaluation methods to define the fishing footprint for all the RFMOs (and FAO Area 41), Deliverable 3 includes a description of the areas with maps, a detailed description of fisheries (e.g. species names, countries, number of boats, fishing gears and their characteristics etc.), the spatial resolution and time frame used to calculate the footprint, availability and quality of data, etc. This review shows that there is a very wide variety of methods that are being used in the different RFMOs, NAFO, NEAFC and CCAMLR being the ones with more advanced experience.

Finally, after analyzing all the information together, Deliverable 3 provides a general section with what could be "General considerations and recommendations" applicable to the different RFMOs and FAO Area 41. This information could be useful as a guideline to study the fishing footprint. A summary of the key findings is:

i) Data needs such as VMS data, Catch data; Information on technical and operative characteristics of the bottom fishing gears; best available spatial and temporal resolution of data.
ii) Data compilation and availability: There are substantial differences between RFMOs, where only some of them have the duty to make available compiled data. In this regard, VMS data is recently operational in NPFC and GFCM is still in a

[118] NPFC (2021) Sustainable use and conservation handbook.
[119] SPRFMO CMM 2.03. (2014) Conservation and Management Measure for the Management of Bottom Fishing in the SPRFMO Convention Area. Paragraphs 6 & 8(d). For the purpose of this measure, the term *'bottom fishing footprint'* means a map of the spatial extent and distribution of historical bottom fishing in the Convention Area of all vessels flagged to a particular Member or CNCP over the period 1 January 2002 to 31 December 2006. CMM 2.03 is superseded/expired and since 2019, the definition of *'bottom fishing footprint'* is missing in the SPRFMO CMMs for the Management of Bottom Fishing (CMM 03-2019, CMM 03-2020, CMM 03-2021).
[120] SC8-DW07 rev 1 Cumulative Bottom Fishery Impact Assessment for Australian and New Zealand bottom fisheries in the SPRFMO Convention Area, 2020.
[121] SIOFA Conservation and Management Measure for the interim management of bottom fishing in the Agreement Area (interim management of bottom fishing) CMM 2020-01.
[122] SIOFA (2019) Report of the Fourth Meeting of the Scientific Committee of the Southern Indian Ocean Fisheries Agreement (SIOFA) Yokohama, Japan 25 – 29 March 2019.
[123] Sharp and Parker (2010) An updated glossary of terms relevant to the management of Vulnerable Marine Ecosystems (VMEs) in the CCAMLR Area (WG-FSA-10/28) https://www.ccamlr.org/en/wg-fsa-10/28.

less evolved stage. The endorsement of a plan and timelines to define the fishing footprint, when the information is not easily available, is recommended.

iii) Data quality of the input data is linked to the accuracy of fishing effort estimation as it has been identified in NAFO. The implementation of improved quality control process is recommended in the RFMOs, as the one implemented in ICES when receiving VMS and logbooks.

iv) Data sharing and international cooperation (management agreements and multilateral action plans) on research is necessary, especially in FAO Area 41 due to the absence of a relevant RFMO, to ensure the monitoring of the fleets. Furthermore, Memoranda of Understanding (MoU) between organizations have proven to be useful to foster closer relationships.

v) Methodology: Given the existence of various approaches to define the fishing footprint, it is recommended to conduct a review of potential new methods and compare with the existing ones as it was done in NAFO. Particularly, this review is a matter of interest in CCAMLR. Besides, when bottom longline fishery footprint is not well defined as in NAFO, it is recommended to explore the implementation of methods used by RFMOS with advanced experience as CCAMLR.

vi) Complementary/potential useful data sources and approaches: Exploration of the utility of AIS data is recommended as potential data source as well as the implementation of tracking devices in small vessels. Additionally, the use of night-time imaging could be recommendable to follow the activity of certain fisheries as jigger fishery in the SW Atlantic Ocean.

vii) Funding studies to analyse the fishing footprint (as NEREIDA EU Programme in NAFO) has been shown to be crucial to improve footprint knowledge and resolution.

Sub-task 4.2 - (Annex 6): Summary of findings and key information

Exploratory bottom fishing has been the subject of an increased volume of regulation by RFMOs in the framework of the implementation of the UNGA Resolution 61/105 and drawing upon the technical advice of the FAO. The process is exemplified by the practice of RFMOS which adopted regulations on bottom fishing, incorporating relevant elements from the UNGA resolution 61/105, and the FAO DSF Guidelines, including the adoption of an exploratory fishing protocol. Annex 6 includes a Table that summarizes the main elements of the existing approaches for "*exploratory fisheries*" in the RFMOs.

Legal framework.

With regard to the legal framework, CCAMLR is the most prominent regulator of exploratory fisheries while GFCM does not have a specific legal framework and NAFO and NEAFC have amended their protocols several times. Furthermore, the definition of the term "*exploratory fisheries*" is inconsistent across the regulatory bodies.

Process and preliminary assessments.

In general terms, RFMOs follow similar specific procedures, where they are expected to apply the precautionary approach. Members of RFMOs are required to provide information in accordance with guidelines and criteria to assess potential SAIs on VMEs. An exceptional case is SIOFA that has not clearly defined what an "Exploratory fishery" is. An intersessional work by the members has been recommended by the Meeting of the Parties (MoP) in 2019 in order to progress with the establishment of a framework for New and Exploratory Fisheries based on a draft proposal presented by the EU (MoP6-Prop08). However, this work has not been taken forward to date. In addition, with regard to exploratory fisheries processes, for most RFMOs, their contracting parties are required to submit a notice of intent and a preliminary assessment of the anticipated impacts on VMEs. In the case of GFCM, the adopted protocols/measures are only voluntary instruments not supported by a binding decision[124] [125].

Conservation and management measures to prevent SAIs.

Most of the RFMOs, with the exception of GFCM, have implemented specific conservation and management measures to prevent Significant Adverse Impacts (SAIs) on VMEs.

Exploratory fisheries monitoring and protocols.

In most RFMOs, monitoring of exploratory fisheries is mandatory, through a strict protocol that includes placing an observer on board to ensure data collection on VME indicator species. In the Atlantic Ocean, there are few experiences using the protocols established following the FAO Guidelines. With respect to the Pacific Ocean, no exploratory fisheries were conducted in the NPFC Area, but there are several experiences in the SPRFMO Area. In the case of SIOFA, this RFMO is working on the definitions of protocols (not yet implemented). In the case of the Southern Ocean, CCAMLR has experience with exploratory fisheries targeting toothfish.

Finally, Annex 6 includes a brief discussion on **strengths** and **weaknesses**, as well as some **recommendations**.

Strengths

In general terms, there are well defined protocols to assess the exploratory fishery proposals in line with the precautionary approach. In this regard, some RFMOs as **NAFO** can be considered as a front-runner in introducing measures to regulate and monitor bottom fisheries. Some other RFMOs such as NEAFC and the **SEAFO** have adopted the VME encounter protocols and thresholds introduced by NAFO. Moreover, NAFO achieved great progress in adopting various measures to decrease by-catch through gear modifications and put in place observer codes for VME indicator species to facilitate the reporting of encounters. All exploratory fisheries in NAFO require prior approval and are conducted under strict controls, which is crucial to make a good assessment of the possible impacts and for the development of appropriate management measures. Furthermore, NAFO has a working group of fishery managers and scientists on VMEs that was created to examine scientific advice and evaluate risks.

In the case of **NEAFC**, mandatory preliminary impact assessment is required before exploratory fisheries can commence. Moreover, PECMAS and ICES (if required) provide scientific advice to the Commission as to whether the proposed exploratory bottom fishing should be approved, or on the mitigation measures needed. For this RFMO, it is mandatory to have scientific observers on board that conduct the monitoring of the exploratory bottom fishing and collect key information. **CCAMLR** has also implemented the presence of scientific observers on-board all exploratory fisheries to undertake data collection plans and has a Scientific Committee to review and advise the Commission on appropriate fishery management and approval of

[124] FAO. 2019. Report of the forty-second session of the General Fisheries Commission for the Mediterranean (GFCM), FAO headquarters, Rome, Italy, 22–26 October 2018. GFCM Report No.42. Rome. 146 pp
[125] FAO. 2020. The State of Mediterranean and Black Sea Fisheries 2020. General Fisheries Commission for the Mediterranean. Rome. https://doi.org/10.4060/cb2429en

Member applications. Since 2003, 100% observer coverage across all toothfish vessels is mandatory.

Several strengths of the exploratory fishing process have been identified in **SPRFMO**, as it has a "*checklist for assessment of exploratory fisheries proposals"* that is a useful tool that guarantees an efficient scientific assessment and advice where all proposals for new exploratory fisheries available publicly. Moreover, new/exploratory fishery within this area can only commence if cautious preliminary conservation and management measures have been adopted and decisions shall be based on the best scientific and technical information available. In addition, fishing Operation Plans requires information on "*the anticipated cumulative impact of all fishing activity in the area of the exploratory fishery if applicable*". Even though there is always room for improvement, this process provides an excellent framework for the development of proposals for new and exploratory fisheries.

Weaknesses

Some RFMOs, such as **GFCM**, do not have specific conservation and management measures applied to the exploratory fishing activities to prevent significant adverse impacts (e.g. Exploratory Fishery Protocol adopted by NAFO and NEAFC). A different case concerns that of those areas with absence of an RFMO (e.g. **Southwest Atlantic**), where the unilateral fishery protocols adopted by a particular flag State are not effective as they apply only to vessels of that particular flag. In addition, **SIOFA** has not yet defined what constitute "*Exploratory*", "*New*" or "*Research*" fishing. In this respect, it is still working to adopt CMMs with respect to new or exploratory fisheries, and research fishing.

Other RFMOs, such as **NPFC** have Interim Measures that are voluntary and there is no penalty for violations. Absence of Technical Guidelines and no specific reporting requirements during and after the proposed exploratory fisheries, together with the lack of detail in the procedures to evaluate impacts on VME based on post-fishing reports is considered as a big weakness to be taken into account.

In **NEAFC**, with the exception of vessels carrying out exploratory fishing in new bottom fishing areas, vessels in the remainder of the Regulatory Area are under no obligation to carry observers.

Other particular weakness concerning the exploratory fisheries is that **SPRFMO** does not specify that a proposal for exploratory fishery should be rejected if there is a shortage of information. Additionally, some authors consider that the adopted thresholds levels, the incomplete list of VME indicators, the procedures for scientific assessment of the encounters and the provision of advice on encounters, are matters of concern in SPRFMO.

SEAFO has a well-defined protocol to assess exploratory fishery proposals, with detailed information about how to present the preliminary assessments and notices of intent to undertake exploratory fishing, with a defined deadline. Therefore, no relevant weaknesses were identified in this aspect.

CCAMLR, in its second performance review in 2017, recommended better coordinating research activities among Members. In order to promote and ensure that the data collected and analysed are suitable to provide the best advice to the Commission, research should be coordinated across multiple management areas rather than fragmented within each management area.

Recommendations on potential elements needed for developing a framework for exploratory fisheries

- Carry out robust environmental assessments to avoid that an initially small exploratory fishery, approved with minimal environmental assessment, could quickly expand, increasing the potential for significant adverse impacts. These assessments are a core tool for ensuring precaution in the development of new fishing activities.
- Expand the impact assessments to all fishing activities and other elements of the marine ecosystems.
- An Integrated approach to environmental assessments is needed to address global conservation concerns and to contribute to the development of regional cooperation, coordination and capacities. Enhanced cooperation includes improved access to information, better alignment of conservation objectives, more participatory decision-making, and improved integration of biodiversity considerations and cumulative impacts.
- Continue to support the undertaking and completion of exploratory fisheries using precautionary conservation and management measures until there is sufficient data to allow the assessment of the impact of the fisheries on the long-term sustainability of the stocks and on VMEs.
- Enhanced cooperation between RFMOs (e.g. NAFO and NEAFC) based on the fact that some species of fish are so wide-ranging that they are found in the regulatory areas of more than one RFMO and the fact that modern-day fishing fleets are highly mobile and may well target similar stocks in adjacent regions almost simultaneously.
- In certain RFMOs, such as SEAFO, there does not seem to be much interest from countries in submitting exploratory fishing proposals. In such cases, it is recommended to analyze the reasons why this is happening, whether it is due to scarce fish stocks, over-legislation, too many restrictions on commercial fishing, or others.
- Update protocols in those RFMOs, such as GFCM or NPFC, where they are still in a very preliminary stage or need to develop detailed technical guidelines for preparation and submission of notifications of exploratory fisheries that qualify the information required. Development of Guidelines about the methodology of the assessment could help contracting parties to prepare the assessments in a more standardized way. This should be done according to the requirements of FAO DSF Guidelines, and taking advantage of the experience with exploratory fishery protocols and impact assessments in other more advanced RFMOs (e.g. NEAFC).
- Furthermore, in the absence of a RFMO, as occurs in the High Seas of SW Atlantic, all States fishing in the area should implement appropriate protocols for exploratory fisheries and impact assessments (including mandatory observer programmes and *ad hoc* mitigation and management measures), based on FAO DSF Guidelines and considering the progress in the RFMOs and their scientific bodies.
- Update and review periodically the list of VME taxa and their threshold levels of as necessary when better information on the taxa become available, so that taxa can be assessed against more VME criteria. Updating this list must help to prevent significant damage to all VMEs impacted by bottom fishing and will ensure that the encounter protocol designed to be established when a VME is like to be encountered is including all VME taxa.

Sub-task 4.3 - (Annex 7): Summary of findings and key information

Role of the scientific advisory bodies.

In general, Scientific Councils or Committees (SC) of the RFMOs have the functions of encouraging, promoting cooperation and coordinating the international scientific research (e.g. NAFO, SEAFO, SPRFMO, SIOFA and CCMLR). In the NPFC Convention, such functions are not specifically mentioned as primary functions of the SC. In the case of the GFCM, this role is played by the Commission. In the case of NEAFC, ICES, as the scientific advisory body the RFMO, is in charge of these functions, supported by the PECMAS[126].

Research work plans.

Most of the RFMOs have developed work plans for their advisory bodies in a multiannual (e.g. NAFO, NPFC, SPRFMO, CCAMLR, SIOFA) or annual (e.g. SEAFO, SPRFMO in the past) basis, including planning of research priorities. Research programmes have been included, through specific recommendations, in the work plan of GFCM. NEAFC does not perform any scientific work, but rather relies on ICES for scientific advice, which develops appropriate research programs with the support of PECMAS.

Guidelines for scientific research.

Most RFMOs have not developed guidelines or codes of conduct for scientific research, although technical protocols for fisheries surveys have been implemented with the aim to standardized data collection (e.g. NAFO, GFCM and CCAMLR). Only SEAFO has developed a specific *"guidelines for fisheries research and basic marine science activity"*. In the case of Northeast Atlantic Ocean, the OSPAR area overlaps with the NEAFC area and OSPAR has developed a *"code of conduct for scientific research in the deep seas and high seas of the OSPAR maritime area"*. Moreover, from the NEAFC side, if the need to set measures to control scientific research should arise, these can be established thanks to Article 10 of the NEAFC Convention.

Measures in force regarding scientific research.

There are a variety of approaches in the RFMOs regarding conservation and management measures related to scientific research. Intended research must be notified to NAFO, but confirmation of scientific validity by the NAFO SC is not required and there are no provisions about impacts on VMEs. Research activities within NEAFC closed areas and/or restricted bottom fishing areas shall be notified, taking account of Article 206 of the UNCLOS. Scientific research in SEAFO is requested to adhere to the SEAFO *"guidelines for fisheries research and basic marine science activity"* during the different phases of the activity. RFMOs such as NPFC and CCAMLR have implemented some conservation and management measures related to scientific research.

Impact of research vessel surveys on VMEs.

The issue of the impact of research on VMEs is addressed in the conservation and management measures of some RFMOs (e.g. NEAFC, SEAFO, SIOFA and CCAMLR). The impact of research vessel groundfish surveys on VMEs is being monitored by NAFO. Currently, there are studies in progress on the effects on fish stock assessments of excluding surveys trawls from the VME closed areas. In addition,

[126] Permanent Committee on Management and Science of NEAFC.

NAFO has outlined the alternative non-invasive sampling methods available to study VME, but has not yet made any decisions on their use[127].

Recent new initiatives to regulate and encourage scientific research.

The regulation of scientific research is currently a matter of concern in some RFMOs and several initiatives are being carried out in this regard. NAFO just started the process to amend Article 4 of NAFO CEM, in order to include a scientific review of proposed major research surveys. Moreover, specific proposals for implement measures on management of the scientific research are currently discussed in SPRFMO and SIOFA.

Finally, Annex 7 includes a brief discussion on **strengths** and **weaknesses,** as well as some **recommendations**.

Strengths

One of the most notable strengths of **NAFO** is the existence of a long series of scientific surveys and associated databases (e.g. groundfish surveys funded by the EU, NEREIDA surveys led by EU-Spain), which underpin management decisions on fish stocks and VMEs. NAFO is one of the few RFMOs that assesses VMEs through scientific surveys; however, these are done as part of groundfish surveys and are themselves invasive, which can also be seen as a weakness. To solve this issue, NAFO is currently evaluating the effects on fish stock assessments of excluding survey trawls from the VME closed areas, and if this exclusion compromises the quality of index data used in the assessments. Additionally, a reflection on the potential use of non-invasive sampling techniques to monitor VMEs has been initiated. The introduction of such methods would potentially strengthen NAFO scientific research programmes and could inform research on VMEs in other regions.

NEAFC has signed Memorandums of Understanding (MoUs) with ICES and OSPAR. Such MoUs strengthen the collaboration between these organizations. ICES is the scientific advisory body of NEAFC, as NEAFC does not undertake research of its own. ICES, supported by the Permanent Committee on Management and Science (PECMAS) of NEAFC, develop appropriate research programs to meet longer-term issues raised by NEAFC. The involvement of ICES strengthens the advisory process: (i) ICES advice is independent and free from political influence, (ii) it is subject to the best international quality procedures for research, and (ii) it includes ecosystem considerations (e.g. fisheries impacts on marine mammals, sea birds and sensitive habitats, etc.). There is a good cooperation between NEAFC and OSPAR over the adoption and delineation of high seas MPAs and bottom fisheries closures (as well as other closures), based on data from scientific research. Both are often held up as examples of cross-organizational cooperation and coordination, it should also be noted that the conditions that enable and facilitate NEAFC and OSPAR's cooperation do not exist in most other areas of the world; while lessons can be learned from their approach, its model could not be successfully replicated across the globe. It is worth noting that the OSPAR Area overlaps with the NEAFC Area and that OSPAR has adopted the non-legally binding "Code of Conduct for Deep Sea and High Seas Scientific Research of the Maritime OSPAR Area" with the aim of mitigating the impacts of research.

The FAO ABNJ Deep Seas Project is providing useful assistance to **SEAFO** on the VME database, best practices for VMEs, work on sponges, ecosystem approaches, and the

[127] Report of the 10th Meeting of the NAFO Scientific Council Working Group on Ecosystem Science and Assessment (WGESA). Northwest Atlantic Fisheries Organization. 8-16 November 2017, Dartmouth, Canada. Serial No N6774, NAFO Scientific Council, 2017. Summary Document 17/21

potential for facilitating fisheries sector representation in international fora among other issues. Its collaboration with SEAFO is of utmost importance.

In **NPFC**, there has been an active collaboration among Japan, the Republic of Korea and the USA on the development of a standard field guide for coral identification. A standard field guide has also been drafted in all three languages for use by observers and scientists at sea.

SPRFMO is a young RFMO that is taking advantage of the opportunities to engage in collaborative research or data sharing with other organisations, and this contributes to strengthening its science-based management. In this regard, SPRFMO is involved in international research programmes (e.g. the ABNJ Deep Seas project). Additionally, SPRFMO has signed different Memoranda of Understanding (MoU) or Agreements with adjacent RFMOs and other organisations. All these initiatives provide opportunities to promote and facilitate cooperation, including collaborative research and capacity building, as well as sharing experiences and data on matters of mutual interest. Since 2013, the SPRFMO research programme considers the incorporation of different components of the exploited resources and their associated ecosystems, and encompasses both the Precautionary Approach and the Ecosystems Approach to Fisheries Management. Moreover, research priorities are set out in the SPRFMO SC work plan (SPRFMO, 2018), and this provides a level of coordination for research that strengthens support for SPRFMO goals.

Most of the SIOFA scientific activity is carried out by external consultants that are financed by the SIOFA budget, with support from members/operators or through projects such as the ABNJ Deep Seas Project from FAO. To promote greater involvement of the scientists from the parties to provide more robust and transparent advice to the Meeting of the Parties would be recommended, rather than delegating scientific work to external consultants. Projects or grants could finance thematic workshops, training courses etc.

A major strength of the **CCAMLR** research projects/programmes is that collaborative research is encouraged and many of the research proposals submitted are joint proposals from a number of Members. The recent synoptic survey on krill, for example, required extensive cooperation between members and scientists to coordinate a survey between several vessels over a large area, including collecting, standardising and analysing the data at the end.

<u>*Weaknesses*</u>

With regard to the research managed by **NAFO**, there are currently no specific provisions for scientific approval of survey plans. To overcome this weakness, in 2021 the SC recommended that the NAFO Commission amend the current protocols to include a scientific review of proposed major research surveys going forward, in order to ensure that best practices are followed. Scientific international research projects such as ATLAS (www.eu-atlas.org) and SPONGES (http://www.deepseasponges.org) funded by the EU, provided important results, based on groundfish survey data, supporting the advice on VMEs and contributing to implement the Galway Statement on Atlantic Ocean Cooperation128.

Research related to activities other than fishing (e.g. oil and gas) is not regulated by NAFO, but is relevant in the **NAFO** Regulatory Area, including within VME closed areas. It could provide useful VME data (e.g. visual surveys) or produce adverse

[128] In 2013, the EU, the US and Canada signed the *Galway Statement on Atlantic Ocean Cooperation*, which aims to join forces on the Atlantic Ocean research, in order to better understand this Ocean and promote the sustainable management of its resources.

impacts (e.g. seismic surveys, drilling surveys) on the ecosystems that support NAFO fisheries. The lack of coordination between the different management authorities (e.g. NAFO and CNLOPB[129]) can be considered a weakness in terms of ocean governance, as this prevents research optimization and impacts mitigation.

NEAFC has not adopted any specific actions to minimise the impacts of research as there has been no suggestion of relevant adverse impacts associated with scientific investigations. NEAFC recommendations contain only general provisions on this issue and this could be considered a weakness. However, NEAFC Convention guarantees the legal competence to take action in this regard.

Further research on orange roughy is desirable and the possibility of extending the Namibian orange roughy surveys to the **SEAFO** Convention Area (CA), has been discussed within SEAFO. However, given Namibian´s current financial situation, a survey is not likely in the immediate future. The spatial distribution of VME indicators such as corals and sponges is however not well known in SEAFO, hence a need for further information from scientific investigations at sea has been recognized. Additionally, there are 11 fishing closures within the SEAFO CA, and a new area on the Valdivia was closed to other gears than pots and longlines. These closures were likely to represent VME locations. Research aimed to validate these potential VMEs locations is highly recommended (e.g. Spanish-Namibian surveys and Nansen surveys). More research efforts are needed.

Although different activities are being carried out at **GFCM**, there are not scientific research projects of scientific surveys carried out under their coordination. In European waters, several projects are carried out whose results can be used for these activities, as well as the Data Collection of commercial and survey data funded by the EU, which includes both demersal bottom trawl surveys and acoustic surveys.

A large focus on VME research in **NPFC** has focused on coral species rather than vulnerable fish and invertebrate species. Both CMM 2019-06 and 2021-05 have identified the need to collect follow up data collection and research to determine whether fished seamounts contain VME taxa. This includes the use of ROV or drop cameras and biological samples collected during research activities or through observer programmes. While this has been recommended, it is unclear whether this is being done on a systematic basis. In addition, there are no detailed mitigation measures that are specific to research activities not related to bottom fisheries outlined in the above-mentioned measures.

Some weaknesses have been noted by the **SPRFMO** Performance Review Panel (Ridings et al., 2018): (i) Research and associated activities to support the scientific work of SPRFMO are primarily funded and conducted by Members and consequently, SPRFMO is dependent on those Members to report on these activities to SPRFMO. The Review Panel noted that a dedicated science programme funded and owned by SPRFMO would facilitate a more integrated and consistent approach; (ii) Fishing research activities in the SPRFMO Convention Area are undertaken on an ad hoc basis and, at present, there is no mechanism for notifying non-fishing research and for approval of fishing research; (iii) SPRFMO does not have a standardised database for Members to submit catch, effort and associated biological data from research cruises, or other scientific research activities (sharing of research data is therefore undertaken on an ad hoc basis and through SC's Working Groups). Moreover, the SPRFMO SC noted the current lack of a mechanism to provide for research activities in the SPRFMO CA. This represents a weakness in terms of sustainability, risks and opportunities for the fishery resources and impacts on resources and ecosystems.

[129] Canada-Newfounland & Labrador Offshore Petroleum Board

For this reason, the SC recommended that the Commission adopt conservation and management measures to address this issue.

There is a limited amount of information available on indicator species in the **SIOFA** Area. The objectives of most research surveys in the SIOFA CA have been focused either on the study of oceanographic variables and the pelagic ecosystem or within the coastal ZEEs that are not part of SIOFA CA. There is a need to collect more data from the benthic ecosystem, including via the use of photographic/video surveys. Multidisciplinary research surveys designed to develop SIOFA definition of VME indicator species and to assess the impact of fishing gears on the seafloor would be of great interest and could serve to analyse different encounter thresholds for VMEs and taxonomic studies within the SIOFA CA. Results from these surveys could help to develop a VME habitat mapping and to make progress with the benthic bioregionalization. Acoustic surveys devoted to the abundance population estimates for orange roughy/alfonsino would be of great interest. There is information available from commercial surveys but independent surveys would enhance this research. The lack of detailed data in most of the fisheries makes difficult to have an integrated stock assessment for most of the commercial species. Although the progress in the last years has been significant, work remains. To fund these research activities and to promote data acquisition would be advisable. Marine mammal depredation on fish catch had been identified as a major concern. Research and commercial surveys could be used as platforms to collect data on sightings and potential catch depredation. **SIOFA**, as SPRFMO, is also a young RFMO and although much progress has been made in their scientific management, some issues remain to be addressed. For instance, the FAO ABNJ Deep Seas Project assisted on: (i) the VME database, (ii) best practices for VMEs, (iii) work on sponges, (iv) ecosystem approaches, (v) the potential for facilitating fisheries sector representation in international fora, and (vi) a prospective work on the electronic monitoring system with the Cook Islands.

In the **CCAMLR** context, the main weakness that has been identified is due to the large number of different research programmes being undertaken by the different Member States. These take place in a variety of areas within CCAMLR and there has been some concern over the standardisation of gear and vessels and how this may affect any conclusions that can be drawn from research data (WG-FSA-2018 report).

Recommendations on potential elements needed for developing a framework for scientific research

- Objectives and purposes of the framework: It is important to clarify the objectives of the framework and if the RFMO has full authority to manage all types of scientific research or if there is any limitation[130]. As most RFMOs have among their functions "to encourage and promote scientific research and cooperation" care must be taken not to create unnecessary barriers to conducting research. An example of a clear purpose statement is in the SEAFO guidelines: "The primary purpose of these guidelines is to facilitate that high-quality science may be conducted freely and to the benefit of all while also ensuring that the activity is conducted in a manner which does not cause significant adverse impacts (SAI) on the marine ecosystems and organisms, including fisheries resources".

[130] Generally, research related to activities other than fishing is not regulated by the RFMOs (e.g. oil and gas), but could provide useful data for the study of VMEs (e.g. visual surveys) or produce adverse impacts on the ecosystems that support the fisheries (e.g. seismic surveys, drilling surveys). In this case, cooperation between RFMOs and other management authorities is recommended in order to optimize the research efforts and minimize the impacts.

- Definitions: It is recommended to have clear definitions of the main types of research that can occur within the RFMOs areas. In addition, the terms "fisheries resources", "scientific research" and "research survey" also need to be clearly defined (see examples of definitions in: SEAFO guidelines for research, SPRFMO and SIOFA proposals for a framework for research). Exploratory fishing should have its own specific framework different from the framework for scientific research.

- Processes and requirements: The framework should establish clear processes and requirements for each type of scientific activity managed by the RFMO (including impact mitigation measures), taking into account the risks and opportunities for the fisheries resources and ecosystems. Examples of protocols and requirements (e.g. notice of intent, submission of detailed Research Plan, measures to avoid impacts on VMES, etc.) are in SEAFO guidelines, CCAMLR conservation measures and SPRFMO and SIOFA proposals for a framework.

- Coordination and collaboration: The framework should encourage and promote coordination and collaboration between members in order to maximize the effectiveness of the research. Multi-year work plans for research can facilitate the coordination of the activities.

- Role of the scientific advisory bodies: The role of the Scientific Councils / Committees in the process should be clearly defined (e.g. review, discussion and approval of the Research Plans of proposed research activities).

- Research Plans: Standardized templates in order to submit the Research Plans should be developed.

- National scientific research reports: Standardized templates in order to submit, on an annual basis, the national scientific research reports, should be developed. These reports should include a list of the scientific research activities (including different types of surveys) in the region.

- Inventory of research activities: A database of research activities (including different types of surveys) can be useful to maintain an inventory of the activities planned and conducted in the RFMO area, to inform the scientific advisory bodies.

- Database of research data and data sharing: A standardized database for members to submit data from research cruises or other scientific research activities and a data-sharing protocol can be helpful in maintaining and sharing the data necessary for the work of scientific advisory bodies (e.g. ICES VME Database and data protocols).

Conclusions

Although the concept of **fishing footprint** is not specifically defined in the FAO Guidelines, in practice, in most RFMOs the terms *"fishing footprint"*, *"bottom fishing footprint"*, *"existing bottom fishing areas"*, *"existing deep-sea bottom fishing areas"* are equivalent and generally refer to the same concept (i.e. those locations in which some level of bottom fishing activity has previously been conducted in a reference period). The findings from D3 (see Annex 5) show that there is a wide variety of methods being used in the different RFMO to define the fishing footprints, with NAFO, NEAFC and CCAMLR having the most advanced experience. In addition, when studying the fishery footprint, several key issues must be taken into account: (i) **Data** (e.g. needs, compilation, availability and quality); (ii) **International cooperation** (e.g. research, management, sharing of information); (iii) **Potential**

of new methodologies, complementary data sources and approaches (e.g. methods to improve footprint resolution, AIS); and (iv) **financing** needs.

Most RFMOs adopted regulations on bottom fishing, incorporating relevant elements from the UNGA resolution 61/105 and the FAO DSF Guidelines, including the adoption of **exploratory fishing protocols** (see Annex 6). CCAMLR is the most prominent regulator of this issue, while GFCM does not have a specific **legal framework,** and NAFO and NEAFC have amended their protocols several times. In general terms, RFMOs follow similar specific **procedures and preliminary assessments**. An exceptional case is SIOFA, that has not clearly defined what an exploratory fishery is. Most RFMOs, with the exception of GFCM, have implemented specific **conservation and management measures** to prevent Significant Adverse Impacts on VMEs, and in most RFMOs, **monitoring** of exploratory fisheries is mandatory, including the deployment of **on-board observers**.

In most RFMOs, their own scientific advisory bodies have the functions of encouraging, promoting cooperation and coordinating the international **scientific research** (see Annex 7). By contrast, in the case of NEAFC, ICES is in charge of these functions. Most RFMOs have developed **research work plans** for their advisory bodies on a multiannual or annual basis, including planning research priorities. Only SEAFO has developed specific **guidelines for fisheries research and basic marine science activity.** Furthermore, there is a variety of approaches in the RFMOs regarding **conservation and management measures** related to scientific research. The issue of the **impact of research on VMEs** is addressed in the conservation and management measures of some RFMOs (e.g. NEAFC, SEAFO, SIOFA and CCAMLR) or is currently being monitored (e.g. NAFO). The **regulation of scientific research** is a current issue in some RFMOs and several initiatives are being carried out in this regard (e.g. NAFO, SPRFMO and SIOFA).

Finally, it should be noted that the review of the diversity of approaches used by the RFMOs, considering their strengths and weaknesses, has been very useful to identify the potential key elements for the development of **frameworks for exploratory fisheries and scientific research**, which are described in detail in Annexes 6 and 7.

TASK 5 – Critical review of the effectiveness of existing measures and management tools, and/or combinations thereof, for the protection and conservation of VMEs in the high seas.

Objectives

The objective is to provide a critical review of the effectiveness of existing management tools, including the move-on rule, and measures to assess impacts and/or combinations thereof (including spatial management tools) for the conservation of VMEs and identify best practices in RFMOs.

Methodology

This task is a desk-based study. A diverse set of literature sources was collated and analysed, including Scientific Committee meeting reports, FAO documents, peer-reviewed papers, and information contained in RFMOs websites and other relevant data sources. The practices adopted by the RFMOs are either familiar or have been summarised by other Tasks. Therefore, the aim was to build on the work of the other tasks, summarise approaches, methodologies and decision-making tools, and identify scientific proposals and suggestions yet to be acted upon.

Sub-task 5.1 undertakes a review of current management approaches for fishing vessels carrying out fishing activities with bottom gears in the high seas. Measures include those such as the move-on rule, and others including closed areas, depth limitations, gear modifications and seasonal limitations, plans adopted or under discussion by RFMOs. Additional measures and decisions making tools, including spatial management tools, such as Marine Protected Areas (MPAs) and other Area-Based Fisheries Management Measures (ABFMs) were reviewed.

Sub-task 5.2 provides recommendations about the appropriateness of existing approaches, and identifies alternatives based on a review of best practice. This is intended to serve as a baseline for other management bodies, help when conducting future reviews, and for the possible updating of Regulation 734/2008. Emphasis is on RFMOs e.g. SIOFA and SPRFMO where such approaches are actively under development. The study critically addressed the articulation between the VMEs protection process and the protected areas process under discussion in SIOFA and the so-called 'regional approach' of SPRFMO, and, where applicable, proposed actions to improve the regulatory framework in those organizations.

In the subsection titled ***"Results; Deliverable 4[131] (D4): Summary of findings and key information"***, the main findings from these sub-tasks are presented:

Results

Deliverable 4 (D4) Summary of findings and key information

Measures for VMEs conservation are in place, and are usually reviewed and revised as appropriate by all RFMOs. In view of the absence of information, the RFMOs had originally applied a precautionary approach and closed underwater features such as seamounts where VMEs were likely to occur. Today, some RFMOs are still applying the precautionary approach. For measures to be effective, the distribution and connectivity of VMEs must be better understood. However, in the case of some RFMOs, such as GFCM, knowledge on the distribution (and connectivity) of VMEs is

[131] Deliverable 4 (D4): Critical review of the effectiveness of existing management tools for VMEs conservation and identification of best practices (Task 5). See Annex 8 of the present report.

poor. If the precautionary approach is to be effective, then there are benefits and hence an incentive in reducing uncertainty. For example, NAFO has been evaluating potential management options for the protection of VMEs by reviewing trade-offs required to achieve conservation measures, whilst minimising the consequences to ongoing fisheries. This evaluation has led to the proposal of ten extensions to existing closures, the creation of three new closures and modifications to existing measures.

Some organisations have mandatory observer coverage for certain fisheries and areas. For example, SIOFA has 100% scientific observer coverage for fisheries targeting toothfish, and inside areas designated as protected areas. However, observers are not required for all targeted fisheries. Dedicated scientific surveys using underwater camera systems can be used to identify VMEs; although this is expensive. An alternative is to use commercial fishing vessels to gather information on fished areas and features such as steep slopes and hard substrates, using multi-beam sonar and underwater camera systems to photograph and map the seafloor.

Thompson *et al.,* (2016)[132] noted that even when surveys are undertaken and images show the presence of VME indicator species, there are other factors to consider before declaring an area a VME. These include, that the area should have a high enough density of indicator species to be considered an ecosystem and not an isolated occurrence, that the area is susceptible to significant impacts from current or future bottom fishing activities, and that the extent of the area is identified and delineated. Since 2006, there has also been increased effort by commercial fishing vessels, in particular in the Indian Ocean, to gather information on the fished areas and other features, such as steep slopes and hard substrates, using multi-beam sonar and underwater camera systems to photograph and map the sea floor. Such initiatives have the potential to provide information to the competent authorities for identifying VMEs in a less costly way than through dedicated research cruises.

There is no actual agreement on how to define and delimit VMEs, as the Expert Consultation that developed the initial draft of the guidelines reduced the level of complexity from the ecosystem to the scales of the populations, communities, and habitats which would experience any impact. Therefore, determining whether a VME is present depends on finding indicator species (UNGA Resolution 64/72), the characteristics of which are determined to have a particular set of attributes that make them especially vulnerable to the impacts of bottom contact fishing gear (FAO, 2009): namely (1) uniqueness or rarity of the species; (2) functionally significant to the habitat; (3) body fragility; (4) life-history characteristics that make probability of recolonization after impact low or unpredictable; and (5) species that serve as habitat for other species through their structural complexity. For example, on seamounts most attention has been given to species of corals and sponges since they generally fit at least one, and often several, of the criteria to be considered as VME indicator species (Ardron *et al*., 2014)[133]. Furthermore, the guidelines that define VMEs acknowledge that Regional Fisheries Management Organizations (RFMOs) and their contracting parties would want some flexibility in implementation.

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[132] Thompson, A., Sanders, J., Tandstad, M., Carocci, F., & Fuller, J. (2016). 'Vulnerable marine ecosystems—Processes and practices in the high seas' (p. 200). FAO Fisheries and Aquaculture Technical Paper No. 595. Rome, Italy.

[133] Ardron, J. A., Clark, M. R., Penney, A. J., Hourigan, T. F., Rowden, A. A., Dunstan, P. K., et al. (2014). A systematic approach towards the identification and protection of vulnerable marine ecosystems. Mar. Policy 49, 146–154. doi: 10.1016/j.marpol.2013.11.017

Therefore, identifying the presence, distribution, and abundance of an indicator species defines the state of that species at a moment (or period) in time. It does not define the composition of an associated community, the suite of species interactions that define and sustain the community, or the flows of materials and energy that define the bounds of the ecosystem. Details about species interactions (including population connectivity, energy flow that mediates growth and reproduction, and interactions mediated by the local oceanographic regime) that will be needed to understand and predict the extent to which fishing and other human activities produce significant adverse impacts. Therefore, significant adverse impacts to indicator species alone simply defines a set of minimum bounds on the effects of human actions on VMEs (Watling and Auster, 2021)[134].

Predictive modelling has been used to estimate the distribution of VME species based on bathymetric, environmental and biological variables. The use of such models, however, has received criticism regarding their accuracy at the scales required for defining VMEs. Models should be validated using data, and so modelling should complement dedicated scientific surveys and the work of scientific observers. Modelling can be used to identify priorities for research, and if combined with cost-benefit analysis is more likely to result in effective management outcomes.

A key issue is that move-on rules were not originally intended as stand-alone measures to protect VMEs. They should only be considered as temporary measures until spatial protection measures are implemented. However, in some regions, e.g., contracting parties within SIOFA, move-on rules within historic fishing footprints are the sole management measure. For example, NAFO's Scientific Council, in June 2013, stated that:

> " … *management through the closing of areas with significant concentrations of VME indicator species is the most effective measure for protecting VMEs in the NRA [NAFO Regulatory Area] and that the need to implement encounter protocols gradually becomes redundant as the locations of the benthic VMEs becomes increasingly well-defined. This avoids issues associated with the implementation of complex move-on rules*"

NAFO is helped by the having access to good data and knowledge, and the relatively small areas of the fishing footprint. This means that the distribution of key VME indicator species is relatively well understood. The SPRFMO Scientific Committee recognised that move-on rules should only be used to complement well-designed spatial closures. They also conclude that move-on rules should act as a rapid response mechanism to unexpectedly high bycatch events outside of closed areas. In contrast, in the GFCM region, although fishing is not restricted to the existing footprint, there is no move-on rule and thresholds still have to be specified by the GFCM.

Even if a precautionary approach is adopted or predictive modelling is used, VMEs are still likely to occur both inside and outside existing fishing footprints and so encounter and exploratory protocols are required to identify and protect areas. Protocols are triggered when VME indicators are caught/found in the gear above a certain threshold level. The taxonomic level of the VME indicators is not the same in all regions, nor are the threshold levels used to trigger action. The threshold levels may vary in terms of kilograms caught, or "units" that act as a proxy for weight or numbers, or for longlines it may be the presence on a certain percentage of hooks. Threshold values are normally higher for sponges than corals. The details of the

[134] Watling, L. and Auster, P.J., 2021. Vulnerable Marine Ecosystems, Communities, and Indicator Species: Confusing Concepts for Conservation of Seamounts. Frontiers in Marine Science, 8, p.622586.

response to an encounter, and the triggering of the move on rule, vary among regions, an immediate temporary closure is normally applied and the vessel must cease fishing and move away some specified distance from where the VME is believed to be.

The need to protect VMEs by the fisheries bodies managing the deep-sea high seas bottom fisheries has impacted both the fisheries operations, but also the work conducted by the RFMO. Some RFMOs are well established and well resourced. For example, NAFO and NEAFC, with contracting parties who are actively undertaking surveys, requiring impact assessments, and modelling to identify VME habitats to be conducted. Others, such as SEAFO and SIOFA, have only been established relatively recently and may lack the experience and resources. This was a reason for the development of the VME database of the FAO, a compendium of information on management measures. It is intended to facilitate the work of scientists and managers by promoting transparency and accessibility. The database is linked to the data providers (RFMOs and other multi-lateral bodies) and users have access to the primary information through direct links, for example to the RFMO websites. The database was developed specifically in response to a request from the UN General Assembly (61/105, paragraph 90) to create a database of information on VMEs in ABNJ. It has been developed within the FAO Deep-sea Fisheries Programme to promote the use of the International Guidelines for the Management of Deep-Sea Fisheries in the High Seas

In addition, the FAO ABNJ Deep Seas Project is providing assistance to the RFMOs, in order to improve deep-sea fisheries management and biodiversity conservation through the harmonization of conservation and sustainable use following the principles of the ecosystem approach, while testing innovative and appropriate management tools. These projects are of particular value to recently established RFMOs such as SEAFO and SIOFA.

The 2008 FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas provide guidance on management factors, ranging from an appropriate regulatory framework to the components of good data collection programs, and include the identification of key management considerations and measures necessary to ensure conservation of target and non-target species, as well as affected habitats.

Based on the review of current practices, recommendations have been made on the appropriateness of existing approaches and alternatives that can be used based on the scientific evidence. This will include for instance, whether there are modelling approaches that could be used. In addition, recommendations on the clarity and efficacy of measures (including the weaknesses of such measures), the structure of the evaluation process, and the usefulness of the measures for providing a robust scientific evidence base for decision-makers have been made. This includes elements that are further explored in Task 6. For example, the refinement of threshold levels, and the use of surveys to determine the likelihood of encounters, and determining the optimal distance for a move on rules that would maximise benefits for a VME while having the lowest impact on the fishery. In addition, increased spatial management could be used to establish the existing fishing footprint and limit any bottom fishing to this area. Any fishing outside of this area is classed as exploratory and subject to a number of requirements, including development and review of a research plan and the requirement to carry observers. Another approach is to close areas to bottom fishing with known (through surveys) or possible (through modelling) VME presence.

In general, all RFMOs should identify current and future areas where deep-water species and VME habitats are likely to better survive the impacts of climate change and greenhouse gas emissions (e.g. acidification, deoxygenation, reduced food availability, temperature changes) and ensure that these areas are set off-limits to bottom contact fisheries to establish refugia and build resilience. Predictive modelling has already been done to identify such areas suitable for the species and habitats under future climate change scenarios. New Zealand has conducted such modelling for the areas fished by New Zealand vessels and conducted a benthic survey on the central Louisville Ridge in 2014 to assist in the mapping of VMEs and for the purpose of validating and improving initial predictive modelling results (Anon, 2015)[135].

These approaches can help include climate change aspects into area-based management decisions such as those aimed to preserve VMEs (Morato *et al*., 2020)[136]. With the potential for climate change to affect the distribution of fished stocks and hence the fishery, this footprint needs to be dynamic, but without the temptation to simply expand it without knowing if VMEs occur in the new fishing areas. With VMEs this is a one-sided argument: the VMEs are unlikely to "move" whereas the fish stocks and fisheries can. With seabirds for example, both the fishery and the species at risk could move, so some low-level constant monitoring is necessary and impact assessments repeated at regular intervals, say every five years (Thomson and Fuller, 2021)[137].

Conclusions

In the absence of information, originally a precautionary approach had been used and underwater features such as seamounts where VMEs were likely to occur were closed to fishing. There is no actual agreement, however, on how to define and delimit VMEs. Today, some RFMOs are still applying the precautionary approach. For measures to be effective, the distribution and connectivity of VMEs must be better understood.

Identifying the presence, distribution, and abundance of an indicator species defines the state of that species at a moment (or period) in time. It does not define the composition of an associated community, the suite of species interactions that define and sustain the community, or the flows of materials and energy that define the bounds of the ecosystem. Details about species interactions (including population connectivity, energy flow that mediates growth and reproduction, and interactions mediated by the local oceanographic regime) that will be needed to understand and predict the extent to which fishing and other human activities produce significant adverse impacts.

A key issue is that move-on rules were not originally intended as stand-alone measures to protect VMEs from SAI. They should only be considered as temporary measures until spatial protection measures are implemented. However, in some regions, e.g., contracting parties within SIOFA, move-on rules within historic fishing

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[135] Anon. 2015. Proposal for exploratory bottom longlining for toothfish by New Zealand vessels outside the bottom lining footprint during 2016 and 2017: Description of proposed activities and impact assessment. SC-03-DW-01_rev. 57 pp. www.sprfmo.int/assets/ Meetings/Meetings-2013-plus/SC-Meetings/3rd-SC-Meeting-2015/Papers/SC-03-DW01-rev2-New-Zealand-Proposal-to-conduct-exploratory-bottom-longlining.pdf.

[136] Morato, T. *et al*. (2020) Climate-induced changes in the suitable habitat of cold-water corals and commercially important deep-sea fishes in the North Atlantic. Global change biology, 26(4), 2181-2202.

[137] Thompson, T. and Fuller, S.D. (2021) 'Technical measures and environmental risk assessments for deep-sea sponge conservation'. Rome, FAO. Available at: https://www.fao.org/documents/card/es/c/cb4878en/

footprints are the sole management measure. For example, NAFO's Scientific Council, in June 2013, stated that:

Predictive modelling can be used to help include climate change aspects into area-based management decisions such as those aimed to preserve VMEs, However, VMEs are unlikely to "move" whereas the fish stocks and fisheries can.

TASK 6 – Identify gaps in research and priority scientific topics (by region).

Objectives

The objective of Task 6 is to identify gaps in research and priority scientific topics to be addressed by region (RFMOs and FAO Area 41 regarding Council Regulation (EC) No 734/2008), with a view to improving our understanding and knowledge of VME identification, and to design a framework for future RFMO observer schemes to identify, record and report on VME associated taxa and hence the potential for VMEs. This will contribute towards strengthening the science used to develop measures to reduce or mitigate impacts on VMEs.

Methodology

This task identified key scientific research areas that are required to provide advice on the protection and conservation of deep sea VMEs. It used the findings from Tasks 1-5 to identify and summarize gaps in science and needs for research to generate robust scientific advice on all matters related to the protection and conservation of VMEs and the sustainability of DSF regarding their potential impacts on marine ecosystems (habitats and species). In addition, analyses were performed to explore whether the gaps are a result of lack of the regulatory regime or poor implementation of existing data collection rules. Work in this Task contributed towards the understanding and knowledge necessary to identify VME distribution and function and ensure effective mitigation measures are adopted and implemented to prevent habitat destruction and degradation and species impacts due to fishing.

This review identified data needs and gaps in the existing data collection frameworks within the scope of Council Regulation (EC) No 734/2008. These were based on the previous study (SC08). Owing to the scarcity of information for the South West Atlantic region, available literature was examined, such as that collected under the ABNJ Deep Sea Project[138]. In addition, the suitability of using the EU Data Collection Framework (DCF) was reviewed and how to improve it to fill identified data gaps was discussed.

Finally, a framework for RFMO observer scheme was designed for those RFMOs where no such scheme yet exists. Before designing a new observer scheme, an assessment was made as to whether the current protocols (templates etc.) for observer schemes by the EU regulation(s) are compatible and therefore could be adopted, or whether new procedures and templates are required.

Results

Identifying Gaps in research and priority research for different regions.

The information was largely taken from the previous tasks, mainly Task 4 and Task 5 and from looking at the research priorities from the Scientific Committees or Working Groups of the RFMOS and CCAMLR. A number of reports also exist comparing protocols between RFMOs (e.g. PAEWG-01016[139], NPFC-2019-SSC VME04-WP01[140]).

[138] http://www.fao.org/in-action/commonoceans/en/

[139] Summary of VME related management measures adopted by adjacent Regional Management Bodies in the context of SIOFA. European Union.

[140] VME post-encounter treatment: review of other RFMO/As practices and the NPFC situation. Bai Li, Aleksandr Zavolokin, Peter Flewwelling, and Dae-Yeon Moon.

RFMO Priorities.

After the introduction of the FAO guidelines in 2008, most RFMOs were quick to introduce measures to provide some form of protection to VMEs through restricting the fishing footprint and developing encounter rules. However due to the nature of deep seas fisheries and the associated costs, research into the effectiveness of these measures has been limited and little progress has been made since they were originally put in place. This has been recognised by the RFMOs themselves who have developed a number of research priorities. These are summarised in Table 1 however the common areas of research can be categorised in three main areas:

- Data collection to refine threshold levels.
- Establishing the effectiveness of encounter rules.
- Increased research into spatial management.

Research into these areas can be fishery dependent through data gathered by observer programmes or by the crew themselves and fishery independent through dedicated surveys and the use of underwater cameras and remote operated underwater vehicles (ROVs). Habitat modelling is also being increasingly used. A recent study by the MSC looked at how different RFMOs dealt with protecting VMEs and at future directions RFMOs were taking[141]. While it focussed mainly on move-on-rules it also looked at the areas of research outlined above, these are summarised below.

Data collection to refine threshold levels.

With the exception of the GFCM, all other RFMOs had developed some kind of threshold level for VME taxa which would trigger an encounter protocol (invariably a move on rule). However, for some Organisations, most notably CCAMLR, there had been little or no review process since the threshold was first decided. The CCAMLR Scientific Committee (SC) noted that in a number of areas there was insufficient VME taxa to trigger the 10 unit threshold despite camera footage showing large numbers of VME taxa present. The SC concluded that when VME units were defined in kilogrammes then the presence of certain lightweight taxa would not be enough to trigger it and that in future lower thresholds should be considered for these 'lightweight' taxa. To date this has not been done.

SPRFMO have however considered catchability when developing threshold levels[142], through use of cameras it was estimated that, even in bottom trawls, the probability of VME taxa being retained was <1%. SPRFMO have since lowered their threshold levels, setting limits on individual taxa or a 'biodiversity threshold' if three or more taxa are caught above threshold levels. There have been no reported catches over the threshold limit, which would suggest either the levels are too high or that the current spatial management measures in place are effective. Work continues on updating encounter thresholds (SC9-DW10[143]).

Other organisations such as SEAFO, NAFO, NEAFC and SPRFMO have all revised their threshold values downwards from their original estimates. NAFO have revised their

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[141] Walmsley, S; Pack, K; Roberts, C; and Blyth-Skyrme, R (2021). Vulnerable Marine Ecosystems and Fishery Move-on-Rules - Best Practice Review. Published by the Marine Stewardship Council [www.msc.org]. 134 pp

[142] Geange, S.W., Rowden, A.A., Cryer, M. & Bock, T.D. (2019) Evaluating the availability of data to assess catchability of VME indicator taxa. SPRFMO 7th Meeting of the Scientific Committee. Available at https://www.sprfmo.int/assets/2019-SC7/Meeting-Docs/SC7-DW14-Availability-of-Data-to-AssessCatchability-of-VME-Indicator-Taxa.pdf

[143] SC9-DW10. Updated Candidate Encounter Thresholds for VME Indicator Taxa in the SPRFMO Area. 9th Meeting of the Scientific Committee. 27 September to 2 October 2021.

estimates four times since first developed in 2009, with the levels being scientifically determined using known locations of VME taxa and their depth. However, it has been noted that scientifically-based encounter thresholds and move-on rules become complicated when different gear types and VME taxa are taken into account. NAFO itself uses the same threshold levels for all gear types, despite differences in catchability. It has however developed different thresholds for sponges, corals and sea pens. No vessel has so far triggered an encounter rule, this is despite having 100% observer coverage which it is assumed would reduce mis-reporting. NAFO instead favours closed areas and limiting fishing effort to its current footprint (NAFO SC, 2013b, VII.1.c.v)[144.]

NEAFC also favour closed areas over move on rules, bottom fishing is restricted to just 2% of the regulatory area and compliance with the closed areas appears to have been effective[145]. While there are encounter protocols in place, which are revised, there have been no reports of these being triggered, although there are no onboard observers to confirm this. NPFC have developed a range of indicator taxa but their threshold levels only apply to cold water corals.

Establishing the effectiveness of encounter rules.

The encounter rules define the actions that should be taken once a threshold level is reached. In most of the RFMOs this would result in an action being taken, in most cases a move-on-rule, and subsequent follow up actions. This may be a temporary closure of the area, scientific surveys undertaken and a review to determine long term management options to either close permanently, subject to future surveys, or re-open as a fishing area if no evidence of a VME is found. A simplified process for this is shown in **Error! Reference source not found.**.

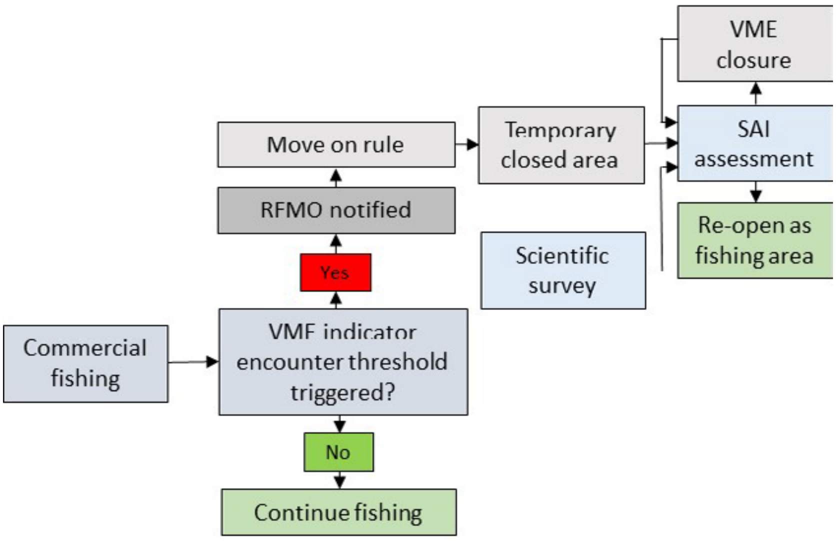

Figure 1. Encounter rule process.

In reality this process is never seen through. Some RFMOs (SPRFMO, NAFO, NEAFC, SEAFO) never trigger the indicator threshold they have put in place, although move

[144] NAFO SC (2013b) Part B: Scientific Council 7-20 June Meeting – 2013. NAFO, Dartmouth, Canada, 232 pp. http://archive.nafo.int/open/rb/2013/partb-2013.pdf
[145] NEAFC. 2004. Recommendation IV from the 23rd Annual Meeting. NEAFC Recommendation for the Protection of Vulnerable Deep-Water Habitats by Denmark (in respect of the Faroe Islands and Greenland), Estonia, the European Community, Iceland, Norway and Poland. 6 pp. https://www.neafc.org/system/files/REC_IV%20_Closure_Reccom_2005.pdf

on rules and temporary closed areas are required if they are. GFCM has no trigger level in place, but the protocol requires them to report encounters but there are no subsequent actions to be taken. NPFC has a trigger level in place (just a general one for corals) and a move on rule but nothing regarding any actions to be taken after that. CCAMLR has triggered a number of temporary closed areas but only a few have had any follow up research with a permanent closure, no areas have been reopened as a fishing area.

There is also a range of move-on-rules in place, distances range between 1 and 2nm and, in the case of trawls, may just be from the point the gear was hauled or along the entire length of the line of the haul (bearing in mind it is not normally possible to determine where on the haul the encounter was). The exact distance that a vessel should move requires more research. In 2012 for example ICES advised that a 2nm was not appropriate for new areas as it has potential to increase SAIs on pristine VMEs in previously unfished areas, as opposed to fished areas. They suggested surveys to determine the likelihood of encounters. They also suggested move on rules on steep slopes may not be appropriate as moving a short distance is unlikely to lower the probability of encountering another patch of VME species[146]. SPRFMO have also been researching the optimal distance for a move-on-rule that would cause the most benefits to a VME while having the lowest impact on the fishery (SC9-DW7[147]).

Increased research into spatial management.

This has been the preferred protection mechanism for most of the RFMOs who follow two main approaches with regards to spatial management. The first being to establish the existing fishing footprint and limit any bottom fishing to this area. Any fishing outside of this area is classed as exploratory and subject to a number of requirements, including development and review of a research plan and the requirement to carry observers. The second being to close areas to bottom fishing with known (through surveys) or possible (through modelling) VME presence. The SPRFMO SC recommended, in 2019, that spatial management had been shown to be the best option to prevent SAIs on VMEs, move-on rules should only be used as a rapid response mechanism to complement them.

SIOFA has been in the process of establishing a bottom fishing footprint since 2016 with CCPs being required being required to outline measures they are undertaking to prevent or reduce SIAs through submitting a Benthic Impact Fishery Assessment (BFIA)[148], which includes restricting their fishing to historical areas. These measures have been compiled and summarised in an 'Interim Bottom Fishing Measures' document[149] with the full BFIAs for each CCP available in their site[150]. Work on a cumulative footprint for all CPCs was completed in 2020, and endorsed by the Commission at the 9th Meeting of the Parties in July 2022[151].

[146] ICES (2012). Review of NEAFC bottom fisheries regulations. Special request, Advice June 2012. 1.5.4.3. Available at https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2012/Special%20Requests/NEAFC_bottom_fisheries_regulations.pdf.

[147] SC9-DW07. Determination of Optimal Move-on Distance in SPRFMO Bottom Fisheries. New Zealand. 9th Meeting of the Scientific Committee. 27 September to 2 October 2021.

[148] CMM 2020/01. Conservation and Management Measure for the Interim Management of Bottom Fishing in the Agreement Area (Interim Management of Bottom Fishing).

[149] SIOFA (2023). Interim Bottom Fishing Measures. A Compilation by Contracting Party, Participating Fishing Entities and Cooperating Non Contracting Parties (CCPs). Updated 09/03/2023.

[150] https://siofa.org/management/bf-impact

[151] Report of the Ninth Meeting of the Parties to the Southern Indian Ocean Fisheries Agreement (SIOFA). Hotel le Récif, Saint-Gilles les Bains, la Réunion 4 – 8 July 2022

Priorities of the working groups.

More specific priorities are highlighted in the proposed workplans of various scientific bodies of the RFMOs. These have been summarised in Table 1.

Most organisations in the study have collected and mapped to some degree potential VME species through commercial fishing, dedicated surveys or habitat modelling. The main gaps in knowledge focus around the lack of quantative data on VME (e.g. abundance and biomass) required to confirm the presence of a VME and effectively map out and manage impacts. In many cases, especially with those identified during the course of commercial fishing there is little follow up, resulting in a temporary closure pending further scientific investigation. There is some work being undertaken by New Zealand in SPRFMO using video and still images to model thresholds of VME taxa and determine the threshold at which a particular coral taxa may be considered a VME (Rowden *et al.*, 2020[152]). This requires the cooperation of industry and is still in its early stages and there is still debate as to what constitutes a VME, given the variation in species from area to area. This is an area other RFMOs are looking at developing as well, for example SIOFA.

Some RFMOs (e.g. NPFC, SIOFA) are working on collating past and current data to more accurately define their cumulative footprint and the potential overlap with VME. Others (e.g. NAFO, NEAFC) are more advanced and have already collated large amounts of data from their trawl fisheries and surveys. The VME data collected is available, through the Working Group on Deep-water Ecology (WG-DEC) and is split between 'VME habitats', where the presence of a VME has been confirmed, for example through the use of an ROV, and 'VME indicators' which are records of that suggest the presence of a VME with varying degrees of uncertainty. Through this they have developed risk assessments for various VME taxa based on the overlap between fisheries and VME, the fragility of the taxa and the proportion of the taxa that is protected by closed areas. Other gaps include the life history and traits of certain VME taxa, particularly with regards to recovery times.

Additional mitigation measures to move-on-rules and spatial management include gear modifications, depth limitations and seasonal closures. Seasonal closures, in the case of NPFC, were introduced to protect certain fish stocks but coincide with seasonal bad weather. This effectively reduced bottom line movement on the seabed and damage to benthos, although the actual effects of this have yet to be confirmed.

[152]Rowden, A.A. et al. (2020) 'Determining Coral Density Thresholds for Identifying Structurally Complex Vulnerable Marine Ecosystems in the Deep Sea', Frontiers in Marine Science, 7. Available at: https://www.frontiersin.org/article/10.3389/fmars.2020.00095.

Table 1. Bodies responsible for providing Scientific Advice on VMEs by Organisation along with their stated Scientific Priorities.

	Scientific Body	Scientific Priorities
NAFO	**Working Group on Ecosystem Science Assessment (WG-ESA)** and **ICES/NAFO Joint Working Group on Deep Water Ecology (WG-DEC)** – Deals with the biology and conservation of deep-sea habitats in the North Atlantic. They meet annually to collate new information and map VMEs	• Provision of data on absence of VME data. • Quantitative VME identification from images. • Quantitative data (e.g. abundance, biomass) needs to be strengthened. • Work in SAIs includes developing a VME fragmentation index, connectivity of VME index, reviewing VME buffer zones and reviewing VME recovery rates.
NEAFC	**Permanent Committee on Management and Science (PECMAS)** - Evaluates exploratory bottom fisheries applications in the Regulatory Area and provides advice to the Commission on the likelihood of SAIs on VMEs of the proposed fishing activity. Works with **ICES WG-DEC).**	• Scientific advice and priorities are given by ICES, through WG-DEC.
SEAFO	**Scientific Committee (SC)** – Covers all aspects of science within the Convention Area, no dedicated working groups.	• Ecosystem status reports on interactions between fisheries and the marine ecosystems. Priorities include developing a risk based assessment. • Means to provide better data to indicate potential VME areas needs to be developed. • Focus also on developing guidelines for using scientific data (video footage & survey counts) in the determination of threshold limits of VME encounters in relation to guidelines in other RFMOs and scientific bodies.
GFCM	**Working Group on Vulnerable Marine Ecosystems and Essential Fish Habitats (WG-VME-EFH)** – Developed initial measures to protect VMEs within the GFCM area of application, gathers information on the distribution of VMEs and reviews proposals for closures and enforcement measures.	• Compile and review the Mediterranean Data Collection Reference Framework (DCRF) data to better understand bycatch and discards from deep-water fishing grounds with inference for the Eastern Mediterranean; • Establish linkages with the distribution of VME indicator species in the Eastern Mediterranean and the fishing footprint or vessel activity; • Use modelling data, where available, for VME indicator species distribution and take it into account for further analysis; • Present the data gathered, to the WG-VME-EFH to analyse the information towards defining VMEs; • Use information gathered and data gaps of VME to provide inputs for preparing additional management measures (including move-on rules, level of scientific observer coverage, fishing restrictions and No Take Zones (NTZs)).
NPFC	**Small Scientific Committee on Bottom Fish and Marine Ecosystems (SSC BF-ME) -** Assesses the status of bottom fish stocks and provides scientific advice for the sustainable management of bottom	• Sablefish and VMEs: Conduct trade-off analysis between commercial fishing and VME protection; • Collect and share fishing footprint data; • Develop a process for establishing quantitative definitions of VMEs; and, • Develop standardized approach to SAI determination.

	Scientific Body	Scientific Priorities
	fisheries resources and prevention of significant adverse impacts on VMEs.	• Priorities include developing a combined footprint and effort map of all bottom fisheries by gear and time using historical and current data.
SPRFMO	**Scientific Committee (SC) –** Holds an annual **Deepwater Workshop (SCW)** which provides advice to the **SC.**	• Developing taxon-specific estimates of catchability for VME indicator taxa. • Determine an optimal move on distance to provide sufficient balance between protection and inconvenience to fishery. • Developing abundance models that can be used for different areas, prioritising 'slope' models. • Review of VME encounters - encounter area environment, known VME indicator taxa distributions and historical bycatch data. • Evaluation of the presence of a potential VME, the encounter impact and the likelihood of future impacts to formulate a suggestion of appropriate management measures to prevent SAIs. This would require use of in-situ cameras and data. • Development / refinement of ID guides and training videos for observers / crew for benthic bycatch.
SIOFA	**Protected Area and Ecosystem Work Group (PAEWG) –** Reviews protected are proposals within SIOFA, provides advice on ecosystem assessment and subsequent management plans and reviews any proposed changes to protocols.	• Mapping VME occurrence; • Encounter thresholds; and • Coordination with other RFMOs (CCAMLR, SPRFMO) on refining ID guides.
CCAMLR	**Working Group on Ecosystem Monitoring and Management (WG-EMM) –** Provides advice on aspects of spatial protection, including marine protected areas and vulnerable marine ecosystems.	• Review VME impact mitigation procedures in regional fisheries management organisations (RFMOs) that may inform CCAMLR. • Review reporting of VME by vessels – assess trends by year, location, gear, flag etc. • Review line section marking/recording and develop standard protocol. • Provide data on efficacy of current sampling methods by comparing observer-derived observations with electronic monitoring at hauling. • Assess efficacy of surface sampling to describe seafloor habitat with the use of benthic camera data. • Review new methods for assessing fishing footprint and compare with existing methods. • Evaluate VME taxa identification materials. • Assess whether current VME taxa list is comprehensive and appropriate. • Consideration of actions following VME encounters (e.g. additional sampling with cameras). • Methods/modelling for incorporating new (electronic monitoring and camera) data streams and external data streams (e.g. research voyages).

FAO Area 41.

A study into the effects of fishing in FAO Area 41[153] used modelling to predict the presence of absence of various VME taxa along the Patagonian shelf, both within the Falkland Island Conservation Zone (FCZ), where a licenced longline fishery exists and in the ABNJ around it, to the south of the Area. The areas were also adjacent to CCAMLR, SPRFMO and the EEZs of Argentina and Chile. There is a high degree of unregulated fishing in this area and it was estimated that the ABNJ footprint was nearly twice as large as that within licensed waters and the subsequent overlap with VME indicator taxa was also considerably higher (32.62 – 61.99% as opposed to 6.45 to 9.82% with a licensed fishery). The report concluded that ABNJ fisheries may undermine domestic VME management and management of VMEs in general would benefit from strengthening regional high-seas fishing governance and monitoring procedures.

Developing a framework for observer programmes for RFMOs.

This part of the task compared observer programmes in place in bottom fisheries across the various regions. This built on information gathered as part of S08, reviewing the previous tasks and information taken from the organisation's sites. There have also been a number of studies comparing observer programmes between RFMOs (NPFC-2018-SC03-WP03 (Rev. 1)[154]). Annex 9 provides a template for Observer Programmes based on data collection protocols from the RFMOs covered in this study. While the levels of coverage may vary between RFMOs and gear types there are common themes in the data collection protocols between them. These have been used to develop Annex 9 which includes a brief description of the elements to be considered when developing an observer programme to monitor VMEs.

Levels of observer coverage both across the fleet (i.e. proportion of vessel covered) and on individual vessels (i.e. fishing effort covered on each vessel).

Observer coverage varies between the various bodies from 100% to 10% for and between particular types of gear. When viewing observer coverage, it is important to define exactly what the coverage is referring to. Most refer just to vessels without defining the effort that should be observed. Only CCAMLR (100% vessel coverage, 50% of hooks observed) and SPRFMO (10% of hooks observed), although in the case of SPRFMO it has been acknowledged that without 100% vessel coverage observations may be biased both spatially and temporally. A number of factors may limit an RFMO's / flag State's ability to increase observer coverage, these include financial, logistical and physical (i.e. vessel size) in which case electronic monitoring could be considered. Table summarises some of the aspects of the observer programmes in this study.

[153] Brewin, P. E., Farrugia, T. J., Jenkins, C., and Brickle, P. (2020) Straddling the line: high potential impact on vulnerable marine ecosystems by bottom-set longline fishing in unregulated areas beyond national jurisdiction. – ICES Journal of Marine Science.

[154] Report on the existing observer programs of NPFC Members and those of other RFMOs. NPFC Secretariat (login details required).

Table 2. Elements of observer coverage across different RFMOs and CCAMLR.

RFMO	Regional Policy	Data Public	Summary reports available	Right to access logs	Different flag state	Coverage gear/ area/specific	100% of fishing vessels?
CCAMLR	Y	N	N	Y	Y	Y	Y
GFCM	Y	N	N	N	N	N	N
NAFO	Y	N	N	Y	N	Y	Y
NEAFC	Y	N	N	N	N	Y[a]	N
NPFC	Y	N	N	N	N	Y[b]	N
SEAFO	Y	N	N	Y	N	Y	Y
SIOFA	Y	N	N	N	N	Y[c]	N
SPRFMO	Y	N	N	Y	N	Y[d]	N

(a) exploratory fishing; (b) 100% coverage in northwestern section, exploratory fisheries only in northeastern section; (c) 100% bottom trawls, 20% other bottom fishing gear except when fishing for Patagonian toothfish (*Dissostichus eleginoides*) which are 100% and (d) 10% observation of hooks on bottom longlines, 100% for bottom trawls, 100% AFMA fisheries.

Data collected on VME taxa encounters, protocols in place for this data collection and the forms or methods used for recording it.

All reviewed programmes required observers to record VME taxa recovered on a haul by haul basis and had developed formats for recording and reporting. This included identification of the taxa to the highest taxonomic level, the quantity (normally either weight or volume), the numbers of different taxa recorded, time, date and location. Data collected in relation to VME taxa are summarised in Table .

With the exception of GFCM, all of the programmes had thresholds in place which, when triggered, would require the implementation of a move-on rule, although only SPRFMO had different thresholds based upon the vulnerability and catchability of the species being recovered. The follow up action once the vessel had moved was inconsistent, with some bodies closing off the area (e.g. CCAMLR) and others not having anything in place (e.g. NPFC) after the vessel has moved on. Only NAFO had a system in place to review the effectiveness of the closures. In all the organizations studied it is the responsibility of the vessel to notify of the presence of a potential VME to the flag State or Secretariat when a threshold level is reached. They must then put in place any follow up actions, if required.

Table 3. Summary of observer data collected in relation to VME taxa.

RFMO	Level of coverage	VME data recorded	Observer data triggers encounter rule
NAFO	100%	Yes. The quantity of all catch by species, including discards and VMEs. VME species are outlined in the CMMs	No. It is the duty of the vessel master to report it to the flag State.
NEAFC	100% for exploratory fisheries	Yes. Data are collected for the identification and mapping of VMEs and to contribute towards the assessment of SAIs.	No. It is the vessel's responsibility to notify the flag State and Secretariat.
SEAFO	100%	Yes. Observers are required to record all locations where VME indicator species are caught.	No. It is the vessel's responsibility, although a threshold trigger level has never been reached.
GFCM	~25%, varies by contracting party	No	No

RFMO	Level of coverage	VME data recorded	Observer data triggers encounter rule
NPFC	100% for all vessels undertaking bottom fishing. No guidance for effort levels to monitored but details on VME species should be taken for every haul.	Yes, identified according to recently developed guide. Information collected on species on VME taxa, quantity (in weight or volume), total quantity of all invertebrate species. Collection of samples and photos also encouraged.	No. It is the vessel's responsibility to notify the flag State and Secretariat.
SPRFMO	Bottom trawl – 100% coverage Longline – 10% effort coverage (number of hooks).	Yes. For all gear types, quantity to the nearest 0.1 kg, method of weight estimation and sample collection.	No. It is the vessel's responsibility to notify the flag State and Secretariat.
SIOFA	Longline vessels targeting toothfish - at least one observer per vessel covering 25% of hooks. Trawl gear – 100% coverage. Other bottom fishing gear – 20%.	Yes. Observers record quantity (weight or volume) and collect samples.	No. It is the vessels responsibility to report to its flag State, the flag State to report to the SC annually in its National Report.
CCAMLR	100% of all vessel deployments. Up to 50% of effort (hooks hauled). At least 30% of line segments for VME specific data. Two observers required for exploratory fisheries	Yes, identified according to the CCAMLR VME taxa guide. Number of different taxa, the identification and count of each species and volume or weight depending on the size.	No. It is the vessel's responsibility to notify the flag State and Secretariat. Observer will record the data and report at the end of the trip to CCAMLR and these data can be used to verify the vessel data and if necessary for compliance purposes (although this has not happened to date).

How these data are submitted and used.

None of the data collected by observers were submitted in real time, including events where a threshold level was reached. Data are either submitted within a given time period at the end of each deployment or, in case of NPFC for example, in summary format on an annual basis. To date, observer data on its own has not been used in the development of management decisions, although a number of RFMOs are in the process of collating observer data, along with other sources, to help develop distribution maps, among other things.

Observer VME ID guides.

Most of the programmes had developed VME guides for observers and vessel crews to use, although for the most part these were simple and easy to use, highlighting the main VME species. One of the main priorities of research that has been identified is related to refining these guides to ensure all species are covered according to the criteria set down in Paragraph 18 of the FAO DSF. Most recently this has been undertaken by NPFC, which in 2020 formally adopted a revised VME guide for use by observers and vessels operating in their area. The FAO has collated all the main VME guides as a resource which can be accessed on their site[155]. Observers working at NPFC photograph any benthos they are unsure of and upload the images to

[155] https://www.fao.org/in-action/vulnerable-marine-ecosystems/background/vme-tools/es/

naturalist[156] for identification. Identification has also been carried out through DNA analysis, although these tend to be for discreet studies rather than common practice[157].

Use of electronic monitoring.

With improvements in technology, the use of remote electronic monitoring (REM) is becoming more commonplace on vessels. All vessels operating in the RFMOs in this study are required to have a VMS system on board, which can be used to monitor compliance with closed areas, although the way these data are reported and used varies between them. REM should enhance the work of observers rather than replacing them. None of the RFMOs in the study had a requirement for electronic monitoring set out in their management measures although NAFO has a derogation of 100% observer coverage for those vessels using VMS to transfer electronic observer and catch data. The technology to identify and quantify individual VME taxa through Artificial Intelligence (AI) to sufficient resolution does not currently exist. Even if reviewed by an observer it is unrealistic to expect them identify certain taxa from a through reviewing footage. It can reduce the workload of the observer in some areas, for example monitoring streamer line deployment, and allow more time to record accurately VME taxa being recovered.

Cameras have been attached to the fishing gear itself to allow comparisons with what is recovered to what is impacted on the sea floor. While this has been done during surveys or during specific studies on fishing vessels (Welsford and Kilpatrick, 2008[158]), it has not been developed as a regular requirement under any programme.

Data Requirements related to Council Regulation (EC) No 734/2008.

The data requirements related to Council Regulation (EC) no 734/2008 are summarized in Annex 10. It outlines the information that needs to be submitted by EU vessels planning to fish on the high seas, how the information is evaluated, encounter rules and VMS and observer requirements. In general, the information submitted prior to the issuance of a permit is in common with most RFMOs, although there is no requirement to include the proposed dates, fishing effort (number of hooks, hauls or sets), modifications to fishing gear to reduce potential impacts or an assessment of the overall fishing footprint. There is also no timeframe outlined for the submission or assessment of proposals or what constitutes a change of plan, under Article 5, to trigger a reassessment.

The encounter rules do not define what constitutes a VME or the threshold levels that will trigger an action, this needs to be defined by gear type and VME taxa according to the best available science. Vessels are required to move 5nm and report the encounter 'without delay', this can be open to interpretation and should be better defined (e.g. within 24 hours).

Article 11 gives an overview of the observer requirements and the data that should be collected with regards to VMEs, although how these data are collected is not well defined, stating that the observer should '…document any unforeseen encounters

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156 https://www.inaturalist.org/

157 WG-FSA-09/23 (2009). Accuracy of benthic invertebrate by-catch identification by observers operating in the Heard Island and McDonald Islands Patagonian toothfish longline fishery. Hibbert, T., Australian Antarctic Division.

158 Welsford, D. and R. Kilpatrick. 2008. Estimating the swept area of demersal longlines based on in-situ video footage. Document WG-FSA-08/58. CCAMLR, Hobart, Australia.

with vulnerable marine ecosystems…’. Data collection protocols, including encounters with VMEs should be harmonised between Member States, as described in Annex 9.

Conclusions

The aim of this task was to look at data gaps and research priorities in the different regions (RFMOs and FAO Area 41 regarding Council Regulation (EC) No 734/2008) with a view to improving VME identification, protection and overall knowledge. This was done primarily through reviewing reports from the groups responsible for managing VMEs within each RFMO as well as other summaries. The main gaps in data are related to the life history of VME species, in terms of their longevity, fragility, larval dispersion and mobility. Without a better knowledge of these traits the effectiveness of various mitigation measures is difficult to assess. Specifically, whether current threshold levels are suitable, what is the ideal distance for a move-on rule, if any, and how best to spatially manage an area to balance maximum protection with minimal interference to fishing. Although fishing vessels are not an effective sampling tool, observer programmes provide a valuable source of data a relatively low cost. All RFMOs in this study had some form of observer programme in place with a requirement to collect data on VMEs when encountered. Annex 9 provides guidelines, based on programmes already in place, for the collection and recording of VME data by observers. The data requirements related to Council Regulation (EC) No 734/2008 are summarized in Annex 10.

TASK 7 – Identify areas, topics and policy options with potential scope and added-value in promoting consistency among relevant organisations and with relevance to any possible revision of Regulation 734/2008.

Objectives

The objective of this task is to identify areas, topics and policy options with potential scope and added-value in promoting consistency among relevant organisations (RFMOs) and with relevance to any possible revision of Council Regulation (EC) No 734/2008.

Methodology

Task 7 was implemented as transversal work throughout the development of the contract. It aimed to identify issues and approaches for which a consistent approach across relevant RFMOs could be required. It provides the rationale and argumentation for promoting such an approach across relevant RFMOs (NAFO, NEAFC, GFCM, SEAFO, CCAMLR, SPRFMO, NPFC and SIOFA) and can also help to ensure that any future revision of Council Regulation (EC) No 734/2008 can be based on such an approach. This Task was a desk-based and was undertaken through a literature review. A tentative list of potential topics of interest in the context of the promotion of consistency, were discussed and identified (see Results section).

Results

A summary of the definitions of "key concepts" used across the RFMOs and Council Regulation (EC) No 734/2008 was compiled (e.g. SAI, VME, VME indicator features and species, encounters, exploratory fisheries, research vessels, etc.). This summary is shown in Annex 11 of the present report. Furthermore, in Task 4 the concept "fishing footprint/existing bottom fishing areas" was previously compiled and compared for the RFMOs. An overview of this concept in the RFMOs is also included in this Annex (it is important to note that in Council Regulation (EC) No 734/2008 there is no definition for fishing footprint). In addition, a comparative table summarizing the main management measures regarding mitigation of potential impacts (SAIs) and conservation of VMEs implemented in the different RFMOs is provided below (Table 1). This table facilitates visualizing the differences found between organisations and the main existing management options. Detailed information about these measures are outlined in Annex 8 (Deliverable 4) and in Task 5

Table 2. Comparative table summarizing the main management measures regarding SAIs and conservation of VMEs.

[1]Fishing only permitted in historical fishing grounds, representing 2% of the area. [2]337 areas defined for permitted bottom fishing. [3]Includes 4 permanent closures, 82 temporary closures and MPAs.[4] Primarily to protect fish stocks and shark species but benthic communities also cited. [5]1,000m recommendation is in place to reduce potential for depredation.[6]Unless otherwise stated in a Conservation Measure.

RFMOs	Closed Areas	Encounter protocols (threshold and distance moved)	Depth limitations	Gear restrictions/modifications	Seasonal closures	Observers
NAFO	27 (2,707,895) 17 tempoary closures also in place	60kg live coral, 300kg sponge, 7kg sea pens - 2nm	None	None	None	100%. VME data collected.
NEAFC	22 (375,606[1])	30kg live coral, 400kg live sponge – 2nm, 10 hooks / 1,000 – 2nm	None	No gillnets >200m	None	100% for exploratory fisheries. VME data collected.
SEAFO	12 (16%)	60kg live coral, 600kg live sponges – 2nm 10 units of VME taxa – 2nm	None, but only 2% - 3% < 2000m	Division 1B closed to all gears except pots and longlines	None	100%. VME data collected.
GFCM	3 (15,659)	N/A	>1000m, <50m[4]	Dredges and trawls >1000m, trawls <50m[4]	None	~25%, varies by contacting party
NPFC	2 (546 (2.1%))	50kg live coral – 2nm	>1,500m	Distance between gillnet and seafloor >70cm	Closures introduced for fish species but can also reduce SAIs on VMEs	100% for vessels bottom fishing. VME data collected.
SPRFMO	N/A[2]	60kg stony coral, 5kg black coral, 15kg sea fans, 35kg anemones, 10kg hexacorals – 1nm	None	Type of gear limited to management area	Only for Protected, Endangered and Threatened (PET) species.	100% bottom trawl, 10% longline (observed hooks) 100% exploratory fisheries. VME data collected.
SIOFA	12 (504,922 (3.2%))	60kg live coral and / or 300kg live sponges – 2nm either side of trawl track plus 2nm each end for trawls 10 units of taxa in the VME indicator taxa list in a single line segment (1,000 hooks or 1,200m of line) – 1nm from midpoint of segment for longline or traps.	Demersal longlines prohibited <500m and encouraged to set >1,000m[5]	All bottom gear types, with the exception of lines and traps, excluded from interim protected and recently fished areas.	None	Longline vessels targeting toothfish - at least one observer per vessel covering 25% of hooks. Trawl gear – 100% coverage. Other bottom fishing gear – 20%.
CCAMLR	86[3] (1,647,092)	10 units of VME taxa – 1nm	<550m[6]	Ban on bottom trawling and gillnets. Use of integrated weights on longlines.	Yes, but for seabirds.	100%. VME data collected on at least 30% of line segments

This study (particularly in Tasks 2, 3, 4, 5 and 6), identified the following list of 11 topics of interest in the context of the promotion of consistency among RFMOs which have special relevance with respect to Council Regulation (EC) No 734/2008. Furthermore, in addressing them, a set of lessons learned was identified for each topic:

1. Bycatch mitigation, including VME indicator species.

In terms of bycatch management, RFMOs are progressing at different paces. Perhaps the biggest issue that remains, and that slows down bycatch mitigation efforts, is the generalised lack of data that still exists in many RFMOs regarding the interactions of vulnerable species with fisheries, that can end up as bycatch. This is especially evident for elasmobranchs, marine mammals and seabirds. As some RFMOs well acknowledges, the lack of data on the occurrence and level of bycatch hinders the ability to manage and apply rules on fishing vessel activities. Even where data exists, the lack of statistically robust and harmonized sampling designs limits its value and, for example, prevents comparisons between different fishing fleets and areas. Detailed information on the **diversity of practices and measures** implemented to reduce and manage bycatch in DSF across the RFMOs are in the Annex 4 (Deliverable 2) of the present report. In view of the variety of approaches used and the varying degrees of progress across RFMOs, there is scope for promoting consistency in the field of bycatch management in order to achieve equivalent development in the different high seas fishing areas. Therefore, actions shall be implemented (or continued) to achieve adequate monitoring programs and frameworks that can provide sound bycatch data collection are urgently required, and the existing programs. Once this data becomes available, better measures can be designed to protect bycaught species in DSF.

Lessons Learned

- Lack of data can hinder progress in managing bycatch in fisheries, particularly for vulnerable species such as elasmobranchs, marine mammals, and seabirds.
- Without statistically robust and harmonized sampling designs, it is difficult to compare data between different fishing fleets and areas, limiting its value.
- Consistency in bycatch management approaches across different RFMOs can help promote equivalent development in high seas fishing areas. Adequate monitoring programs and frameworks that provide sound bycatch data collection are urgently required. Once data becomes available, better measures can be designed to protect bycaught species in deep-sea fisheries.

2. Fishing footprint.

Although the identification of the fishery footprint is of great relevance for the conservation of VMEs, both the FAO DSF Guidelines and the Council Regulation (EC) No. 734/2008 lack a definition of this key concept. Nevertheless, in most RFMOs the terms "*fishing footprint*", "*bottom fishing footprint*", "*existing bottom fishing areas*", "*existing deep-sea bottom fishing areas*" are equivalent and generally refer to those locations in which some level of bottom fishing activity has previously been conducted in a reference period. In terms of fishing footprint definition, RFMOs are progressing also at different paces. This study shows that there is a **wide variety of methods**

for defining fishing footprints in the different RFMOs, and that Spain has used one of these for the areas subject to Council Regulation (EC) No. 734/2008. When studying the fishery footprint in RFMOs (and in areas subject to Council Regulation (EC) No. 734/2008), several key issues should be taken into account: Data needs (e.g. compilation, updating, availability and quality), the possibilities of international cooperation (e.g. research, management, sharing of information), the potential use of new methodologies, as well as complementary data sources and approaches (e.g. methods to improve footprint resolution, including mobile and static bottom gears, use of AIS, etc.), and the financing needs to conduct the fishing footprint studies. Detailed information on the variety of approaches to define footprints are in Annex 5 (Deliverable 3). In view of the variety of approaches used and the varying degrees of progress in the different areas, there is scope for promoting consistency in the field of fishing footprint definition. The definition of the fishery footprint is a key factor for the conservation of VMEs. For this reason, promoting consistent standards among the different RFMOs, based on the experience of the most advanced organizations (e.g., the methodology to be used to define the fishery footprint) can help to achieve a more balanced and consistent development of this factor in the different high seas areas, improving the management results (see Annex 5 for general considerations and recommendations on the study of the historical fishing footprint).

Lessons Learned

- The identification of the fishery footprint is essential for the conservation of VMEs. The lack of a clear definition of the fishing footprint in the FAO DSF Guidelines and Council Regulation (EC) No. 734/2008 can complicate efforts to manage and conserve VMEs.
- RFMOs have made varying progress in defining the fishing footprint, with a wide variety of methods being used across different organizations.
- To effectively define fishing footprints, data needs, international cooperation, new methodologies, and financing requirements must be taken into account.
- Promoting consistent standards for defining the fishing footprint across RFMOs can help achieve more balanced and effective VME conservation efforts.

3. Framework for exploratory fisheries.

In terms of exploratory fisheries, most of RFMOs adopted regulations on bottom fishing, incorporating relevant elements from the UNGA resolution 61/105 and the FAO DSF Guidelines, including the adoption of exploratory fishing protocols. Some RFMOs have strict protocols, others do not have a specific legal framework for this issue and others have modified and improved their protocols on several occasions. In general terms, RFMOs follow similar specific procedures and preliminary assessments. An exceptional case is SIOFA that has not clearly defined what an exploratory fishery is. Most of the RFMOs, with some exceptions, have implemented specific conservation and management measures to prevent SAIs on VMEs during the exploratory fisheries and in most RFMOs, monitoring of exploratory fisheries is mandatory, including the deployment of on-board observers. Detailed information on the **variety of existing exploratory fishing protocols** are in the Annex 6 (Sub-task 4.2) of the present report. In view of the variety of approaches used and the varying degrees of progress across RFMOs, there is scope for promoting consistency in the framework for exploratory fisheries in order to achieve equivalent development in the different high seas fishing areas. In addition, the national experience of the few countries that have already conducted some preliminary impact assessment of high seas exploratory fisheries, incorporating recent UNGA and FAO requirements (e.g. Spain, snow crab exploratory fishery within the NEAFC Regulatory Area), may be useful as a starting point, or even a model, to guide possible frameworks for such assessments. See Annex 6 for details on potential elements needed to develop such a framework.

Lessons Learned

- Most RFMOs have adopted regulations on bottom fishing and exploratory fishing protocols, incorporating elements from UNGA and FAO guidelines.
- Some RFMOs have strict protocols, while others do not have a specific legal framework for exploratory fisheries, and some have modified their protocols on several occasions.
- Most RFMOs have implemented specific conservation and management measures to prevent SAIs on VMEs during exploratory fisheries, and monitoring of exploratory fisheries is mandatory in most RFMOs.
- Promoting consistency in the framework for exploratory fisheries across RFMOs can help achieve equivalent development in different high seas fishing areas.

4. Framework for scientific research, including mitigation of impacts from research.

Scientific research activities play an essential role in the assessment of DSF and the advice on VMEs in the high seas. They provided high-quality, robust and timely data, and their results have been routinely integrated into the RFMO advisory processes. This is essential to underpin management policies, not only in the RFMOs Regulatory Areas, but also in areas subjected to Council Regulation (EC) No. 734/2008 (i.e. multidisciplinary research conducted by Spain in the SW Atlantic). In general, there is a **diversity of approaches in the different RFMOs with regard conservation and management measures related to scientific research**. It is worth noting that only SEAFO has developed specific guidelines for fisheries research and basic marine science activity, but the regulation of research is currently a matter of concern in some RFMOs, and several initiatives are being carried out in this regard. Moreover, the issue of the **impacts from research on VMEs** is addressed in the conservation and management measures of some RFMOs or is currently being monitored. In most RFMOs, their own scientific advisory bodies have the functions of encouraging, promoting cooperation and coordinating the international scientific research. In the case of NEAFC, as an exception, an independent external advisory body (ICES) is in charge of these functions. Most of the RFMOs have developed research work plans for their advisory bodies in a multi-annual or annual basis, including planning of research priorities. Detailed information on the variety of existing scientific research frameworks are in the Annex 7 (Sub-task 4.3) of the present report. In view of the variety of approaches used and the varying degrees of progress across RFMOs, there is scope for promoting consistency in the framework for scientific research in order to achieve equivalent development in the different high seas fishing areas. In addition, the national experience of countries that have already developed *ad-hoc* scientific research on DSF and VMEs in the areas of application of Council Regulation

(EC) No. 734/2008, may be useful as a start point, or even a model, to guide a future research framework for these areas. See Annex 7 for details on potential elements needed to develop such a framework.

Lessons Learned

- Scientific research activities play an essential role in the assessment of DSF and the advice on VMEs in the high seas, and their results have been routinely integrated into the RFMO advisory processes.
- There is a diversity of approaches in the different RFMOs with regard to conservation and management measures related to scientific research. Moreover, impacts from research on VMEs is addressed or is currently being monitored.
- There is a need for promoting consistency in the framework for scientific research across RFMOs. National experiences of countries that have already developed *ad-hoc* scientific research may guide a future research framework for areas under Council Regulation (EC) No. 734/2008.

5. Framework for Observers on board, including VMEs data collection.

The present study compared the **variety of observer programmes in place in DSF**, showing that there is a wide variability in observer coverage across different RFMOs and gear types, ranging from 100% to 10%. All reviewed programmes required observers to record VME taxa (identified to the lowest taxonomic level possible) recovered on a haul by haul basis and had developed a variety of formats for recording and reporting. Most of the programmes have developed VME guides. Most of them have thresholds in place which, when triggered, would require the implementation of a move-on rule, but the follow up action once the vessel has moved is inconsistent, with some RFMOs closing off the area and others not having anything in place. In all cases, it is the responsibility of the vessel to notify of the presence of a potential VME. Annex 9 of the present report provides guidelines, based on programmes already in place in RFMOs, for the collection and recording of VME data by observers, including a brief description of the elements to be considered when developing a potential observer programme to monitor VMEs. This could help to develop consistent programmes across RFMOs. Requirements for observer programmes to record and report VME taxa, include: i) identification to the highest taxonomic level, ii) quantity, iii) number of taxa, iv) time, v) date, and vi) location. In addition, it should be noted that remote electronic monitoring (REM) methodologies developed to date, have been developed and optimized primarily for fish, not VME taxa, and none of the study RFMOs require the use of REM. However, in the future, the use of REM could enhance the work of observers (rather than replace them).

Lessons Learned

- There is a wide variability in observer coverage across different RFMOs and gear types, ranging from 100% to 10%.
- Most observer programmes require the recording of VME taxa (identified to the lowest taxonomic level possible) recovered on a haul by haul basis and have developed VME guides. Most of them have thresholds in place, but the follow-up action once the vessel has moved is inconsistent.
- REM methodologies have been developed primarily for fish, not for VME taxa, and none of the studied RFMOs require their use, but it could enhance the work of observers in the future.
- Observer programmes are an essential component of DSF to assess and manage the impact on VMEs. Promoting consistency in the framework for observers on board across RFMOs can help achieve equivalent development in different high seas fishing areas.

6. Framework for VMEs.

All reviewed programmes required observers to record VME taxa recovered on a haul by haul basis and had developed formats for recording and reporting. This included **identification of the taxa** to the highest taxonomic level, the quantity (normally either weight or volume), the numbers of different taxa recorded, time, date and location. In addition, in some RFMOs, the lists of VME indicators include few taxa and more work is needed to update those lists as new information becomes available. Also, expert reviewers often indicate a lack of information to evaluate candidate VME indicators against FAO criteria.

All of the programs, except for GFCM, had predetermined **thresholds** that, when reached, would necessitate the implementation of a **move-on rule**. SPRFMO was the only program that had varying thresholds depending on the vulnerability and catchability of the species being recovered. However, the actions taken after the vessel had moved varied greatly among the different bodies. Some organizations, such as CCAMLR, would close off the area, while others like NPFC had no measures in place. Only NAFO had a system in place to evaluate the effectiveness of the closures. In all the organizations examined, it was the responsibility of the vessel to notify the flag State or Secretariat of the presence of a potential VME once a threshold level had been reached, and to take any necessary follow-up actions. Furthermore, the majority of the programs had created **VME identification guides** that were intended for the use of observers and vessel crews. These guides were typically straightforward and user-friendly, with a focus on highlighting the key VME species. One of the main priorities in research has been to **refine these guides to ensure that all species are covered** in accordance with the criteria outlined in Paragraph 18 of the FAO DSF. In view of the variety of approaches across RFMOs, there is scope for promoting consistency in the establishment of a framework for VMEs. First of all, it is necessary to carry out research to fill the gaps regarding biological information of benthic organisms and their distribution, in order to allow their evaluation against FAO criteria. Moreover, only a small portion of the seafloor has been directly observed for VMEs, usually through underwater imagery, due to the high cost and logistical difficulties of conducting research surveys in remote locations like seamounts and other VME habitats. As a result, **alternative approaches** are required to **identify VMEs**, such as species distribution models or multi-criteria assessments. However, not all RFMOs can utilize repeatable and quantitative methods due to insufficient data. Additionally, bottom trawls used in research surveys to collect samples are harmful to VMEs, necessitating the development of alternative methods like exploring the potential of using **environmental DNA to detect and monitor VMEs**. Detailed information on this topic can be found in Annex 3 (Deliverable 1), Annex 4 (Deliverable 2) and Task 6 of the present report.

Lessons Learned

- Reviewed programs record and report VME taxa recovered on a haul by haul basis. Programs (except for GFCM) have predetermined thresholds and move-on rules when thresholds are reached.
- Vessels are responsible for notifying flag State or Secretariat of potential VMEs and taking follow-up actions.
- Alternative approaches are required to identify VMEs, and consistency is needed in the establishment of a framework for VMEs.
- Further research is required to fill gaps regarding biological information of benthic organisms and their distribution.
- In view of the variety of approaches across RFMOs, there is scope for promoting consistency in the establishment of a framework for VMEs.

7. Framework for collection and reporting of data, including quality control.

Collection and reporting of data, including quality control, plays a crucial role in ensuring the accuracy, completeness, and consistency of information that is gathered and shared. The review of existing data collection and reporting in DSF allowed us to have a general view of the different RFMO approaches in different fields. For example, **data regarding VMEs** is collected in different ways, for example in research surveys (e.g., catches of VME indicators and underwater imagery) or recording bycatch data from fisheries (collected through scientific observers). However, the availability of VME data varies greatly throughout RFMOs, with some having regular programs of research surveys and 100% observer coverage (e.g. NAFO) while others have limited data available. Therefore, not all of the RFMOs can apply repeatable, quantitative approaches for VME identification because there are not enough data. On the one hand, regarding **catch reporting of VME indicator species**, the image recognition technology/software (on-board cameras) is not fully developed in comparison with fish identification. It is recommended to undertake research studies to determine the feasibility of VME indicator species image recognition systems. In summary, it is recommended to continue work on identification guides for VME indicators, consolidate all available data sources, including bycatch, scientific and fisheries independent surveys, historical literature, the fishing industry, and potentially relevant information from within exclusive economic zones (EEZs), while ensuring that sampling programs record biological data at the highest possible taxonomic resolution, and to consider conducting standardized training programs for observers and development of regional observer programs. Besides, collection of absence data (locations where VME taxa are not present) shall be encouraged, because they are fundamental to fully evaluate the occurrence of VME habitats and indicators, and, specifically, to support mapping of benthic habitats. On the other hand, the **determination of the historical bottom fishing footprint** is crucial for the adequate management of DSF. In this field, following data was considered essential to define appropriately the bottom fishing footprint in the DSF: VMS data; Catch data collected in a haul by haul basis; Information on technical and operative characteristics of the bottom fishing gears. It is important to note that the resolution of spatial and temporal data needs to be of a sufficient quality to enable the definition of a reliable bottom fishing footprint. This is still a practical constraint in some RFMOs (e.g. SIOFA). Some RFMOs compile and maintain VMS and logbook data, having the duty to make available such data to be used for scientific purposes. However, in some other RFMOs VMS is recently operational. In terms of **quality of the data**, the accuracy of fishing effort estimation is primarily linked to the quality of the input data. Therefore, it is recommendable to develop further studies on the problems detected, (including an implementation of an **improved quality control (QC) check process**) with the aim to propose measures to solve such issues. Finally, there is a lack of information about fishing fleets in areas without RFMOs (e.g. FAO Area 41). International cooperation is needed to establish **data sharing** and management agreements to monitor these fleets. A **multilateral action plan** involving organizations such as FAO is recommended through a stepwise approach for data collection programs, which could contribute to establishing RFMOs or Agreements. Moreover, **Memoranda of Understanding (MoUs)** between organizations are useful tools to facilitate advice on matters of mutual interest, raise questions of concern, and foster closer relationships. Detailed information is in the Annex 3 (Deliverable 1) and Annex 5 (Deliverable 3).

Lessons Learned

- Collection and reporting of data is crucial for ensuring accuracy, completeness, and consistency of information in DSF.
- Different RFMOs use different approaches to collect data on VMEs, with some having limited data available. Therefore, there is room for improvement in terms of consistency.
- Image recognition technology/software for VME indicator species catch reporting is not fully developed.
- Determining the historical bottom fishing footprint is crucial for adequate management of DSF, and VMS data, catch data, and information on fishing gears are essential to define it.
- International cooperation is needed to establish data sharing and management agreements to monitor fishing fleets in areas without RFMOs, and MoUs between organizations can facilitate advice on matters of mutual interest.

8. Assessment of Significant Adverse Impacts (SAIs).

Results from present study shows that **there is disparity regarding the assessment of SAIs** of bottom fishing activities in the different RFMOs, and that not all RFMOs have completed impact assessments. Moreover, some of the impact assessments may have not been carried out according to the Guidelines and UNGA

Resolutions. Also, there is a need to discuss what threshold would be appropriate for the protection of VMEs without causing SAI, because there is no set threshold in the Guidelines. Such a threshold would help to operationalize VME protection according to the Guidelines, and it is important because it may not be realistic to be able to protect 100% of VMEs. Detailed information on the approaches followed by RFMOs that have recently completed bottom fishing impact assessments/re-assessments is in the Annex 3 (Deliverable 1) of the present report. In view of the current situation, there is scope for promoting consistency in the assessment of SAIs of bottom fishing across RFMOs. In this regard, some recommendations should be considered: (i) Develop quantitative impact assessments; (ii) Identify appropriate protection levels for VMEs; (iii) Assess SAIs on relevant VME indicator taxa as the VME indicator taxa lists are updated; (iv) Assess and monitor the recovery of VMEs and protect recovering sites in addition to pristine ones: (v) Develop a standardized approach and metrics to assess the cumulative impact of all bottom fisheries on VMEs; and (vi) Develop measurable objectives for determining the occurrence of SAIs. Abandoned, lost or discarded fishing gear (ALDFG) should be considered because it can cause physical impacts to benthic ecosystems[159]: Gillnets can be dragged along the bottom by strong currents and wind during retrieval, potentially damaging sponges and corals. Potential impacts of traps depend on the type of habitats and their presence with respect to trap distribution. Hook and line can entangle both VME indicator species (e.g. cold-water corals) and vulnerable habitats, causing detrimental effects. The effects of lost fishing gear on the deep sea benthic ecosystems are direct and immediate (e.g. damaging corals and other erect biogenic structures, removing non-target species trough bycatch), persisting over time (e.g. ghost-fishing)[160].

In addition to this, SAIs from activities other than fishing (e.g. offshore oil and gas) is a controversial issue due to jurisdictional aspects. Although outside the scope of the FAO Guidelines, it is now a matter of growing concern in some RFMOs (i.e. NAFO) and should be taken into account when considering the cumulative impacts of human activities in the high seas. As a first step in assessing impacts, it is necessary to map such activities, as NAFO has already done.

Lessons Learned

- There is a disparity in the assessment of SAIs of bottom fishing activities in different RFMOs and not all have completed impact assessments.
- There is a need to discuss an appropriate threshold for the protection of VMEs without causing SAI as there is no set threshold in the Guidelines.
- Some recommendations to promote consistency in assessing SAIs of bottom fishing include developing quantitative impact assessments, identifying appropriate protection levels for VMEs, and developing a standardized approach to assess cumulative impacts. Moreover, ALDFG should also be considered due to its detrimental effects on VMEs.

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[159] Macfadyen, G.; Huntington, T.; Cappell, R. Abandoned, lost or otherwise discarded fishing gear. UNEP Regional Seas Reports and Studies, No. 185; FAO Fisheries and Aquaculture Technical Paper, No. 523. Rome, UNEP/FAO. 2009. 115p.

[160] Vieira, R.P., Raposo, I. P., Sobral, P., Gonçalves, J.M.S, Bell, K.L.C. and Cunha, M.R. (2015). Lost fishing gear and litter at Gorringe Bank (NE Atlantic). Journal of Sea Research, 100: 91-98.

- Other human activities such as offshore oil and gas should be taken into account when considering cumulative impacts on the high seas. As a first step, it is necessary to map such activities, as NAFO has already done.

9. Work plans of the RFMO scientific advisory bodies.

RFMOs have adopted annual or multi-annual work plans, programs or roadmaps for their scientific bodies (i.e. Scientific Councils - SC), which include prioritizing research. In the case of NEAFC, ICES, as an independent external advisory body, can develop appropriate research programs, with the support of the RFMO's Permanent Committee on Management and Science (PECMAS). In general SC work plans of the RFMOs are focused on the provision of specific scientific advice to assist the RFMO´s work, more than to develop general science (it should be primarily developed through mechanisms other than the work programs, e.g. CCAMLR). In some cases, SC work plan also includes research on the impacts of activities other than fishing (e.g. NAFO: oil and gas and marine litter). Most of RFMOs have developed their own technical guidelines to have a unique framework for a certain type of surveys (e.g. demersal trawl, pelagic acoustic surveys, etc.) with the main aim of standardizing data collection in fisheries research. Annex 7 (Sub-task 4.3) of the current report contains comprehensive details regarding the **variety of work plans** of the RFMO scientific advisory bodies. This facilitated comparable progress across various high-seas fishing zones. Promoting consistent features in the planning of scientific work across RFMOs can help improve consistency in the management of DSF and the conservation of VMEs on the high seas. In addition, as mentioned before in the case of the research frameworks, the national experience of countries that have already developed *ad-hoc* scientific research on DSF and VMEs in the areas of application of Council Regulation (EC) No. 734/2008, may be useful as a start point to guide future research work plans for these areas.

Lessons Learned

- RFMOs have annual or multi-annual work plans, programs or roadmaps for their scientific bodies that prioritize research, including developing specific scientific advice to assist the RFMO's work.
- Most RFMOs have developed technical guidelines for standardizing data collection in fisheries research.
- SC work plans may also include research on the impacts of activities other than fishing, such as oil and gas and marine litter.
- Promoting consistent features in the planning of scientific work across RFMOs can help improve consistency in the management of deep-sea fisheries and the conservation of VMEs on the high seas.

10. Framework for advice on management options to reduce the risk of SAI and to the protection of VMEs, while limiting potential losses to fishers (balance between improvements in the protection and potential losses to fishery sector).

In this regard, some RFMOs such as **NAFO** evaluated possible management options for the protection of VMEs in the NRA, giving careful consideration to the review of existing coral and sponges closures and the outcome of the SAI in evaluating possible tradeoffs required to achieve appropriate conservation measures and **the possible consequences to ongoing bottom-contact fisheries**. There are no established rules to quantify such tradeoffs, but the basic principles applied were to **reduce the risk of SAI and improve the protection of VMEs** while **limiting potential losses to harvesters** relative to the overall activities for all fisheries monitored in the NRA. The evaluation performed in NAFO yielded proposals for ten extensions to existing closures, the creation of three new closures, and modifications to Area 14. The consequences of the protection of VMEs and the potential impact on fishing activities and catches were discussed taking into account that improvements to VME protection must be **balanced against the potential constraints that would be imposed on the fisheries** within the NRA. Along the same lines, about the implementation of Regulation (EU) 2016/2336 ("Deep-sea Access Regulation"), the European Commission (EC) asked **ICES for scientific advice** on the listing of areas where VMEs exist or are likely to exist, about the so-called "existing deep-sea fishing areas" in waters of the North-East Atlantic Ocean, where the European fleet using bottom gears operates between 400 and 800 metres depth. **ICES advice proposed different scenarios and management options**, with different implications for the protection of VMEs and potential repercussions for bottom fishing activity (e.g. areas closed to fishing in certain localised areas in European waters). Based on this advice, the EC decided to establish **87 closures to bottom fishing in the waters of Spain, Portugal, France and Ireland**, which generated much controversy in the Member States and a strong reaction[161] in some of them, including legal actions for annulment before the Court of Justice of the EU. This issue continues to be of great concern and attention to some Government[162], the bottom fishing industry[163] [164], the sectoral media[165] [166] [167] and the European Parliament[168]. In addition, recent action plans from the EC, related to the future regulation of bottom fishing have generated much

[161] *"Spain appeals to the court of justice of the European Union against the deep-sea fishing regulation"* https://www.lamoncloa.gob.es/lang/en/gobierno/news/paginas/2022/20221114_deep-sea-eu-fishing-regulation.aspx

[162] *"The Spanish Ministry for Agriculture, Fisheries and Food, considers that this measure lacks rigour because it has not considered the latest scientific reports available, and has been taken without taking into account the criteria of proportion and balance set out in the Common Fisheries Policy (CFP)".* See: https://www.lamoncloa.gob.es/lang/en/gobierno/news/Paginas/2022/20220919_eu-fisheries.aspx

[163] *"European Bottom Fishing Alliance (EBFA) condemns current initiative to ban bottom fishing at the European Parliament".* See: https://bottomfishingalliance.eu/newsletters/

[164] *"EBFA meets commissioner Sinkevicius to outline the sector's concerns regarding the area closures, but frustration remains"*
See: https://bottomfishingalliance.eu/newsletters/ebfa-meets-commissioner-sinkevicius-to-outline-the-sectors-concerns-regarding-the-area-closures-but-frustration-remains/

[165] *"Gaps in science and consultation as commission shuts fishing grounds".* See: https://fiskerforum.com/

[166] *"EU industry threatens court action over MPAs". See* https://fishingnews.co.uk/news/eu-industry-threatens-court-action-over-mpas/

[167] *"El cierre de áreas de pesca para artes de fondo, un cisma entre España y Bruselas"*
See: https://industriaspesqueras.com/noticia-73657-seccion-IP_en_2022

[168] *"During its last plenary session at the beginning of October 2022, the EU Parliament voted on a text criticising the implementing Regulation for being adopted on the basis of insufficient data and without sufficient stakeholder consultation. It urged the Commission to review its decision in light of the forthcoming scientific advice to be published in November 2022 and once a socio-economic impact assessment is available".* See: https://www.eppgroup.eu/newsroom/news/european-commission-mustn-t-endanger-fishers-livelihood

controversy[169] [170] [171] due also their potential adverse socio-economic impact on the European fishing industry.

Conducting **socio-economic studies** can **help policymakers make informed decisions** that balance the fishing industry´s need, the sustainability of fish stocks, and the social and economic well-being of fishing communities. These studies are crucially important as they can provide **valuable insights into the potential impacts of management measures** and help **identify strategies to mitigate any negative effects**. Furthermore, socio-economic studies of the implications of management measures in the fisheries sector are critical for **stakeholders** to understand the impacts of such measures on their businesses, communities, and livelihoods. These studies can also inform **policy development**, **promote collaboration**, and **support sustainable development in the industry**.

Lessons Learned

- Some RFMOs, such as NAFO, have evaluated management options to protect VMEs in the high seas. Basic principles applied were to reduce the risk of SAI and improve the protection of VMEs while limiting potential losses to harvesters relative to the overall activities for all fisheries monitored in the NRA.
- Regarding national waters, the European Commission requested ICES for scientific advice on the listing of areas where VMEs exist or are likely to exist, leading to the establishment of 87 closures to bottom fishing in certain localised areas in European waters. This generated much controversy in the Member States due to their potential adverse socio-economic impact on the European fishing industry.
- Conducting socio-economic studies is crucial for policymakers to make informed decisions that balance the fishing industry's needs, the sustainability of fish stocks, and the social and economic well-being of fishing communities.
- Socio-economic studies of the implications of management measures in the fisheries sector are critical for stakeholders to understand the impacts on their businesses, communities, and livelihoods, and to inform policy development and support sustainable development in the industry.

11. Measures to combat illegal, unreported and unregulated (IUU) fishing.

Monitoring, control and surveillance systems (MCS) are a critical component of sustainably managed fisheries. It also addresses issues such as IUU fishing, that may affect VMEs directly because IUU fishing often uses illegal fishing methods, which can seriously damage the deep-sea ecosystems. Moreover, there is the problem that, in

[169] *"France is firmly opposed to the implementation of a ban on bottom fishing gear in marine protected areas, said the Secretary of State for the Sea, Hervé Berville, on Wednesday 8 March. On the same day, the Spanish Minister for Agriculture and Fisheries, Luis Planas, also protested against the bottom trawl ban and said that trawling, which is practised by 805 vessels in Spain, i.e. 10% of the national fleet, should not be* demonised*"* https://agenceurope.eu/en/bulletin/article/13138/33

[170] *"La pesca europea se hace escuchar a bocinazos el Día de Europa"* https://www.lavozdegalicia.es/noticia/somosmar/2023/05/08/pesca-europea-escuchar-bocinazos-dia-europa/00031683561240881289387.htm

[171] *"Fishermen from EU Member States to demonstrate against bottom-trawling ban"* https://thefishingdaily.com/latest-news/fishermen-from-eu-member-states-to-demonstrate-against-bottom-trawling-ban/

order to avoid inspection, illegal fishing gear is abandoned directly into the sea, causing a large number of ghost fishing gear that can damage marine ecosystems, including VMEs. IUU fishing remains a constant threat for all of the deep-sea RFMO/As and the coordinated, consistent, and rigorous implementation and further development of the MCS and enforcement regimes are essential to address this threat. While all the deep-sea RFMOs have implemented measures to establish IUU vessel lists that respond to their conservation and management mandates and the recommendations of the international plan of action to prevent, deter, and eliminate illegal, unreported and unregulated fishing (IPOA-IUU), **there is scope for improvement and harmonization of these measures. Harmonization is a critical need, particularly for those RFMOs that manage similar species, share the same oceans or have overlapping areas of competence.** In an ideal world, cross-listing procedures would be established across all of the deep-sea RFMOs. To support this cross-listing, the criteria for including and removing a vessel from an IUU vessel list would be harmonized. Key findings on MCS regarding IUU fishing are in the Annex 3 (Deliverable 1) of the present report. It is clear that by addressing the issues such as IUU and by improving cooperation and information sharing among RFMOs, the protection of VMEs can be enhanced (e.g. implementing similar quantitative approaches to identify VMEs to those used in RFMOs with more experience, or sharing information on which measures are working better). Although this has been done already to some extent by RFMOs, either formally or informally, there is room for improvement.

Lessons Learned

- MCS are crucial for sustainable fisheries management and addressing issues such as IUU fishing that can harm VMEs. IUU fishing involves illegal methods that can cause significant damage to deep-sea ecosystems, including VMEs, and lead to the abandonment of ghost fishing gear.
- All deep-sea RFMOs have implemented measures to establish IUU vessel lists, but there is a need for improvement and harmonization of these measures.
- Harmonization is essential, particularly for RFMOs that manage similar species, share the same oceans, or have overlapping areas of competence.
- Improving cooperation and information sharing among RFMOs can enhance the protection of VMEs by implementing similar approaches to identify VMEs and sharing information on effective measures.

Conclusions

The comparison of the different **concepts and definitions** in the context of the *FAO DSF Guidelines*, allowed us to obtain the following conclusions: (i) In most of RFMOs, main "key concepts" are defined based on the *FAO DSF Guidelines* (e.g. SAI, VME, bottom fishing). However, the list of "key concepts" described by the *Guidelines* is quite brief and could be expanded and improved; (ii) Some concepts are not clearly defined by the *FAO DSF Guidelines*, nevertheless the different RFMOs have adopted similar definitions based (or inspired) on the "spirit" of the *Guidelines* (e.g. fishing footprint, encounter); (iii) There are different approaches in the RFMOs regarding the implementation of some concepts: lists of VME indicators; VME indicator units/threshold levels; (iv) Framework for VMEs in Council Regulation (EC) No 734/2008: The concept "VME" is defined, but not "VME indicator"; a move-on rule is specified but the concept "encounter" is not clearly defined (e.g. indicators and threshold levels). In addition, as was previously mentioned, there is no definition for “fishing footprint” concept in areas under this regulation. Some of these gaps could complicate the effective implementation; (v) The use of a similar set of definitions of main “key concepts” related to VME/DSF management could help in promoting consistency between organizations and DSF regulations: The main “key concepts” should be clearly defined and equivalent concepts should have the same meaning across different organizations and DSF regulations.

A total of **11 key topics** were brought up and discussed with the goal of providing opportunities for promoting consistency across RFMOs, including some that pertain to any possible revision of Council Regulation (EC) No 734/2008. In general, there is a **diversity of approaches** in the different RFMOs with regard to all the topics that were discussed. They cover a **wide range of aspects** related to: (i) **Fisheries management and conservation** (such as By-catch mitigation, including VME indicator species, Framework for VMEs and Measures to combat IUU fishing activities); (ii) **Scientific research and data collection** (including Frameworks for Exploratory Fisheries, for Scientific Research, including mitigation of impacts from research, for Observers on board, including VMEs data collection, for collection and reporting of data, including quality control and fishing footprint), and; (iii) **Ecosystem-based fisheries management** (SAI assessment, requirements and methods, Work plans of the RFMO scientific advisory bodies, Framework for advice on management options to reduce the risk of SAI and to the protection of VMEs, while limiting potential losses to fishers). After considering these wide range of aspects, a set of **lessons learnt** was identified and compiled (see blue boxes).

TASK 8 – Support the evaluation of Council Regulation (EC) No 734/2008 on the protection of VMEs.

The overall objective of this task is to support the possible evaluation of Council Regulation (EC) No 734/2008 on the protection of VMEs from the impacts of bottom fishing gears. Specifically, we aim to:

- Analyze the extent to which the regulation is effective, efficient, still relevant given the current needs, coherent both internally and with other EU rules (CFP, MSFD), and has achieved EU added value.

- Identify where the Regulation needs to be updated to reflect best practices, particularly within RFMOs, best available science, as well as providing recommendations on how the Regulation can be updated to reflect the findings.

Methodology

The measures contained in the Regulation were extracted and appraised with those of the RFMOs. To achieve this, information already synthesised in the reports of Tasks 2-5 was used. Details of for example, how many special fishing permits have been issued, for which areas, for what Member States under the Regulation or RFMOs were not collected. Instead, the work focused on providing an overview of the different measures in the Regulation and checking the extent to which they are implemented by the different RFMOs (see Annex 12). It has been indicated where this information could not be found.

A questionnaire (see Annex 13) was designed to explore the views of stakeholders regarding Regulation No 734/2008 and to obtain feedback on (i) the extent to which the Regulation is effective, efficient, still relevant, coherent and has achieved EU added value, and (ii) measures in the Regulation that might need updating to reflect current knowledge and best practices.

The questionnaire comprised of statement-based questions using Likert scale answer categories (e.g. to a very great extent; to a great extent; to some extent; to a small extent; and not at all) for the stakeholder to choose from. It also included open-ended questions to capture stakeholder opinions on e.g. the most likely consequences of stopping applying the Regulation, and what needs improving/updating under Regulation 734/2008.

The questionnaire (in English) was translated into all 23 EU languages and set up as an online survey. A cross section of stakeholders from national authorities, representatives of the fisheries sector in Member States including the Long-Distance Advisory Council, NGOs interested in marine biological resources, in particular the Deep-Sea Conservation Coalition (DSCC), and scientists were selected and entered onto a list of potential participants. The stakeholders were identified based on project team experiences of scientists and other interest groups that work on deep sea fisheries including VMEs.

The questions were grouped into eight broad categories to encapsulate the key issues under study. These included:

(i) **Respondent information**. The first section required basic information from the respondent, including their name, institution and the type of stakeholder category they belonged to.

(ii) **Application of Regulation 734/2008**. The second section of the questionnaire focused on how the Regulation was being applied. Stakeholders were asked to provide their opinions on the extent to which various aspects of the Regulation were applied e.g. the extent to which Member States issue special fishing permits for the use of bottom fishing gears on the high seas under the scope of the Regulation.

(iii) **Effectiveness of Regulation 734/2008**. The third section of the questionnaire explored stakeholders' views on the effectiveness of the Regulation with questions requiring stakeholders to describe the contribution of Regulation 734/2008 towards different actions in areas of the high seas where no RFMO has been established or where no interim measures are in place.

(iv) **Efficiency in applying Regulation 734/2008**. The fourth section of the questionnaire focused on efficiency of the process of applying the Regulation and explored stakeholders' satisfaction with different elements of the Regulation. Stakeholders were asked to state how satisfied they were with the timeliness for reporting, appropriateness of compliance and enforcement, and appropriateness of the administrative burden to apply the Regulation.

(v) **Relevance of Regulation 734/2008**. This section of the questionnaire focused on the relevance of the Regulation towards the protection of VMEs from the adverse impacts of bottom fishing gear.

(vi) **Coherence of Regulation 734/2008 with other interventions**. This section of the questionnaire focused on how coherent measures for the protection of VMEs under Regulation 734/2008 are with those undertaken by the best performing RFMOs and those under Chapter 4 of the Sustainable Management of External Fishing Fleets (SMEFF).

(vii) **EU added value of Regulation 734/2008**. The final section of the questionnaire focused on the added value of Regulation 734/2008 and was mainly comprised of open-ended questions. Stakeholders were asked to indicate what would be the most likely consequences of stopping applying Regulation 734/2008, what needs improving/updating under the Regulation, what they would you do to improve the effectiveness and applicability of the Regulation, and whether there is anything else they would like to say about the Regulation.

A cross section of stakeholders from national authorities, representatives of the fisheries sector in Member States including the Long-Distance Advisory Council, non-governmental organisations interested in marine biological resources, in particular the Deep Sea Conservation Coalition, and scientists were selected and entered onto a list of potential participants. The list included a total of 64 potential participants (Table 1).

Table 1. List of potential participants that were asked to take part in the study showing the stakeholder category and number of people invited.

	Stakeholder	Number
1	ARVI	1
2	Cefas	1
3	CEPESCA	1
4	CETMAR	1
5	Deep-Sea Conservation Coalition	2
6	Europeche	1
7	FAO	1
8	Fisheries attaches	32
9	GFCM	3
10	ICES	1
11	IEO-CSIC	1
12	IFREMER	2
13	INTECMAR	1
14	ISPRA	2
15	IUCN	1
16	Long Distance Fisheries Advisory Council (LDAC)	1
17	NFFO	1
18	NIOZ	2
19	Pesquerias Georgia SL	1
20	Polytechnic University of Marche (UNIVPM)	1
21	Scottish Fishermen's Federation	1
22	Scottish Whitefish Producers Association	1
23	SEAFO EU-representative	1
24	Secretaría de Pesca	1
25	University of A Coruña	1
26	University of Santiago de Compostela	1
27	Wageningen Marine Research (WUR)	1
	Total	64

Links with the various translations were circulated to all 64 potential participants on the list and asked to take part. They were also asked to forward the link to others that they think should take part including all members of the Deep Sea Conservation

Coalition. The online survey was carried out from 10^{th} May to 10^{th} June. Half way through the survey (25^{th} May), reminders were sent to everyone on the list asking/encouraging them to ensure they fill it in before the deadline.

In total, 31 responses were received (Table 2). Of these, only three have completed the survey in full. The remaining 28 provided partial responses usually the first six questions i.e. their personal details. Sections 2-8 were left blank.

Table 2. Response to the online survey showing the number of stakeholders that have taken part.

Type of stakeholder	Number of responses
Fisheries sector	5
National authority	1
NGO	2
IGO	1
Scientist	3
Not stated	19
Total	31

The provisional timetable for addressing the stakeholder consultation is in Table 3.

Table 3. Provisional timetable.

Activity	Original Deadline	New Deadline
Final questionnaire including translations	Friday 8th April	Wed 27 Apr
Compile a list of contacts with email addresses	Friday 8th April	Wed 27 Apr
Set up questionnaire for online survey	Thursday 14th April	Mon 9 May
Send online survey link to contacts	Thursday 14th April	Mon 9 May
Conduct the survey	Tuesday 19th April to 20th may	Tue 10 May – Fri 10 Jun
Send online survey link to targeted/underrepresented stakeholders group (if needed)	22 May	Mon 13 Jun
Conduct the targeted/ specific consultation (if needed)	22 June	Mon 11 Jul
Analyse survey and write up	End June	End Jul

The main findings from Task 8 are presented below, in the subsection titled ***"Results; Deliverable 5*[172] *(D5): Summary of findings and key information".*** In addition, the D5 document is included in the Annex 12 of the present report.

Results

Deliverable 5 (D5): Summary of findings and key information

Comparison of measures in Regulation with those of RFMOs.

Findings show that the measures in the Regulation are being applied to some extent by the different RFMOs. NAFO and NEAFC are especially applying most of the measures to a great extent (Table 4).

[172] Deliverable 5 (D5): Support the evaluation of Council Regulation (EC) No 734/2008 (Task 8). See Annex 12 of the present report.

Table 4. A comparison of RFMO vulnerable marine ecosystem conservation measures with the Regulation (EC) No 734/2008.

	Regulation (EC) No 734/2008	NAFO	NEAFC	SEAFO	GFCM	NPFC	SPRFMO	SIOFA	CCAMLR
Do they clearly define a VME data collection protocol?	✓	✓	✓	✓	✕	✕	✓	✕	✓
Do they have an exploratory fishing protocol?	✓	✓	✓	✓	✕	✓	✓	✕	✓
Do they have encounter protocols & move-on rules?	✓	✓	✓	✓	✕	✓	✓	✓	✓
Have they defined VME encounter thresholds?	✓	✓	✓	✓	✓	✓	✓	✓	✓
Do they have area closures?	✓	✓	✓	✓	✕[1]	✓	✓	✓	✓
Are fisheries observers required onboard vessels?	✓	✓	✓[2]	✓	✕[3]	✓[2]	✓[4]	✓	✓
Do observers record VME data?	✓	✓	✓	✓	✕	✓	✓	✓	✓
Have they identified & frozen the fishing footprint?	✓	✓	✓	✓	✕	✓	✓	✓	✓
Have they defined the key concepts?	✓	✓	✓	✓	✕	✓	✓	✕	✓

[1]Fisheries Restricted Areas (FRA) not closed areas; [2]for exploratory fisheries only; [3] ~25% depending on the contracting party; [4]100% for bottom trawling, 10% for bottom longline.

Application of Regulation 734/2008.

Respondents to the online questionnaire were asked to indicate to what extent they were applying specific aspects of the Regulation. Regarding whether Member States (MS) issue special fishing permits for the use of bottom fishing gears on the high seas under the scope of the Regulation, responses by the fisheries sector indicate that this aspect of the Regulation is applied to some extent (average score 2.3 on a five-point Likert scale from 'not at all' to 'a very great extent') while the NGO respondent stated that it was applied to a small extent. The breakdown of results for the different stakeholder groups indicates that special fishing permits for the use of bottom fishing gears on the high issues are issued by MS to some extent.

Regarding whether MS issue the special fishing permits after having carried out an assessment on the potential impacts of the vessel's intended fishing activities including whether the activities are not likely to have significant adverse impacts on VMEs, apart from the scientist who stated that this is done to a small extent, the other three respondents indicate that this is done to a great extent. Comments provided on this aspect however, indicate that the fisheries sector thinks there is double standards. They stated that 'the fishing sector is extremely surprised and disgusted with the different treatment granted to the interactions related to fishing and those derived from other anthropogenic activities. As an example, the position clearly is in favour of the development of underwater mining, an industry that will determine a high and indisputable impact on areas that are closed to fishing'.

Respondents also indicated that MS use information on the potential risk to VMEs to a great extent by asking applicants to amend fishing plans to avoid them. An example was provided where fishing fleets that used to operate on seamounts in the Central Atlantic ridge from the 1990s to 2014 were not reissued with fishing licences for those areas despite using semi-pelagic and pelagic trawling gear with little or no contact with potential VMEs. This was because a precautionary approach was being applied to protect potential VMEs around the seamounts. Respondent from the fisheries sector was therefore worried that while they have not been reissued with fishing licences, the International Seabed Authority (ISA) may end up approving mining to take place in the areas around the North Atlantic central ridge. ISA has published a public consultation within the framework of the negotiation process on the seabed mining regulations, which deals specifically with the Regional Environmental Management Plan (REMP) for the North Atlantic central ridge. The respondent was therefore wondering how deep-sea mining on the mountains and oceanic ridges would protect potential VMEs. Similarly, it was mentioned that it is discouraging for fisheries to see how Canada is putting out to tender an oil field in the middle of the Flemish Cap, directly affecting closed area 9 (by NAFO) and potential VMEs closed within the exploitation license.

On whether MS prohibit the use of bottom gears because there has been no proper scientific assessment carried out and made available on VMEs, respondents from the fisheries sector stated that this is applied to a great extent. The scientist who responded however, stated that this is applied to a small extent. The fishing sector provided similar comments, i.e. insisting that there is lack of logic in applying such rigid criteria to fishing activity while applying totally lax ones to underwater mining.

Effectiveness of Regulation 734/2008.

Questions on the effectiveness of the Regulation were answered by one person from the fisheries sector and another from NGO. Their views indicate that the Regulation:

- Has contributed significantly towards the identification and protection of VMEs in fishing areas.
- Is not clear how it promotes scientific research on VMEs
- Has made significant contribution towards data collection programmes in general according to the NGO respondent. However, it has not altered/impacted the data collection programmes of certain countries such as Spain that already collected most of the relevant data according to the fisheries sector respondent.
- Has had a significant contribution towards the assessment of risk of significant adverse impacts (SAIs) from bottom fishing according to the NGO respondent but has had no contribution according to the respondent from the fisheries sector.
- Has contributed significantly towards the assessment and submission of fishing plans alongside potential impacts to VMEs by MS.
- Has had no contribution towards the assessment and submission of potential impacts when applying to undertake bottom fishing. A comment was made that the regulation requires this exercise, but in the case of countries like Spain, the fishing authorities had already been applying similar criteria before.
- Has contributed significantly towards the dentification and establishment of area closures according to NGO respondent but no contribution according to fisheries sector respondent.
- Has contributed significantly towards the establishment of bottom fishing footprint.
- Has contributed significantly towards the use of exploratory fishing protocols especially by restricting/disabling the development of exploratory fishing until its verified.
- On the use of encounter protocols and identification and use of thresholds based on gear types and indicator species, the Regulation has contributed significantly according to the NGO respondent but made no contribution according to the fisheries sector respondent.
- Towards the implementation of conservation and management measures that establish monitoring, control and surveillance (MCS) for compliance and enforcement, the regulation requires this exercise, but in many cases, the fishing authorities had already been applying similar control and monitoring criteria before the entry into force of the Regulation.
- Towards the implementation of measures relating to illegal, unregulated and unreported (IUU) fishing, the fisheries respondent stated that it is hard to tell whether the Regulation has had a significant impact on the elimination of IUU fishing, since the activity of non-EU fleets falls outside the Regulation.

Efficiency in applying Regulation 734/2008.

Questions on the efficiency in applying the Regulation were answered by one member of the fisheries sector, one scientist and a member of NGO. While the fisheries sector respondent stayed neutral regarding the timeliness of reporting, both the Scientist and NGO respondents stated that they were satisfied. Regarding the appropriateness of compliance and enforcement, both the fisheries sector and NGO respondents stayed neutral to this question. The respondents stated that compliance and enforcement are part of any fishing regulation, so these cannot be attributed to this Regulation. The scientist did not think there was any enforcement, stating that compliance is based on VMS/AIS data that he thought depended on the fishers keeping the systems turned on. Regarding the appropriateness of the administrative burden to apply the regulation, the NGO respondent indicated that they were satisfied while the fisheries sector respondent stated that they were unsatisfied. The fisheries sector respondent commented that the Regulation was formulated from a theoretical point of view and therefore does not reflect the reality on the fishing ground, and is therefore an administrative overload.

Relevance of Regulation 734/2008.

Questions on the relevance of Regulation 734/2008 to protect VMEs from the adverse impacts of bottom fishing gear were answered by one member of the fisheries sector, one scientist and a member of an NGO. While the respondent from the fisheries sector stated that the Regulation was not necessary when conducting assessments of whether bottom fishing activities have SAIs on VMEs, the scientist though the Regulation had some use while the NGO respondent stated that it was essential. The fisheries sector respondent expanded on why they think the Regulation is not necessary by stating that 'what the Regulation intends to achieve with respect to adverse effects on VMEs is not understood and seems unnecessary since fishing takes place within the existing fishing footprint and not in identified and closed VMEs zones. The scientist expanded on their response by stating that most States rely on the regulations set by UNGA; more work needs to be done for these regulations to be effective.

Similar responses were provided on the different aspects studied with the fisheries sector respondent stating that the Regulation was not necessary, the scientist stating that it is of some use while the NGO respondent stating that the Regulation was essential towards (i) ensuring that if bottom fishing activities have SAIs, they are managed to prevent such impacts; (ii) establishing and implementing protocols to cease fishing where an encounter with VMEs occurs during bottom fishing activities, and reporting such encounters so that appropriate measures can be adopted with respect to that site; and (iii) implementing measures in accordance with the precautionary approach, ecosystems approaches and international law, and to sustainably manage deep-sea fish stocks.

Coherence of Regulation 734/2008 with other interventions.

Coherence of the Regulation was assessed by comparing how well-aligned it was with the measures adopted by the best performing RFMOs (NEAFC, NAFO) and those under Chapter 4 of the Sustainable Management of External Fishing Fleets (SMEFF) regulation. Responses were provided by one member of the fisheries sector, one scientist and one member of an NGO. Towards coherence with the measures by the best performing RFMOs, the fisheries sector respondent stated that there is overlap while both the scientist and member of NGO stated that the measures are complementary but could be better coordinated. Regarding coherence with measures under SMEFF, both the fisheries sector and NGO respondents stated that there was an overlap. The scientist had no opinion on these aspects.

EU added value of Regulation 734/2008.

When asked to provide opinion on the most likely consequences of stopping applying Regulation 734/2008, the member of NGO stated that it would increase the amount of fishing on VMEs with impacts on seabed habitats and related biodiversity that were harmful and long-lasting, the fisheries sector respondent stated that it would have little consequences in practice, while the scientist stated that it depends on how much the regulation is applied. A common EU regulation relating to VMEs could be very helpful but must use EAFM.

Regarding what needs improving/updating under Regulation 734/2008, the following thoughts were provided:

- Surveillance and strengthening of knowledge of seabed in poorly studied parts of the seabed.
- Reducing the level of bureaucracy required and simplification of the measures contained in the Regulation. Furthermore, there is a need to make the conditions set more flexible, especially due to the contradiction generated by the application of extremely strict criteria for fishing activities and the promotion and support of new activities on the seabed whose impacts will be exponentially greater than the intended protection that the regulation has been addressing.
- Made more specific towards each region and the socio-political environment of the different regions, better definition of the key concepts such as a glossary, getting a wider range of stakeholders involved in defining the Regulation.

On the question of what the different stakeholders would do to improve the effectiveness and applicability of Regulation 734/2008, the following thoughts were provided.

- Observers and strict reporting
- Open a real and direct consultation between the fisheries sector and the public authorities to adapt the rules to the reality of the fishing activities of the EU fleet. In this vein, any Regulation that has the support and contribution of the fishing sector will always be better implemented and monitored, besides being fairer.
- More data, more information, more regional focus - additionally documents with species thresholds etc for that particular region, taking in to account all the different aspects such as type of fishery, type of control and geomorphology of the area.
- Must take into account the local condition of the area within the Regulation - the EU is a diverse community and the regulation needs to reflect this.

Conclusions

The aim of this task was to analyse the extent to which the Regulation is effective, efficient, still relevant given the current needs, coherent and complementary to other interventions and has achieved EU added value. We also aimed to identify where the Regulation needs to be updated to reflect best practices and best available science, as well as providing recommendations on how the Regulation can be updated (if needed) to reflect the findings. This was done both through a stakeholder consultation, to gather the views of people impacted by its implementation, and through analysing information taken from other Tasks. Despite several efforts to get stakeholders to take part, the response was too low. It is therefore difficult to draw any key conclusions. However, given that the key area covered by the Regulation is FAO Area 41 which is mainly fished by Spanish flagged vessels, the respondents included two members of the Spanish fishing sector, a member of the IUCN Fisheries Expert Group, and a scientist from an EU research institute. Despite the low sample size, the views discussed in this report provide some background to the different aspects of the Regulation and, along with the information taken from other Tasks, should inform aspects on how and which areas of the Regulation could be updated/revised if that decision is taken.

4. GENERAL CONCLUSIONS FOR THE WHOLE STUDY

The individual country reports (Annex 1) produced under **Task 1**, summarized useful information (Annex 2) on the **work undertaken by five relevant countries in support of VME protection and the identification of mitigation measures for the impacts of bottom fishing**. These provided an overview of how each country is addressing a set of 6 key topics related with the protection of VMEs and management of DSF (including the main gaps), particularly in waters under national jurisdiction. It also expands on the knowledge of the state of play obtained under the previous SC08 study, which focused on approaches developed in the high seas by intergovernmental organizations (RFMOs). It is essential to exercise caution when interpreting the outcomes from this task, as they rely only on publicly available information and therefore, interpretation of the results must be approached very carefully. The analysis conducted provided a better understanding of how different countries deal with DSF management and VMEs conservation efforts. The analysis showed that all countries reviewed (USA, Canada, Argentina, Australia and New Zealand) have implemented some form of **governance and data collection frameworks** for DSF and VMEs, and that most have **described sensitive species and habitats** in some way. Moreover, some countries have made significant efforts towards co-management, involving a variety of stakeholders. The **assessment of bottom fishing impacts** has in general a good degree of implementation for almost all countries (addressing, in some cases, the issue of the impacts of activities other than fishing), just like the **mapping of sensitive species and habitats**. Sometimes the approach adopted is broader and focuses more on the identification, designation and protection of essential fish habitats, or in the assessments of risk for benthic habitats, rather than assessing SAIs on corals and sponges. There is room for improvement in the **impact mitigation and protection measures**, as some documented vulnerable areas still remain unprotected, but in general, progress is being made in this area. Most countries have successfully implemented some kind of **monitoring of VME impacts**, or such implementation is still partially in progress, or is planned. Finally, the differences between countries and the gaps identified are explained either by the different development of management frameworks, or by the availability and accessibility of information, or the degree of detail of the available data.

In light of the **review of the 2008 DSF FAO Guidelines (Task 2)**, it is clear that many aspects related to the protection of VMEs need to be improved (Annex 3: Deliverable 1), starting with creating operational definitions of key concepts and determining thresholds of protection level for VMEs. The lack of information of VME indicator taxa prevents evaluating their vulnerability using FAO criteria, and further research is needed. Direct observations from research surveys of are only available for few areas, so RFMOs must rely on indirect approaches to identify VMEs (i.e. species distribution models), but generally there are not enough data to apply them. Most RFMOs have adopted regulations to prevent SAIs on VMEs through area-based management approaches (i.e. areas closed to bottom fishing), but the long-term viability of the VMEs will depend on understanding the VME functioning (e.g. connectivity). In addition, climate change should be also considered for developing appropriate area closures, because it might lead to shifts in VME distributions. In addition, more attention should also be paid to the restoration of damaged VMEs.

With respect to **bycatch mitigation (Task 3)**, it is clear that RFMOs are advancing at different paces (Annex 4: Deliverable 2). In many RFMOs, the biggest issue that slows down bycatch mitigation efforts, is the generalised lack of data on the interactions of vulnerable species with fisheries (e.g. elasmobranchs, marine mammals and seabirds). The lack of data on the incidence and level of bycatch makes fisheries management difficult. Even where data exists, the lack of statistically robust and harmonized sampling designs limits its value. Therefore, it is urgent to initiate (or continue) actions to achieve adequate monitoring programs and frameworks that can provide robust bycatch data collection. This is essential to design and implement better measures to protect bycatch species in the DSF.

Although the concept of **fishing footprint (Sub-task 4.1)** is not specifically defined in the FAO Guidelines, in practice, in most RFMOs the terms "fishing footprint", "bottom fishing footprint", "existing bottom fishing areas", "existing deep-sea bottom fishing areas" are equivalent and generally refer to those locations in which some level of bottom fishing activity has previously been conducted in a reference period. The review of the approaches implemented in the different high seas areas shows that there is a wide variety of methods used in the different RFMOs to define fishing footprints (Annex 5: Deliverable 3), with some RFMOs being more advanced in this area than others. In addition, it was concluded that when studying the fishery footprint, several key issues should be considered: (i) Data (e.g. needs, compilation, availability and quality); (ii) Potential of international cooperation (e.g. research, management, sharing of information); (iii) Potential of new methodologies to improve footprint resolution, complementary data sources and approaches (e.g. AIS); and (iv) financing needs. The review of the diversity of approaches used by the RFMOs has been very useful to identify the potential key elements for the development of **frameworks for exploratory fisheries and scientific research**, which are described in detail in **Sub-task 4.2** and **Sub-task 4.3** respectively. With regards to exploratory fisheries (Annex 6), most of RFMOS adopted exploratory fishing protocols incorporating relevant UNGA and FAO requirements: CCAMLR is the most prominent regulator of this issue, while GFCM does not have a specific legal framework. In general terms, RFMOs follow similar procedures and preliminary assessments. An exceptional case is SIOFA that has not clearly defined what an exploratory fishery is. Most of the RFMOs, with the exception of GFCM, have implemented specific measures to prevent SAIs on VMEs and, in general, monitoring of exploratory fisheries by on-board observers is mandatory. In general, in most RFMOs, their own scientific advisory bodies (e.g. Scientific Councils) are responsible for the functions of encouraging, promoting cooperation and coordinating the scientific research (Annex 7). By contrast, in the case of NEAFC, ICES, as external advisor, is in charge of these functions. Most of the RFMOs have developed research work plans for their advisory bodies, including planning of research priorities. The regulation of scientific research is a current issue and several initiatives are being carried out in this regard. Only SEAFO has developed specific guidelines for fisheries research and basic marine science activity. Furthermore, there is a variety of approaches in the RFMOs regarding conservation and management measures related to scientific research and the issue of the impact of research on VMEs is being addressed (e.g. NEAFC, SEAFO, SIOFA and CCAMLR) or is currently being monitored (e.g. NAFO).

The **effectiveness of existing management tools for VMEs conservation (Task 5)** was reviewed and best practices were identified (Annex 8: Deliverable 4). In general, in the absence of data, a precautionary approach had been used and underwater features where VMEs were likely to occur (e.g. seamounts) were closed to fishing. There is no actual agreement, however, on how to define and delimit VMEs. For measures to be effective, the distribution and connectivity of VMEs must be better understood. Identifying the presence, distribution, and abundance of an indicator species defines the state of that species at a moment (or period) in time. It does not define other characteristics of the community, or the bounds of the ecosystem. Details about species interactions will be needed to understand and predict the extent to which fishing and other human activities produce SAIs. A key issue is that move-on rules were not originally intended as stand-alone measures to protect VMEs from SAI. They should only be considered as temporary measures until spatial protection measures are implemented. However, in some regions (e.g. SIOFA) move-on rules within historic fishing footprints are the sole management measure.

Data gaps and research priorities in the different regions (RFMOs and FAO Area 41 regarding Council Regulation (EC) No 734/2008[173]) **(Task 6)** were identified through reviewing reports from the groups responsible for managing VMEs within each RFMO as well as other summaries. The main gaps in data are related to the life history of VME species, in terms of their longevity, fragility, larval dispersion and mobility. Without a better knowledge of these traits the effectiveness of various mitigation measures is difficult to assess. Specifically, whether current threshold levels are suitable, what is the ideal distance for a move-on rule, if any, and how best to spatially manage an area to balance maximum protection with minimal interference to fishing. Despite its limitations, observer programmes provide a valuable source of data a relatively low cost. All of RFMOs reviewed have some form of observer programme in place with a requirement to collect data on VMEs when encountered. Annex 9 provides guidelines, based on programmes already in place, for the collection and recording of VME data by observers. In addition, the data requirements related to Council Regulation (EC) No 734/2008 are summarized in Annex 10, which outlines the information that needs to be submitted by EU vessels, how the information is evaluated, encounter rules and VMS and observer requirements.

The comparison of the different concepts and definitions used in DSF management across different areas (Annex 11) in the context of the FAO DSF Guidelines, allowed us to summarizing some key findings: (i) In most of RFMOs, main key concepts are defined based on the FAO DSF Guidelines, but the list of key concepts described by the Guidelines is quite brief and could be expanded and improved; (ii) Some concepts are not clearly defined by the FAO DSF Guidelines, nevertheless the different RFMOs have adopted similar definitions based (or inspired) on the spirit of the Guidelines; (iii) There are different approaches in the RFMOs regarding the implementation of some specific concepts; (iv) Some gaps were identified in the definitions of key concepts in Council Regulation (EC) No 734/2008, which may hinder its effective implementation (e.g. VME indicator, encounter, fishing footprint); (v) The use of a similar set of definitions of main key concepts related to VME/DSF management could help in promoting consistency between organizations and DSF regulations. In addition, a number of key topics covering a wide range of aspects (e.g. fisheries management and conservation, scientific research and data collection, ecosystem-based fisheries management) were brought up and discussed with the goal of **providing opportunities for promoting consistency across RFMOs (Task 7)**, including some that pertain to any possible revision of Council Regulation (EC) No 734/2008. It was concluded that, in general, there is a diversity of approaches among RFMOs with respect to all the issues discussed. Based on these approaches, a set of lessons learned was identified that may be useful for promoting consistency among relevant RFMOs, as well as for any possible revision of Council Regulation (EC) No 734/2008.

Finally, **Task 8** analysed the extent to which **Council Regulation (EC) No 734/2008** is **effective**, **efficient**, **still relevant** given the current needs, **coherent** and **complementary** to other interventions and has achieved EU added value (Annex 12: Deliverable 5). This was done both through a stakeholder consultation, to gather the views of people impacted by its implementation (Annex 13), and through analysing information taken from other Tasks. Despite several efforts to get stakeholders to take part, the response was too low. It is therefore difficult to draw any key conclusions. However, given that the key area covered by the Regulation is

[173]Council Regulation (EC) No 734/2008 of 15 July 2008 on the protection of vulnerable marine ecosystems in the high seas from the adverse impacts of bottom fishing gears. Official Journal of the European Union, L 201, 30 July 2008, 6 pp. The purpose of this regulation was to transpose the measures contained in UNGA Resolution 61/105 into Union law for ships flying flags of its Member States, for those areas of the high seas where no RFMO had been established or where no interim measures were put in place during negotiations for the establishment of an RFMO.

FAO Area 41 which is mainly fished by Spanish flagged vessels, the respondents included two members of the Spanish fishing sector, a member of the IUCN Fisheries Expert Group, and a scientist from an EU research institute. Despite the small sample size, the views discussed in this report are illustrative of the various aspects of the Regulation and, along with the information taken from other Tasks, have given some guidance as to which areas of the Regulation could be updated and revised.

Stakeholders highlighted a number of areas that could be improved, these related to:

- surveillance and strengthening of knowledge of seabed in poorly studied parts of the seabed;
- reducing the level of bureaucracy required and simplification of the measures contained in the Regulation;
- making it more specific towards each region and the socio-political environment of the different regions;
- increased observer coverage and strict reporting;
- an open and direct consultation between the fisheries sector and the public authorities to adapt the rules to the reality of the fishing activities of the EU fleet;
- more data, more information, more regional focus - additionally documents with species thresholds etc for that particular region, taking into account all the different aspects such as type of fishery, type of control and the geomorphology of the area; and,
- take into account the local condition of the area within the Regulation as the EU is a diverse community and the regulation needs to reflect this.

Through looking at the RFMOs in the case studies it is apparent that as well that there are areas of the Regulation that can be updated. These include:

- developing a list of VME species (area specific) and their related threshold values;
- updating the encounter protocol and subsequent actions;
- develop of process and timeframe for reviewing VME closures; and,
- to the extent possible, harmonising observer programmes, data collection and reporting protocols.

ANNEX 1

Individual Reports by Country

(Data and Information Reviews)

CONTENTS

For each country, information on the following six key topics was compiled:

1. *Data availability and governance framework.*

2. *Description of sensitive species and habitats.*

3. *Assessment of bottom fishing impacts.*

4. *Mapping of sensitive species and habitats.*

5. *Impact mitigation and protection measures.*

6. *Monitoring of VME impacts.*

CASE STUDY 1 – UNITED STATES OF AMERICA (USA)

1.1 – Data availability and governance frameworks

The *National Marine Fisheries Service* (NMFS), also referred as *NOAA Fisheries*[1], is the office of the *National Oceanic and Atmospheric Administration* (NOAA), responsible for the stewardship of the nation's living marine resources and their habitats, interactions, and ecosystems[2], including deep-sea coral and sponges. It is the federal government body with primary responsibility for managing marine fisheries (460 stocks or stock complexes in 46 fishery management plans) from three miles to 200 miles offshore (or nine miles off the Florida west coast, off Texas and Puerto Rico). In terms of fisheries management, this area[3] is refereed as U.S. federal waters or the exclusive economic zone[4] (EEZ) (Figure 1).

Coastal states are in charge of the fisheries that operate inshore. The *Interstate Fishery Commissions* (IFCs) help coordinate management among states in the same region[5]. IFCs are a mechanism to coordinate and cooperate in data collection, preparation of scientific advice, management, and enforcement for fishery resources that migrate between states. They do not have management authority, but agree on management plans to be adopted by the states.

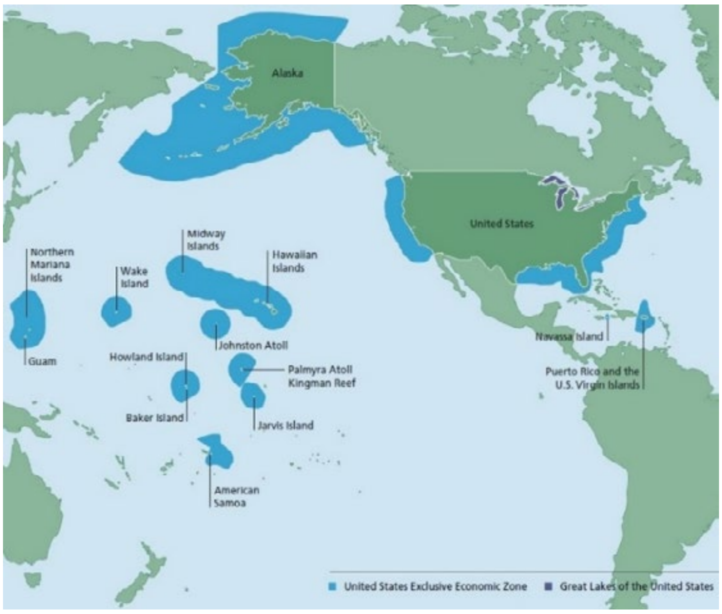

Figure 1. The U.S. exclusive economic zone (EEZ).

[1]https://www.fisheries.noaa.gov/about-us
[2]Understanding Fisheries Management in the U.S. https://www.fisheries.noaa.gov/insight/understanding-fisheries-management-united-states
[3]Wallace, R. and Fletcher, K. (2001) Understanding Fisheries Management: A Manual for understanding the Federal Fisheries Management Process, Including Analysis of the 1996 Sustainable Fisheries Act. 2nd ed. University, MS: Mississippi-Alabama Sea Grant Consortium.
[4]The U.S. EEZ extends no more than 200 nautical miles from the territorial sea baseline and is adjacent to the 12 nautical mile territorial sea of the U.S. Nevertheless, under certain fisheries laws, such as the Magnuson-Stevens Fishery Conservation and Management Act, the term "exclusive economic zone" is defined as having an inner boundary that is coterminous with the seaward (or outer) boundary of each of the coastal states. While its outer limit is the same as the EEZ, its inner limit is coterminous with the coastal states' boundary at 3 nautical miles, except for Texas, western Florida, and Puerto Rico, which claim a 9 nautical mile belt. https://oceanservice.noaa.gov/facts/eez.html
[5]Atlantic States Marine Fisheries Commission (http://www.asmfc.org/), Gulf States Marine Fisheries Commission (https://www.gsmfc.org/) and Pacific States Marine Fisheries Commission.

NOAA Fisheries has 5 regional offices, 6 science centers, more than 20 laboratories around the U.S. and U.S. territories. The national headquarters (12 offices, including national program and other mission support offices) are located in Silver Spring, Maryland. The agency employs about 4,200 staff including scientists, policy managers, and enforcement officers, located across the country. There are several national programs offices[6] related with DSF and VMEs. NOAA Fisheries assesses and predicts the status of fish stocks, sets catch limits, ensures compliance with fisheries regulations, and reduces bycatch using the *Magnuson–Stevens Fishery Conservation and Management Act* (MSFCMA)[7] as a guide. More than 100 federal laws guide fisheries management, but the MSFCMA is the primary law that governs marine fisheries management in U.S. federal waters. First passed in 1976, was last reauthorized in 2006. Its objectives include: (i) preventing overfishing, (ii) rebuilding overfished stocks, (iii) increasing long-term economic and social benefits, and (iv) ensuring a safe and sustainable supply of seafood. The MSFCMA evolved over time in three stages[8]: (i) *"Americanization"* of fisheries (1977-95): Reduce foreign fleets and promote national fisheries, optimum yield and co-management (ii) *Rebuilding stocks* (1996-2006) and (iii) *Responsibility* (since 2007): Stop overfishing, implementation of annual catch limits and accountability measures if limits are exceeded, importance of the science. The key aspects of the MSFCMA are highlighted below:

1. In 1976, as part of the MSFCMA, the U.S claimed **exclusive fishery management authority** over waters contiguous to its territorial sea and extending 200 nautical miles from its shoreline. The MSFCMA allowed to phase out foreign fishing activities, promote domestic commercial and recreational fishing as well as encourage development of underutilized fisheries.
2. **Fisheries management based on three pillars**[9]: (i) Science: a rigorous, peer-reviewed process provides fishery managers with the information necessary to manage the long-term sustainability of fisheries, (ii) Management: the science-based process ensures continuous improvement of fishery management plans (see below, point 3 about *Regional Fishery Management Councils*), and (iii) Enforcement: the U.S. has a strong law enforcement and compliance monitoring capability[10], as a critical component of sustainably managed fisheries. A VMS program is primarily used to monitor the location and movement of more than 4,000 commercial fishing vessels in the EEZ and treaty areas. The main source of data for fisheries management are (i) NOAA research surveys[11], (ii) NOAA fishery observers[12] and at-sea monitors and (iii) fisheries landings[13] collected by NOAA for each year in all states. Moreover, the *Deep Sea Coral Research and Technology Program*[14] *(DSCRTP)* supports resource management in fisheries and other sectors[15] (see section 1.3). A wide range of scientific reports, papers and data[16] are publicly available from the *NOAA Deep-Sea Coral Data Portal*[17] and the

[6]Office of Habitat Conservation; Office of International Affairs and Seafood Inspection; Office of Protected Resources; Office of Law Enforcement (includes the VMS program); Office of Sustainable Fisheries.
[7]https://www.fisheries.noaa.gov/topic/laws-policies#magnuson-stevens-act
[8]NRC (2014) National Research Council. Evaluating the Effectiveness of Fish Stock Rebuilding Plans in the United States. Washington, DC: The National Academies Press. https://doi.org/10.17226/18488.
[9]https://www.fisheries.noaa.gov/insight/understanding-fisheries-management-united-states
[10]https://www.fisheries.noaa.gov/about/office-law-enforcement
[11]https://www.fisheries.noaa.gov/national/science-data/research-surveys
[12]https://www.fisheries.noaa.gov/topic/fishery-observers
[13]https://www.fisheries.noaa.gov/national/sustainable-fisheries/commercial-fisheries-landings
[14]MSFCMA, Sect. 408 Deep sea coral research and tecnology program.
[15]NOAA (2021) *Deep Sea Coral Research and Technology Program*. 2020 Report to Congress.
[16]https://www.fisheries.noaa.gov/science-and-data
[17]NOAA's National Database for Deep-Sea Corals and Sponges: https://deepseacoraldata.noaa.gov/

websites of *NOAA Fisheries*, *NOAA Ocean Exploration*[18], the *Bureau of Ocean Energy Management* (BOEM)[19] and the *U.S. Geological Survey*[20] (USGS).

3. Creation of eight ***Regional Fishery Management Councils***[21] (RFMCs) across the U.S. coast. All of them include deep water areas (Figure 2). The RFMCs are advisory bodies, responsible for the fisheries that require conservation and management in their region. RFMCs manage fisheries within the U.S. EEZ (approximately 3.4 million square nautical miles). RFMCs are key regional partners of federal government in fishery management, responsible[22,23] for: (i) Develop and amend *fishery management plans* (FMPs) for approval and implementation by NOOA Fisheries on behalf of the Secretary of Commerce, (ii) Set annual catch limits and accountability measures based on the best available science, (iii) Develop research priorities with partners, (iv) Adhere to MSFCMA's mandate and 10 National Standards, (v) Select fishery management options, (vi) Develop and implement rebuilding plans and (vii) Convene committees and advisory panels and conduct public meetings. FMPs contain information on the biology of the stocks and the fisheries. Several sections of the MSFCMA require or permit NOAA and RFMCs to include management measures that protect deep-sea corals and sponges[24] in FMPs. RFMCs promote co-management and stakeholder participation, considering socio-economic aspects. FMPs and management measures are developed in a fully transparent and public process, based on sound scientific advice. This system emphasizes local participation and allows adaptation to characteristics of regional fisheries, resulting in different approaches to protecting deep-water vulnerable benthic habitats in different regions[25]. Besides FMPs, four RFMCs have developed *fishery ecosystem plans* (FEPs)[26] as a metric to help fishery managers determine whether management effectively incorporates core ecosystem principles.
4. Definition of ten ***National Standards*** (NS). NS are principles that must be followed in any fishery management plan to ensure sustainable and responsible fishery management: 1. *Optimum yield*: prevent overfishing, achieving optimum yield; 2. *Scientific information*: based on best scientific data (considering uncertainty); 3. *Management units*: Management of individual/interrelated stocks; 4. *Allocations*: Non-discrimination of fishermen, promote conservation; 5. *Efficiency*: Practicable and efficient; 6. *Variations and contingencies*: Consider variations and contingencies in fisheries; 7. *Cost and benefits*: Minimize costs, avoid duplications; 8. *Communities*: Socio-economic aspects: participation and minimize adverse economic impacts; 9. *Bycatch*: Minimize bycatch/mortality of bycatch;10. *Safety of life at sea*: Promote safety of human life at the sea. NS guidelines developed by NOAA, make NS operational[27]. The Secretary of Commerce must ensure that FMPs, amendments and regulations are consistent with the NS guidelines.

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[18]The website ensure public access to scientific data and information collected during ocean expeditions supported by the *NOAA Ocean Exploration program*. https://oceanexplorer.noaa.gov/data/welcome.html
[19]https://www.boem.gov/renewable-energy-research-completed-studies
[20]https://www.usgs.gov/centers/wetland-and-aquatic-research-center/science/usgs-role-deep-search-deep-sea-exploration
[21]https://www.fisherycouncils.org/: North Pacific Fishery Management Council (NPFMC); Western Pacific Regional Fishery Management Council (WPRMFC); Pacific Fishery Management Council (PFMC); New England Fishery Management Council (NEFMC); Mid-Atlantic Fishery Management Council (MAFMC); South Atlantic Fishery Management Council (SAFMC); Gulf of Mexico Fisheries Management Council (GMFMC); Caribbean Fishery Management Council (CFMC).
[22]https://www.fisherycouncils.org/s/RFMC-Overview-flyer-FINAL.pdf
[23]https://www.fisheries.noaa.gov/topic/partners
[24]https://www.coris.noaa.gov/activities/deepsea_coral/dsc_strategicplan.pdf
[25]Hourigan, T.F. (2009). Managing fishery impacts on deep-water coral ecosystems of the USA: emerging best practices. Marine Ecology Progress Series 397, 333-340
[26]https://www.fisheries.noaa.gov/national/ecosystems/ecosystem-based-fishery-management-implementation-plans
[27]https://www.fisheries.noaa.gov/national/laws-and-policies/national-standard-guidelines

5. Call for attention to **bycatch**. The *National Bycatch Reduction Strategy*[28] (2016) has the following objectives: (i) monitor and estimate the rates of bycatch and bycatch mortality to understand the level of impact, (ii) conduct research to improve bycatch estimates, understand the impacts, and develop solutions, (iii) conserve and manage fisheries and protected species by implementing mitigation measures, (iv) enforce fishery management measures and (v) communicate to develop a common understanding of bycatch, to share information on the efforts to address bycatch, and to identify areas where we can improve. Bycatch includes fish, marine mammals, sea turtles, seabirds, and habitat-forming species (corals and sponges). The implementation of the strategy occurs at the regional, national, and international levels according to the *National Bycatch Reduction Strategy Implementation Plan 2020-24*[29]. Fisheries observers obtain first-hand data on interactions with protected resources[30]. Additionally, bycatch data from observers, contributed to understand the distribution[31] of deep-sea corals and sponges.
6. Call for attention to the identification, designation and conservation of ***Essential Fish Habitat*** (EFH)[32] for federally managed species. Specific RFMCs responsibilities are threefold: (i) to address the description and identification of EFH and *Habitat Areas of Particular Concern* (HAPCs)[33], minimization of adverse impacts to EFH and make recommendations for action, (ii) may take part in consultation with the Secretary, NOAA and Federal agencies on the Federal projects that may adversely affect EFH, and (iii) to continue to manage and support a sustainable fishery.
7. **Recreational fisheries** are included in the fisheries management, as they are a source of mortality and a relevant socio-economic sector in the U.S. NOAA use data collected from anglers and for-hire operators, under the Marine Recreational Information Program, to estimates recreational catch and effort. These estimates help scientists and managers assess and maintain sustainable fish stocks.
8. **International dimension**: promote the MSFCMA provisions internationally and strengthen international fisheries management organizations (e.g. RFMOs[34]). All fishery management actions must comply with the MSFCMA, as well as with other applicable regulations[35]. NOAA *Operational Guidelines for the MSFCMA Fishery Management Process* provide guidance on such other applicable laws.

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[28]https://www.fisheries.noaa.gov/international/bycatch/national-bycatch-reduction-strategy
[29]https://media.fisheries.noaa.gov/dam-migration/national_bycatch_reduction_strategy_implementation_plan-final.pdf
[30] https://www.fisheries.noaa.gov/insight/fishery-observers
[31]https://www.fisheries.noaa.gov/alaska/habitat-conservation/deep-sea-corals-and-sponge-research-alaska
[32]EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity and may include migratory routes, open waters, wetlands, estuarine habitats, artificial reefs, shipwrecks, mangroves, mussel beds and coral reefs. https://www.fisheries.noaa.gov/national/habitat-conservation/essential-fish-habitat
[33]HAPCs are defined as subsets of EFH that exhibit one or more of four specific traits (see details in section 1.2). The HAPC designation does not confer any specific habitat protections, but can focus habitat conservation efforts through several pathways.
[34]The U.S. is a member of several RFMOs with competency in DSF, working to improve management measures, including VME protection. https://www.un.org/depts/los/bfw/United-States__2022.pdf
[35]National Environmental Policy Act, Marine Mammal Protection Act, Endangered Species Act, National Marine Sanctuaries Act, Fish and Wildlife Coordination Act, Deep Seabed Hard Mineral Resources Act, American Antiquities Act, Shark Conservation Act, IUU Fishing Enforcement Act, Moratorium Protection Act, High Seas Fishing Compliance Act.

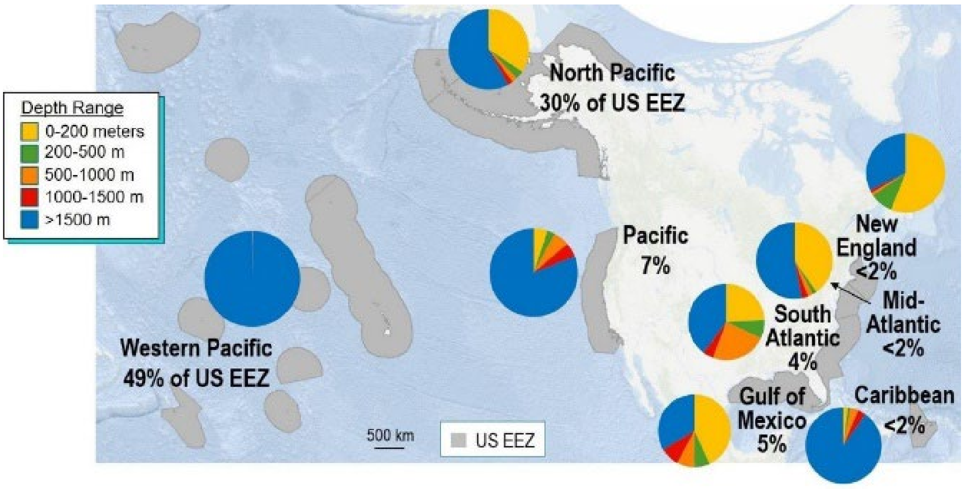

Figure 2. Relative size and depth profiles of each of the eight RFMC management areas. Source: NOAA[36].

1.2 – Description of sensitive species and habitats

Deep-sea corals and sponges are mainly located in federal waters. Distribution of these species have been observed directly (e.g. ROVs, AUVs, cameras, bycatch in commercial fisheries and groundfish surveys, etc.) as well as inferred using habitat suitability models (in some regions). Abundance and diversity estimates are available for both corals and sponges in several deep-sea areas (e.g. NOAA CAPSTONE[37] project). A comprehensive list of known deep-sea corals in the U.S. EEZ[38] is available since 2017 and updated regional[39] deep-sea coral species lists for all different RFMCs regions were published in 2020. In addition, an *Atlas of Large Submarine Canyons*[40] of the U.S. outer continental shelf, including information on the sensitive habitats that they contain is publicly available online.

Biogenic habitats (e.g. deep-sea corals, sponges, bryozoans, bivalves, tubeworms, xenophyophores, etc.) are mentioned as vulnerable to human-induced impacts, particularly from physical disturbances, both in the *NOAA strategic plan for deep-sea coral and sponge ecosystems,* and in the DSCRTP reports. The vulnerable marine ecosystem (VME) terminology is not usually used in the U.S. jurisdiction[41]. We were unable to find either a specific definition of VME, nor specific lists of VME indicator species and VME features. Generally, the VME concept is mentioned in the context of the fishing activities conducted in international waters: The strategic plan indicates that any regulations governing U.S. flagged vessels designed to implement protection of VMEs on the high seas would be implemented under the *High Seas Fishing Compliance Act* (see section 1.3).

Sensitive (i.e. vulnerable) benthic habitats within U.S. EEZ are included under the FMPs developed by the RFMCs. For each federal managed fishery, *Essential Fish Habitats (EFH)* are identified, described and mapped to define the areas (waters and

[36]https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=ba469d2d7fef4885b2f9076a2f969dc c
[37]https://www.un.org/depts/los/bfw/United-States__2022.pdf
https://www.frontiersin.org/articles/10.3389/fmars.2019.00480/full
[38]https://deepseacoraldata.noaa.gov/library/2017-state-of-deep-sea-corals-report
[39]https://deepseacoraldata.noaa.gov/library/2020-regional-deep-sea-coral-species-list/
[40]This Atlas is a depository of maps and information about the major submarine canyons of the outer continental shelf: https://www.boem.gov/environment/large-submarine-canyons-atlas
[41]The U.S. at its highest levels of government, recognizes the issue of the effects of destructive fishing practices on VMEs in all parts of the ocean. The U.S. has taken action both within areas under its national jurisdiction and areas beyond national jurisdiction (ABJN) to give effect to the relevant UNGA Resolutions. Since 2015, the U.S. has taken actions within the EEZ to reduce the risk of significant adverse effects from deep-sea fishing to vulnerable benthic habitats (equivalent to VMEs in ABJN). See: https://www.un.org/depts/los/bfw/United-States__2022.pdf

substrate) necessary for the spawning, breeding, feeding, and growth to maturity of target fish species (see section 1.1, point 6). In the case of EFH for managed coral species, it includes any areas where the managed species exist. FMPs for each EFH also requires the identification of *Habitat Areas of Particular Concern* (HAPC). HAPCs are subsets of EFH that meet one or more of the following four criteria:

1) importance of ecological function provided by the habitat for federally managed species,
2) area or habitat is sensitive to human induced degradation,
3) the habitat is stressed by development (exposure to development stress),
4) is considered rare.

RFMCs take similar approaches to defining and interpreting the four HAPC criteria[42], drawing from ecological theory, peer-reviewed literature, and other information sources. Ecological importance is the most frequently criteria invoked. The considerations of sensitivity and exposure to development stress are related. Together they describe the susceptibility of a habitat area or type to impacts from anthropogenic activities, and the time horizon and likelihood of impacts. Criteria of rarity is prioritized differently across regions. Moreover, the HAPC criteria align with most of the five criteria used by FAO in the identification of VMEs, although there is no HAPC criterion similar to the FAO criterion (v) called *Structural Complexity*:

- (HAPC criterion 1) Importance of ecological function → (FAO criterion ii) *Functional significance of the habitat.*
- (HAPC criterion 2) Sensitivity to human induced degradation and (3) exposure to development stress → (FAO criterion iii) *Fragility* and (iv) *Life story traits.*
- (HAPC criterion 4) Habitat considered rare → (FAO criterion i) *Uniqueness or rarity*.

HAPCs can cover a specific location (e.g. a bank) or cover habitat that is found at many locations (e.g. corals). Seamounts, certain submarine canyons (based on its unique geomorphology and the presence of habitat-forming species), corals and associated habitats meet the criteria as HAPCs because they are especially sensitive to human-induced degradation by fishing and non-fishing activities. Moreover, they provide complex habitat for many species (e.g. fish, shrimp and crabs). Each FMP must minimize adverse effects to EFH caused by fishing. Designating Seamounts, canyons, corals and associated habitats as HAPCs helps identify these areas as important to protect and manage regarding fishing impacts. The aim is to protect coral species and EFH, and maintain suitable habitat quality and quantity to support sustainable fisheries (e.g. in the Gulf of Mexico, some areas have been identified as having sufficient numbers and diversity of deep-water corals to be considered EHF)[43]. Coral areas can be also protected using the deep-sea coral discretionary provision of the MSFCMA. HAPC designation process can prohibit the use of some or all forms of bottom contact fishing gear in most of these areas. These HAPCs and gear restrictions can be adopted via amendments to the relevant FMPs.

[42] https://static1.squarespace.com/static/511cdc7fe4b00307a2628ac6/t/573a073937013bed07239025/1463421108737/Regional-HAPC-Report_WEB.pdf
[43] https://gulfcouncil.org/press/2020/noaa-fisheries-announces-designation-of-habitat-areas-of-particular-concern-for-deep-water-coral-and-associated-fishing/

1.3 – Assessment of bottom fishing impacts

According to FAO (2005)[44], the U.S. fishing fleet is quite diverse in terms of sizes and gear types varying significantly among fisheries as well as among geographic areas. Since 2011, U.S. total capture production has been quite stable (FAO, 2019)[45] despite catch fluctuations of the two main species (Alaska pollock and Gulf menhaden). Each year, NOAA compiles key statistics of the U.S. domestic fisheries. Table 1 shows the principal domestic species groups landed in 2019.

Table 1. Major U.S. domestic species groups Landed in 2019. Source: NOAA, 2021 [46].

Rank	Species	Thousand Pounds
1	Alaska pollock	3,352,595
2	Menhaden	1,507,831
3	Salmon	838,267
4	Hakes	701,595
5	Flatfish	561,741
6	Cod	466,195
7	Crabs	271,933
8	Shrimp	248,055
9	Rockfishes	227,297
10	Lobsters	130,321

In 2019, commercial landings (edible and industrial) by U.S. fishermen at ports in the 50 states were 9.3 billion pounds (4.2 million metric tons) valued at $5.5 —a decrease of 76.7 million pounds (down by 0.8%) and a decrease of $113 million (down 2.0%) compared with 2018. Finfish accounted for 89% of the total landings, but only 45 percent of the value. Commercial landings by U.S. fishermen at ports outside the 50 states provided an additional 477 million pounds (216,357 metric tons). Alaska led all states in volume of landings (5.6 billion pounds), followed by Louisiana (896.4 million), Washington (544.4 million), Virginia (390.6 million) and Mississippi (340.8 million).

In 2019, the main commercial bottom species in the U.S. were the following (landings and value are summarized):

- Pacific trawl fish (Pacific cod, flounders, hake, Pacific Ocean perch, Alaska pollock, and rockfishes): Landings were 5.2 billion pounds valued at $744.1 million.
- Atlantic and Pacific halibut: Landings were 24.8 million pounds (round weight) valued at $99.8 million. The Pacific fishery accounted for all but 109,000 pounds of the 2019 total halibut landings.
- North Atlantic trawl fish (butterfish, Atlantic cod, cusk, flounders, haddock, red and white hake, ocean perch, pollock and whiting): Landings in the New England and Middle Atlantic Regions were 77.8 million pounds valued at $90.2 million.
- Sablefish: Landings in the Pacific coast were 40.6 million pounds valued at $89.2 million.
- Clams: Landings yielded 75.7 million pounds, valued at $218.3 million.
- Crabs: Landings were 271.9 million pounds valued at $635.7 million.
- Lobsters: Landings of American lobster were 125.8 million pounds valued at $628.7 million. Together, Maine and Massachusetts produced 93% of the total

[44] https://www.fao.org/fishery/docs/DOCUMENT/fcp/en/FI_CP_US.pdf
[45] https://www.fao.org/fishery/en/facp/usa?lang=en
[46] NOAA (2021) Fisheries of the United States 2019. https://www.fisheries.noaa.gov/national/sustainable-fisheries/fisheries-united-states

national landings. Landings of spiny lobster were 4.5 million pounds valued at $39.7 million. Florida accounted for 82 percent of the total landings.

- Scallops: Landings totalled 60.8 million pounds valued at $572 million.
- Shrimps: Landings were 248 million pounds valued at $467.4 million. Gulf region landings were the nation's largest with 72 percent of the national total.
- Squids: Landings were 119.9 million pounds valued at $87.3 million. California landings were the nation's largest with 23%, followed by New Jersey (18% of the national total).

Stock assessments measure the impact of fishing on fish and shellfish stocks. NOAA Fisheries manages ~500 fish stocks (pelagic and bottom fisheries). However, they only have data and resources to assess ~200 stocks each year. Stock assessment prioritization allows NOAA to work with regional partners to decide which stocks are assessed each year[47] [48] [49].

A wide range of bottom fishing gears are used along the U.S. waters (e.g. bottom trawls, bottom gillnets, bottom longlines, dredges, pots, traps, etc.). According to NOAA Fisheries[50], some fishing gears have minimal impacts on bottom habitats (e.g. pots are less damaging than mobile gear, as they are stationary and contact a much smaller area of the seafloor) or rarely contacts the ocean floor (e.g. mid-water trawl). Some resources (e.g. flounders) are mainly harvested over sand and or mud habitats, more resilient to trawling than corals. In other cases, gears used (e.g. bottom trawls, dredges) have negative impacts to habitat. Management measures to protect sensitive habitats (e.g. deep-water corals, sponges and canyons) that are affected by some types of bottom gears, have been implemented (e.g. area closures, gear restrictions, gear modifications), as well as measures to minimize bycatch (e.g. closed areas, bycatch excluder devices, certified reducer devices, gear modifications such as raised-footrope trawls, etc.). In many fisheries (e.g. Alaska), regulations are in place to limit the amount of incidentally caught and discarded fish. In the West Coast fisheries, the catch shares program creates incentives to reduce bycatch. In Florida, programs have been developed to removing lost and abandoned traps. Table 2 presents a summary of perceived levels of threats to deep-sea coral and sponge communities for U.S. regions. Impacts from bottom trawl fishing are the principal matter of concern, particularly in Alaska, West coast and Northeast regions. Perceived threat levels reflect only the occurrence of these stressors in a region and their potential, if unmitigated, to damage communities. The change in perceived threats for fishing in the Northeast and Southeast reflect recent protections.

In the U.S., VMS[51] is primarily used to monitor the location and movement of commercial fishing vessels, focused on enforcement and compliance issues (see section 1.2, point 2). Footprint information for most of the U.S. regions is difficult to obtain. We have not found a global map of the footprint of U.S. bottom fisheries, although there is detailed footprint information for some specific regions. For example, maps of bottom fishing footprint for the Northeast region are available[52] from the *Northeast Ocean data portal*[53].These maps broadly characterizes commercial fishing vessel activity in the Northeast, based on VMS data (2006-2016), provided by NOAA Fisheries (e.g. multispecies groundfish, monkfish, scallop and surfclam/quahogh fisheries). This information was used by the New England Fishery Management Council to facilitate public review of proposed fishery management areas intended to reduce impacts on deep-sea corals, balancing coral protection and commercial fisheries. Figure 3 shows an example of these maps.

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[47]https://www.fisheries.noaa.gov/national/population-assessments/fish-stock-assessment-report#archive-and%C2%A0more-information
[48]https://www.st.nmfs.noaa.gov/stocksmart?app=homepage
[49]https://www.fisheries.noaa.gov/stock-assessment-prioritization
[50]https://www.fisheries.noaa.gov/species-directory
[51]https://www.fisheries.noaa.gov/topic/enforcement#vessel-monitoring
[52]K. Sosebee (NOAA/NMFS, Northeast Fisheries Science Center), *Personal communication.*
[53]https://northeastoceandata.org/

Table 2. Summary of perceived levels of threats to deep-sea coral communities (2007 and 2017) and sponge communities (2017) for U.S. regions. NA = Not Applicable (i.e., this threat is prohibited or does not occur anywhere within the region). Source: NOAA (2017) The state of deep-sea coral and sponge ecosystems of the United States.

<table>
<tr><th rowspan="3">THREATS</th><th colspan="14">U.S. REGIONS</th></tr>
<tr><th colspan="2">Alaska</th><th colspan="2">West Coast</th><th colspan="2">Pacific Islands</th><th colspan="2">Northeast</th><th colspan="2">Southeast</th><th colspan="2">Gulf of Mexico</th><th colspan="2">Caribbean</th></tr>
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<tr><td>Bottom Trawl Fishing Impacts</td><td>High</td><td>High</td><td>High</td><td>High</td><td>NA</td><td>NA</td><td>High</td><td>Medium</td><td>High</td><td>Medium</td><td>Low - Medium</td><td>Low - Medium</td><td>NA</td><td>NA</td></tr>
<tr><td>Other Bottom Fishing Impacts</td><td>Low - Medium</td><td>Medium</td><td>Low - Medium</td><td>Low - Medium</td><td>Low</td><td>Low</td><td>Low - Medium</td><td>Low - Medium</td><td>Low - Medium</td><td>Low - Medium</td><td>Low - Medium</td><td>Low - Medium</td><td>Low</td><td>Low</td></tr>
<tr><td>Deep-Sea Coral Harvest</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td><td>Medium</td><td>Medium</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td></tr>
<tr><td>Oil & Gas Development</td><td>Low</td><td>Low</td><td>Low</td><td>Low</td><td>NA</td><td>NA</td><td>NA</td><td>Low</td><td>NA</td><td>Low</td><td>Medium</td><td>Medium</td><td>NA</td><td>NA</td></tr>
<tr><td>Cable Deployment</td><td>Low</td><td>Low</td><td>Low</td><td>Low</td><td>Unknown</td><td>Low</td><td>Low</td><td>Low</td><td>Low</td><td>Low</td><td>Low</td><td>Low</td><td>Unknown</td><td>Low</td></tr>
<tr><td>Sand and Gravel Mining</td><td>Low</td><td>Low</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td><td>Low</td><td>Low</td><td>Low</td><td>Low</td><td>Low</td><td>Low</td><td>NA</td><td>NA</td></tr>
<tr><td>Deep-Sea Mining</td><td></td><td>Low</td><td></td><td>Low</td><td></td><td>Low - Medium</td><td></td><td>Low</td><td></td><td>Low</td><td></td><td>Low</td><td></td><td>Low</td></tr>
<tr><td>Invasive Species</td><td>Unknown</td><td>Unknown</td><td>Unknown</td><td>Unknown</td><td>Medium</td><td>Medium</td><td>Unknown</td><td>Unknown</td><td>Unknown</td><td>Unknown</td><td>Unknown</td><td>Unknown</td><td>Unknown</td><td>Unknown</td></tr>
<tr><td>Climate Change</td><td rowspan="2">Unknown</td><td>Unknown</td><td rowspan="2">Unknown</td><td>Unknown</td><td rowspan="2">Unknown</td><td>Unknown</td><td rowspan="2">Unknown</td><td>Unknown</td><td rowspan="2">Unknown</td><td>Unknown</td><td rowspan="2">Unknown</td><td>Unknown</td><td rowspan="2">Unknown</td><td rowspan="2">Unknown</td></tr>
<tr><td>Ocean Acidification</td><td>Medium</td><td>Medium</td><td>Medium</td><td>Low</td><td>Low - Medium</td><td>Low - Medium</td></tr>
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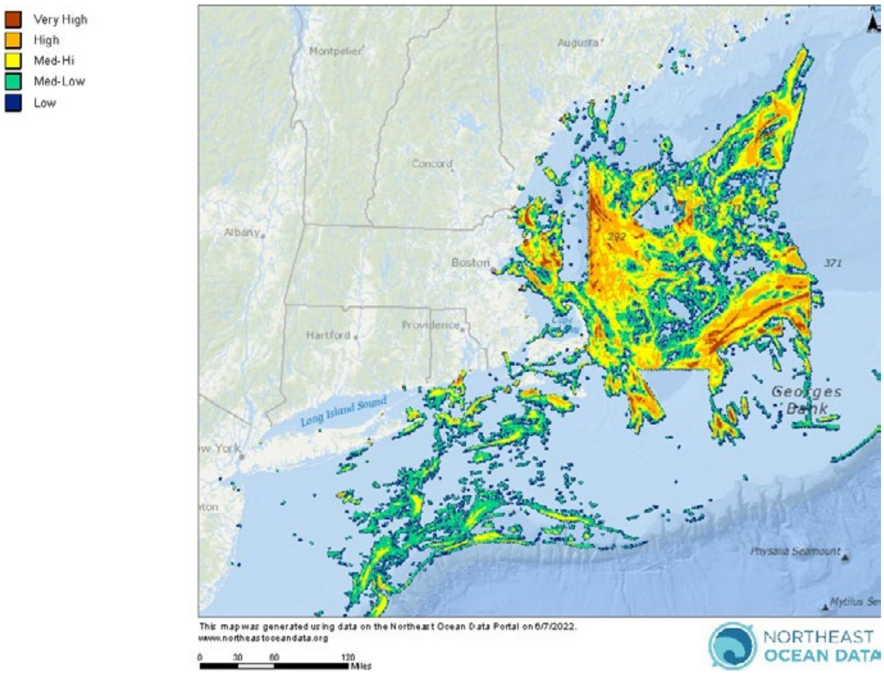

Figure 3. Footprint of the Northeast multispecies (groundfish) fishery, based on VMS data (2015-2016).
Source: https://northeastoceandata.org/data-explorer/?commercial-fishing|vessel-activity

The approach adopted in the U.S. to address bottom fishing impacts within national jurisdiction, is focused on the identification, designation and protection of sensitive fish habitats, rather than assessing the significant adverse impacts of bottom fisheries on VMEs, as the VME terminology is not usually used in the U.S. jurisdiction (see section 1.1, point 6 and section 1.2, footnote 41). In this regard, the RFMCs are required to designate EFHs and take steps to minimize the impacts of fishing to the extent practicable. This includes the description of threats from fishing and non-fishing activities.

The RFMCs develop actions (e.g. the MAFMC habitat policy[54]) to address impacts of fishing activities on fish habitat to (i) ensure that changes to FMPs incorporate effective approaches to managing the impact of fishing on sensitive fish habitat, (ii) to assist Council committees in considering policy elements in support of ecosystem approaches to fisheries management when making changes to FMPs, and (iii) to focus research and funding opportunities on information needs regarding habitat mapping and possible impacts of fishing activities.

The identification of EFH[55] requires information on current and historic stock size, geographic range, time and space distribution, and life stages within habitats occupied by the managed species. As a result, EFH is multi-dimensional and can be identified for a specific species in a certain geographic area or in a particular level of the water column. EFH descriptions and identifications should also account for spatial and temporal variation in the distribution of each major life stage to aid in understanding managed species habitat needs. While a specific habitat may only be essential to a particular species during a certain time of year or season, the regulations governing EFH designation do not provide for temporal designation (i.e., once a habitat is designated EFH, it is EFH all year long). Many parties participate in the public process of designating EFH. The eight RFMCs and NOAA Fisheries, which have the responsibility for drafting FMPs, are charged with proposing EFH descriptions and identifications for each life stage of the managed species in their jurisdiction.

[54]See in Mid-Atlantic Fisheries Management Council (MAFMC): https://www.mafmc.org/s/Fishing-Impacts-Policy-16-08-12-Final.pdf
[55]EPA (2005) Reviewing Environmental Impact Statements for Fishery Management Plans.

These descriptions and identifications must be based on the best available science regarding the habitat requirements of each managed species and are developed through a public process. Once proposed descriptions and identifications have been made by a Council through an FMP or Amendment, a notice is published in the Federal Register to inform the general public that the FMP or Amendment has been submitted to NOAA for Secretarial review. NOAA reviews public comments on the FMP or Amendment before making a final decision on whether to approve a Council's proposed EFH descriptions and identifications.

EFH must be included in the FMPs (see section 1.2, point 3). NOAA Fisheries works with RFMCs and uses the best available scientific information to identify (see section 1.2), describe, map (see section 1.4) and monitor (see section 1.6) EFH. The RFMCs uses this information to pinpoint and protect sensitive habitats. To achieve the goal of minimizing the impacts to EFH, three broad categories of management measures have been adopted: (i) gear modifications, (ii) closed areas, and (iii) overall reductions of fishing effort, including the freezing of the fishing footprint (see section 1.5).

In 1994, the U.S. adopted the *High Seas Fishing Compliance Act* [56](HSFCA) to implement the FAO *Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas*. The HSFCA requires, among other things[57], that all U.S. commercial fishing vessels operating on the high seas possess a permit[58] issued in accordance with section 104 of the Act and be marked for identification purposes. Permits are only issued for those fishing activities reviewed pursuant to the *National Environmental Policy Act* (NEPA). Pursuant to NEPA, should NOAA Fisheries decide to authorize bottom fishing on the high seas outside of RFMOs, such authorization will only be granted upon completion of an impact assessment (including VMEs). *Title 50 of the Code of Federal Regulations*, particularly Chapter III, Part 300, Subpart R-High Seas Fisheries[59] implements the HSFCA. Fishing on the high seas must generally be associated with at least one fishery that is authorized by a FMP or a RFMO. The following fisheries are authorized (most of them are pelagic fisheries): (i) Eastern Pacific Tuna[60], (ii) South Pacific Tuna[61], (iii) Antarctic Marine Living Resources, (iv) Atlantic Highly Migratory Species[62], (v) U.S. West Coast Fisheries for Highly Migratory Species[63], (vi) Western Pacific Pelagic[64], (vii) South Pacific Albacore Troll, and (viii) Northwest Atlantic.

In general, bottom fishing may be permitted on the high seas when authorized by international conservation and management measures recognized by the U.S. For bottom fishing activity not subject to international conservation measures recognized by the U.S., a person who seeks to engage in such fishing must request authorization of a new high seas fishery and then, if the fishery is authorized, must obtain all applicable permits including a high seas fishing permit. NOAA Fisheries may specify conditions and restrictions to mitigate adverse impacts on VMEs, which may include the conditions that have been adopted in the relevant RFMO recognized by the U.S.

Regarding bottom fishing in the RFMOs regulatory areas (i.e. international waters), currently there are some fishing opportunities available to U.S. vessels in the fisheries

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[56]https://www.fisheries.noaa.gov/permit/high-seas-fishing-permits
[57]Installation and operation of enhanced mobile transceiver units for vessel monitoring, carrying observers, reporting of transshipments taking place on the high seas, and protection of VMEs. https://www.un.org/depts/los/bfw/United-States__2022.pdf
[58] https://www.un.org/depts/los/bfw/United-States__2022.pdf
[59]https://www.ecfr.gov/current/title-50/chapter-III/part-300
[60]Within Inter-American Tropical Tuna Commission (IATTC) Convention Area
[61]Under the South Pacific Tuna Act and the Treaty on Fisheries Between the Governments of Certain Pacific Island States and the U.S.
[62]Conservation and management of Atlantic tunas, Atlantic billfish, Atlantic sharks, and Atlantic swordfish.
[63]EEZ off the coasts of Washington, Oregon, and California and in adjacent high seas waters.
[64]The Western Pacific Pelagic fishery management area includes all areas of fishing operations in the EEZ or on the high seas for any vessels of the U.S.

managed by NAFO[65] for the stocks for which the U.S. has an allocation under NAFO or through arrangements with other Contracting Parties (CPs), as well as under the ‘‘Other’’ species NAFO allocations. The opportunities for the period 2022-2024 were announced by NOAA with the aim to alert U.S. fishing vessels, to relay the available quotas, and to outline the process and requirements for vessels to apply to participate in NAFO fishery. Applicant U.S. vessels must possess or be eligible to receive a valid *High Seas Fishing Compliance Act* permit (see below).

As a CP within NAFO, the U.S. receives annual quota allocations at the NAFO Annual Meetings for two stocks to be fished in the subsequent year (Division 3M Redfish and Subareas 3 and 4 Illex squid). Moreover, the U.S. shares the "Others" quota with other NAFO CPs and access is on a first come, first served basis across all CPs. As an example, for 2022, the U.S. was allocated 69 metric tons (mt) of 3M redfish, 453 mt of Subareas 3 and 4 Illex squid, and was also allocated "0" fishing days for the Division 3M shrimp fishery (the shrimp fishery is currently closed). Additional directed quota for stocks managed by NAFO could be made available to U.S. vessels through industry-initiated chartering arrangements or government-to government transfers of quota from other NAFO CPs. For example, the U.S. has agreed to receive a transfer of 1,000 mt of NAFO Division 3LNO yellowtail flounder from Canada's 2020–2024 quota allocations, consistent with a recent bilateral arrangement, and from 2012-2021 at least one vessel[66] fished in the NAFO area. U.S. vessels may also retain bycatch of NAFO managed species to the maximum amounts outlined in Article 6 of the NAFO Conservation and Enforcement Measures (CEM). Opportunities to fish for species not listed above (i.e., species listed in Annex I.A of the NAFO CEM and non-allocated on non-regulated species), but occurring within the NAFO Regulatory Area, including Atlantic halibut, may also be available under specific authorizations.

According to the available information, the U.S. currently has no vessels participating in bottom fisheries managed by other RFMOs than NAFO[67].

1.4 – Mapping of sensitive species and habitats

The *NOAA Office of Ocean Exploration and Research* (OER), also referred as *NOAA Ocean Exploration*[68] is the only U.S. federal program dedicated to exploring the deep ocean. Created in 2001, OER's primary activities fall into four major areas: (i) *Ocean Exploration*: Mapping and characterization of features and resources, (ii) *Technology*: Development, application, and program use, (iii) *Data and information*: Public availability and access, (iv) *Engagement*: Reaching the public. OER supports research expeditions to explore previously unvisited areas of the deep ocean, providing partnership coordination, funding, staff, tools, and expertise needed to develop mission plans that deliver rigorous, systematic observations and documentation of biological, chemical, physical, geological, and archaeological aspects. The program mapped and explored a variety of sensitive habitats and features along the U.S., including canyons, seamounts, coral communities, seeps, vents and volcanoes. NOAA Ship *Okeanos Explorer* is used as main sampling platform. The ship is equipped with mapping sonars to collect seafloor and water column high-resolution data, a ROV capable of diving to depths of 6,000 meters, and other instruments to help characterize the deep ocean. Data collected, from coral ecosystems to seafloor

[65]Department of commerce - NOAA [RTID 0648–XX057] International Affairs; U.S. Fishing Opportunities in the Northwest Atlantic Fisheries Organization Regulatory Area. Federal Register / Vol. 85, No. 144 / Monday, July 27, 2020.
[66]Sosebee, K.A. (2022) United States Research Report for 2021. NAFO SCS Doc. 22/14 Serial No. N7300 Northwest Atlantic Fisheries Organization.
[67]Currently, only one U.S. vessel is authorized to conduct bottom fisheries in NAFO waters, and No U.S. vessels are authorized to conduct bottom fisheries in areas beyond national jurisdiction outside of RFMOs. See: https://www.un.org/depts/los/bfw/United-States__2022.pdf
[68]https://oceanexplorer.noaa.gov/about/welcome.html

mapping, can be found in the OER website[69] and in the *Ocean Digital Atlas*[70]. OER is a key partner for the *Deep Sea Coral Research and Technology Program* (DSCRTP). As the major NOAA funder of deep-sea exploration and research, OER's expertise, research, and information products are central to the DSCRTP mission. As a management-oriented research program, the DSCRTP complements OER's work and directly links it to resource managers' needs.

The *DSCRTP*, which began operations in 2009, was stablished following the 2006 MSFCMA Reauthorization[71], which tasked NOAA with submitting, in consultation with the RFMCs, *"biennial reports to Congress and the public on steps taken by the Secretary to identify, monitor, and protect deep sea coral areas, including summaries of the results of mapping, research and data collection performed under the program"* (see section 1.6). It also authorized RFMCs to designate zones to protect deep sea corals from damage caused by fishing gear under FMPs discretionary provisions. The DSCRTP builds a bridge between research results and applied conservation programs. The DSCRTP addresses fishing and other threats to deep-sea corals and sponges with the *NOAA Deep-Sea Coral Data Portal*[72]. It supports new research and preserves existing information. The Portal provides access to *NOAA's National Database for Deep-Sea Corals and Sponges*, which contains data, images, and technical reports from research funded by the DSCRTP and its partners. The portal includes a digital map (Figure 4) displaying more than 500,000 records and predictive habitat suitability models that allow some extrapolation of these data to unsurveyed areas. Moreover, updated maps of deep-sea coral and sponge taxa locations by U.S. region are included in the last DSCRTP biennial report to Congress[73] (see section Supplementary Maps at the end of the U.S. review).

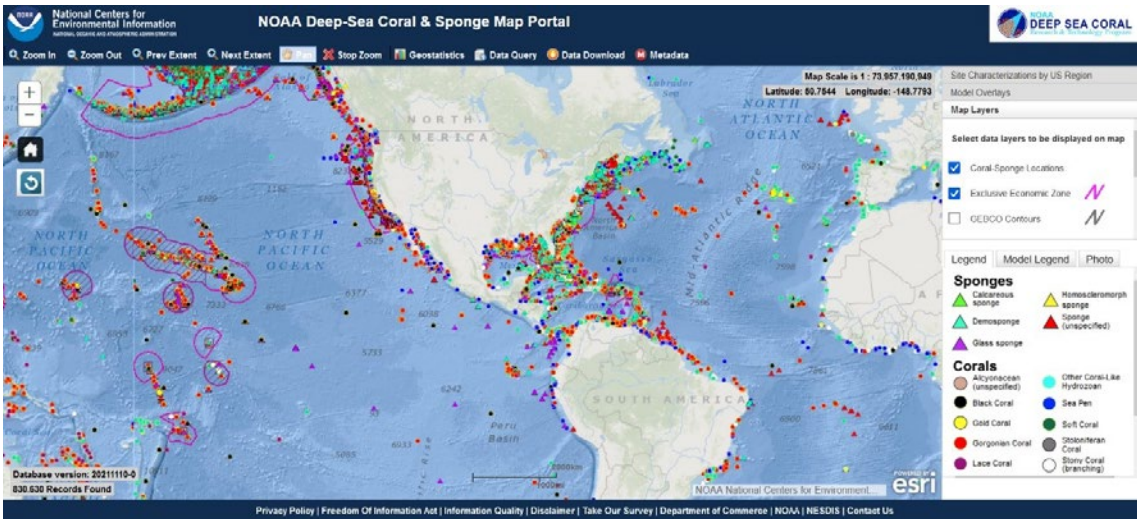

Figure 4. NOAA's National Database for Deep-Sea Corals and Sponges
Source: https://www.ncei.noaa.gov/maps/deep-sea-corals/mapSites.htm.

The National Database is continually expanding, incorporating new records from recent fieldwork observations and historic archives quarterly. The Database has resulted in the first comprehensive maps of coral and sponge presence in sampled areas. Additionally, the *NOAA Essential Fish Habitat (EFH) mapper*[74] provides an interactive platform for viewing data and spatial boundaries of such habitats (see section 1.4, point 6).

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[69]https://oceanexplorer.noaa.gov/data/access/access.html
[70]https://www.ncei.noaa.gov/maps/oer-digital-atlas/mapsOE.htm
[71]NOAA (2008) Report to Congress on the Implementation of the *Deep Sea Coral Research and Technology Program*.
[72]https://deepseacoraldata.noaa.gov/
[73]NOAA (2021) *Deep Sea Coral Research and Technology Program*. 2020 Report to Congress. Appendices.
[74]https://www.habitat.noaa.gov/apps/efhmapper/?dlg=dialog_17

Operating through *NOAA Fisheries' Office of Habitat Conservation*, and funded at approximately $2.3 million annually to support national-scale research, the DSCRTP collaborates widely to cost-effectively study the role of corals in support of deep-sea ecosystems. The DSCRTP works closely with the RFMCs to address key fishery management needs and inform decision-making (e.g. protection of deep-sea coral areas, or reopen of less vulnerable habitats to fishing). The DSCRTP sponsored field research programs[75] (e.g. the Deep-Sea Coral and Sponge Initiatives) in Alaska, Northeast region, Pacific Islands, Southeast coast[76] and West coast, with the aim to study the deep-sea ecosystems in order to further their management, conservation and protection. These field initiatives have been supplemented by targeted projects (i) to map deep-sea coral distributions (e.g. using ROVs, AUVs, towed/drift cameras, manned summersibles, multibeam sonar), (ii) to model predicted deep-sea coral habitat, and (iii) to study coral genetics and connectivity.

In 2010, NOAA presented a *Strategic Plan for Deep-Sea Coral and Sponge Ecosystems (2010-2019)*[77], designed to integrate the regional approaches into a comprehensive ecosystem management framework on a national level. The primary goal of the plan is to improve research, conservation and management of deep-sea coral and sponge ecosystems. The plan addresses the requirements of the DSCRTP, but is broader in scope and addresses all NOAA's relevant mandates and programs. It was designed to guide NOAA activities for deep-sea coral and sponge ecosystems as they relate to (i) exploration and research (e.g. locate the ecosystems, understand the impacts, etc.), (ii) conservation and management (e.g. protection, encourage impact mitigation measures, etc.), and (iii) international cooperation (e.g. promote international collaboration to conserve VMEs in deep-sea fisheries, increase international research, etc.).

In 2017, a report summarizing the state of deep-sea coral and sponge ecosystems in the U.S. waters was presented by NOAA[78], including updated information on mapping efforts conducted in each U.S. region. The report also reviews predictive habitat modeling (PHM) methodologies and their application in each region. PHM integrates the spatial distribution of deep-sea corals with environmental data to estimate their potential niche and distribution. The spatial resolution of model results has improved, and model outputs are now used to target areas for field sampling efforts and to help inform RFMCs management actions designed to protect deep-sea coral habitats (identification of boundaries of closed areas, EFHs, and HAPCs). PHM also helped guide BOEM-funded field surveys of canyons in the Mid-Atlantic region.

Spatial predictive modeling has been also used in several NOAA collaborative research projects in the Gulf of Mexico, West coast, and Atlantic coast[79].

In the case of Alaska and the U.S. West coast, the most comprehensive picture of deep-sea coral and sponge presence comes from bycatch in annual scientific trawl surveys conducted by NOAA. Some trawl surveys have now been complemented by towed/drift camera surveys. In both regions, another source of coral and sponge distribution information is from commercial fisheries bycatch records collected by NOAA fishery observers in the groundfish fisheries.

Moreover, NOAA collaborates with several partners such as BOEM and USGS to conduct scientific research, including surveys for location and characterization of deep-sea coral, sponge, and chemosynthetic communities (e.g. the EXPRESS[80] multi-

[75]https://deepseacoraldata.noaa.gov/browse-studies#b_start=0
[76]https://coastalscience.noaa.gov/project/southeast-deep-coral-initiative-sedci-exploring-deep-sea-coral-ecosystems-off-the-southeast-u-s/
[77]https://www.coris.noaa.gov/activities/deepsea_coral/dsc_strategicplan.pdf
[78]https://spo.nmfs.noaa.gov/sites/default/files/OHC4_v2.pdf
[79]https://coastalscience.noaa.gov/project/characterizing-spatial-distributions-of-deep-sea-corals-and-hardbottom-habitats-in-the-u-s-southeast-atlantic/
[80]https://www.usgs.gov/centers/pcmsc/science/express-expanding-pacific-research-and-exploration-submerged-systems

year, multi-institution cooperative research campaign in deep sea areas of California, Oregon, and Washington, including the continental shelf and slope).

In addition, new tools[81] to improve the knowledge on VME indicator species distribution and diversity are being tested by NOAA. The DSCRTP has supported the development of scientific techniques that advance the ability to detect and identify deep-sea corals, sponges, and associated fishes. One emerging tool that can enhance traditional deep-sea cold-water corals biodiversity surveys is *environmental DNA* (eDNA)[82]. eDNA is DNA captured directly out of the surrounding environment. eDNA can identify deep-sea organisms (e.g. VME indicator species) and characterize their role in the ecosystem. eDNA does not require interacting with living organisms, making it a non-invasive sampling technology to supplement traditional surveys.

1.5 – Impact mitigation and protection measures

The U.S. EEZ is very large area (more than 4 million square nautical miles of ocean[83]). NOAA Fisheries manages U.S. fisheries based on FMPs developed by the RFMCs. With regards with VMEs, RFMCs can create[84]:

- Coral-specific fishery management plans that regulate harvest of corals or sponges directly. For example, the SAFMC created the world's first deep-sea coral protected area, the Oculina Banks HAPC, in 1984. The WPRFMC oversees the nation's only precious coral fishery, and has developed strong measures to ensure its sustainability. The following RFMCs have coral-specific fishery management plans: (i) Caribbean, (ii) Gulf of Mexico, (iii) South Atlantic and (iv) Western Pacific.
- FMPs for other species that can lead to protection for corals from unintended fishing impacts. Each fishery management plan is required to define an EFH. Specific restrictions can be developed for these areas using FMPs. Deep-sea corals or sponges can therefore be protected by identifying connections between commercially or recreationally valuable fishery species and deep-sea coral or sponge habitats. Prior to 2016, most protections for deep-sea coral areas were enacted using these provisions. FMPs also require fisheries to minimize bycatch (including deep-sea corals and sponges). Restrictions on fishing gears can also contribute to minimizing bycatch.

In 2006, the MSFCMA, was amended to explicitly allow protection of deep-sea corals in their own right. The Deep-sea Coral Discretionary Authority allows RFMCs to adopt measures (e.g. restrict or prohibit fishing or fishing gear) to protect areas with deep-sea corals identified by NOAA's DSCRTP. Deep-sea coral habitat can be protected for its own sake, even if its benefit to managed fish species is not known. In addition, there are other protection mechanisms available to RFMCs, such as federally managed *National Marine Sanctuaries*, *U.S. Fish and Wildlife Refuges*, and *Marine National Monuments*, that can provide protection for deep-sea coral and sponge habitats. Boundaries of deep-sea Sanctuaries and Monuments are accessible on the *NOAA Deep-Sea Coral Data Portal*[85] and the *National Marine Sanctuaries System*[86]. Moreover, federal and state *Marine Protected Areas* (MPAs), have been established. Boundary and classification information of MPAs are available from the NOAA's *MPA Inventory*[87] geospatial database. The Pacific Islands region has the highest proportion

[81] https://oceanexplorer.noaa.gov/technology/technology.html
[82] Everett, M.V. and Park, L.K. (2018) Exploring deep-water coral communities using environmental DNA. Deep Sea Research Part II, 150: 229-241. doi.org/10.1016/j.dsr2.2017.09.008
[83] https://www.fisheries.noaa.gov/insight/understanding-fisheries-management-united-states
[84] Deep-Sea Coral Protection in U.S. Waters; Authorities for Deep-sea coral protection: https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=ba469d2d7fef4885b2f9076a2f969dcc
[85] https://deepseacoraldata.noaa.gov/
[86] https://sanctuaries.noaa.gov
[87] https://marineprotectedareas.noaa.gov/dataanalysis/mpainventory/

of waters in MPAs (52%) while Alaska has the lowest (<1%), and 54% of deep-sea coral habitats (based on their current extent mapped) are contained within an MPA[88].

Figure 5 shows the current percentage of each region's seafloor within U.S. waters that is closed to seafloor trawling. RFMCs have protected between 0.8 percent to 100 percent of their regions. Coleman *et al.* (2020)[89] summarized the history of the cold-water coral protection in the U.S. Since 1980s, implementation of protection evolved differently in the different RFMCs regions (Figures 6 to 10), and in 2020 the 76% of the overall U.S. EEZ seafloor was protected from trawling.

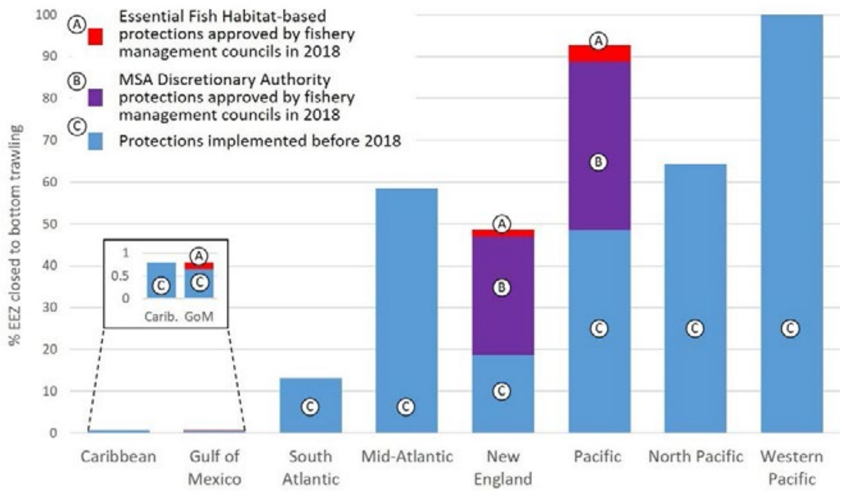


Figure 5. Percent of U.S. EEZ that is protected from seafloor trawling in each RFMC region. This chart summarizes federal fishing restrictions. It does not include state restrictions. (MSA) Magnuson-Stevens Fishery Conservation and Management Act Source: NOAA DSCRTP 2020 report to Congress.

Additional information regarding the protection measures in place within the different RFMCs regions can also be found in the NOAA website[90]:

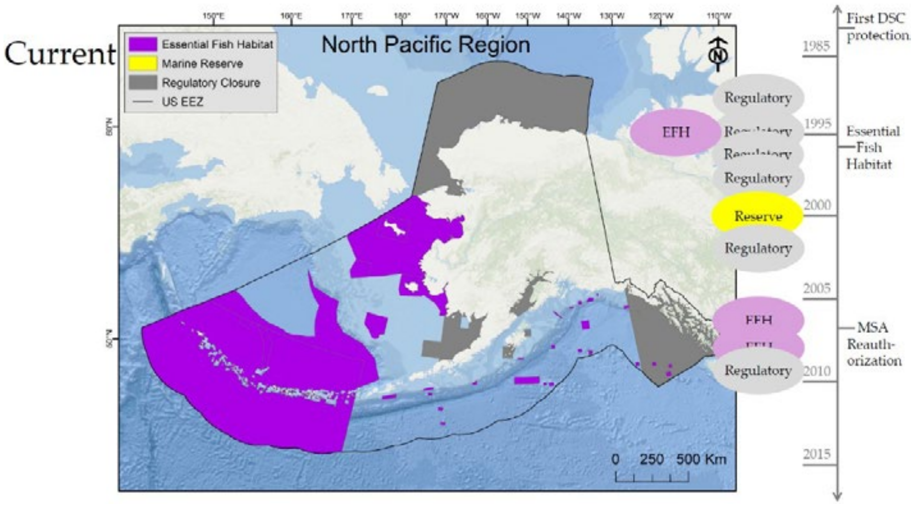
North Pacific Region (Figure 6a). Beginning in the Aleutian Islands area, over 95% of the NPFMC management area[91] was closed to bottom trawl gear in 2005 (277,100 nm^2) to prevent damage to deep-sea coral habitats, along with establishment of six coral habitat protection areas (110 nm^2) that prohibit all bottom-contact gear. In 2005, 10 locations were designated as Gulf of Alaska Slope Habitat Conservation Areas (2,086 nm^2) to prohibit all trawling for groundfish species. The Alaska Seamount Habitat Protection Area encompasses all 16 seamounts in Federal waters off Alaska. Fifteen of these seamounts have been designated as HAPCs in the Gulf of Alaska to prohibit all use of bottom-contact fishing gear. In addition, three sites were studied with submersibles and found to have high densities of gorgonian corals which promoted their designation as HAPCs (67 nm^2). Within the HAPCs all bottom-contact gear is prohibited in five zones (13.5 nm^2) called the Gulf of Alaska Coral Habitat Protection Area. In the Bering Sea region, the trawling footprint was frozen in 2007, which limited trawling to areas used recently, and prohibited new areas from being developed. Additionally, the Northern Bering Sea Research Area is fully closed to bottom trawling while the NPFMC develops a research plan. There are three habitat

[88] https://marineprotectedareas.noaa.gov/media/docs/2020-mpa-building-effective-conservation-networks.pdf
[89] Coleman, H., Hourigan, T., Eaton, R.; McGuinnand, R. and Dornback, M. (2020) History of Deep-Sea Coral Protection in U.S. Waters. Deep Sea Coral Research and Technology Program.
[90] https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=ba469d2d7fef4885b2f9076a2f969dcc
[91] https://www.npfmc.org/habitat-protections/

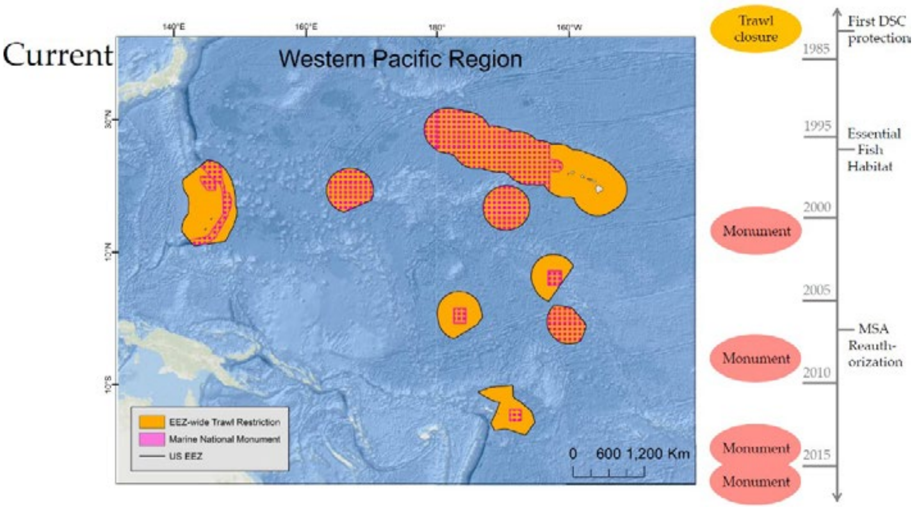
conservation areas located in the Bering Sea. All non-pelagic trawl fishing gear is prohibited in these areas.

Western Pacific Region (Figure 6b). The WPRFMC pioneered seafloor habitat protection in 1983, by prohibiting all bottom trawl gear, bottom-set gillnets, explosives, and chemicals for fishing in the entire EEZ around Guam, the Commonwealth of the Northern Mariana Islands, American Samoa, Hawaii and the other U.S. territories. These protections were established to prevent habitat degradation, incidental killing of monk seals and sea turtles, and overfishing or decreasing catch quality. Moreover, since 2006, several Marine National Monuments were established: Marianas Trench (2009), Pacific Remote Islands (2009, expanded 2014), Rose Atoll (2009) and Papahānaumokuākea (2006, expanded 2016). WPRMFC is also unique in managing the U.S. only significant precious coral industry.

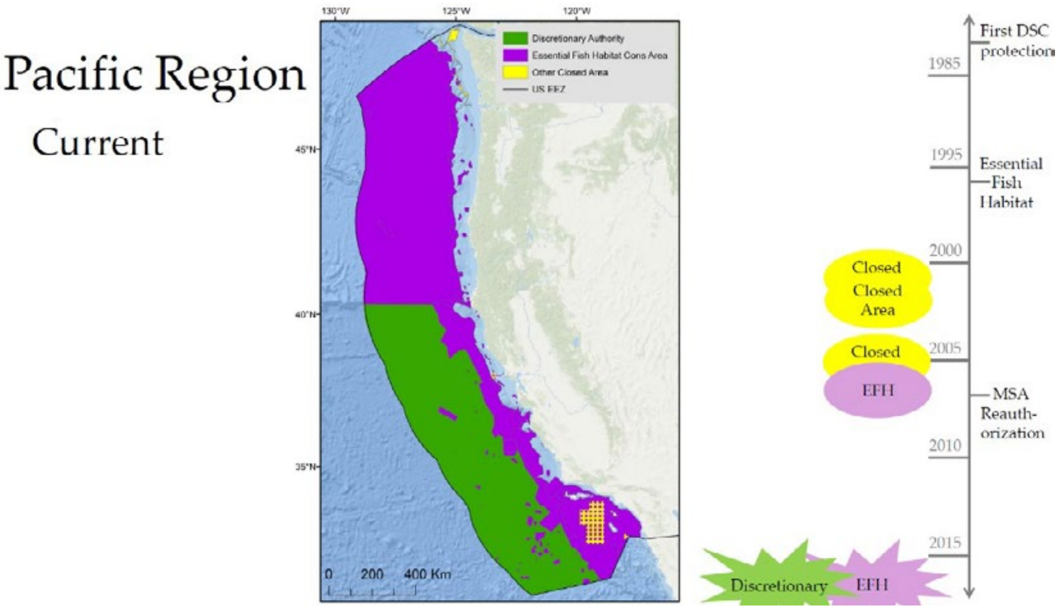
Pacific Region off California, Oregon, and Washington (Figure 6c). The PFMC has established groundfish EFH in all waters from the high tide line to 3,500 meters in depth. In 2006, *EFH conservation areas* were established to protect seafloor features such as canyons, banks, and seamounts that host biological communities such as deep-sea corals and sponges. The protections for groundfish EFH benefit deep-sea coral and sponge communities by restricting the use of fishing gears (particularly bottom-contact gears). The EFH conservation areas provide protection from fishing gear impacts to seafloor habitats in over 40% of the U.S. EEZ off the West Coast. Moreover, additional areas are closed to bottom trawling for reasons other than habitat protection. The PFMC *groundfish EFH conservation area* prohibitions include: (i) 34 bottom trawl closed areas, (ii) 17 bottom contact closed areas These areas are closed to all types of bottom contact gears, (iii) Bottom trawl footprint closure in the EEZ between 1,280 meters and 3,500 meters. This closure is similar to the other bottom trawl gear closures listed above, but spans a much larger region. The prohibition is designed to prevent new bottom trawling in areas not historically fished with bottom trawl gear, and (v) 7 federal marine reserves in the Channel Islands off Southern California. They were established in 2007 in collaboration with the state of California and prohibit all fishing within their boundaries, thus providing the highest level of protection. Adjoining areas in California state waters have similar restrictions. In April 2018, the council added new protections for groundfish EFH conservation areas and opened trawling in a few previously closed areas. The new protections resulted from a seven-year collaborative effort between fishermen and conservation organizations. This collaboration achieved both goals (i) improving fishing opportunity and (ii) increasing the level of protection for sensitive habitats. Aside from fishing protections, five marine sanctuaries provide comprehensive management to important marine resources.



(a) North Pacific Region



(b) Western Pacific Region



(c) Pacific region

Figure 6. Protected areas in the Pacific Ocean. Source: Coleman *et al.* (2020).

New England Region (Figure 7). Protection began throughout the 1990s and early 2000s as EFH designations of various areas. In 2004, habitat closure areas were established mostly as subsets of these EFH designation areas, ultimately avoiding major conflict with commercial fishermen as these areas were already understood as important protection areas. In 2016, using the *Antiquities Act*, the Northeast Canyons and Seamounts Marine National Monument was designated to close the area to all bottom-contact fishing, except for the deep-sea red crab fishery. The Georges Bank Deep-Sea Coral Protected Area was established in 2021 to reduce the impacts of fishing gear on deep-sea corals. Within the area, vessels are prohibited from fishing with bottom-tending gear but may continue to use crab pot gear[92].

Mid-Atlantic Region (Figure 7). The MAFMC was the first Council to implement the Discretionary Authority through the designation of the Frank R. Lautenberg Deep-Sea Coral Protection Area. With the information provided by the Mid-Atlantic and New England habitat suitability model developed by NOAA, the area was designated in 2015. It extends from 450 meters depth to the border of the exclusive economic zone, creating the largest area protecting benthic habitats in the U.S. Atlantic. These comprehensive protections complement earlier gear restrictions and bottom trawling prohibitions applied to Lydonia Canyon, Norfolk Canyon, Oceanographer Canyon, and Veatch Canyon (while some of these canyons are not in the Mid-Atlantic region, the Council was jointly involved in their protection with the New England Council, so they are included in the map).

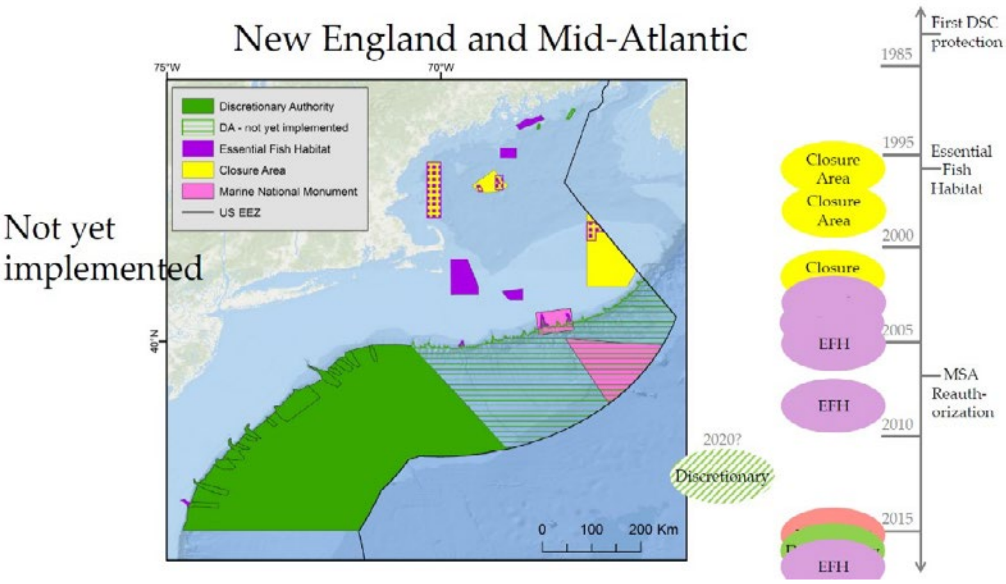


Figure 7. Protected areas in the New England and Mid-Atlantic Regions. Source: Coleman *et al.* (2020).

South Atlantic Region (Figure 8). The SAFMC was an early leader in deep-sea coral protection. The first area to be protected was Oculina Bank Habitat Area of Particular Concern (HAPC) and it has been considerably expanded throughout the 1990s and 2000s, despite the extensive damage it has suffered, mainly from shrimp trawling. In 2010, NOAA established five deep-water Coral HAPCs that encompass the nation's richest deep-sea coral reef habitats. These Coral-HAPCs prohibit all bottom tending gear, anchoring, and possession of coral year-round, except in certain areas designated for small golden crab or royal red shrimp fisheries. Additionally, marine protected areas that were designated under Amendment 14 to the Snapper Grouper FMP include habitats for different coral species and are permanently closed to fishing for snapper and grouper, as well as shark bottom longlining year-round.

[92]The crab pot fishery is scheduled to be phase out in 2023: https://www.un.org/depts/los/bfw/United-States_2022.pdf

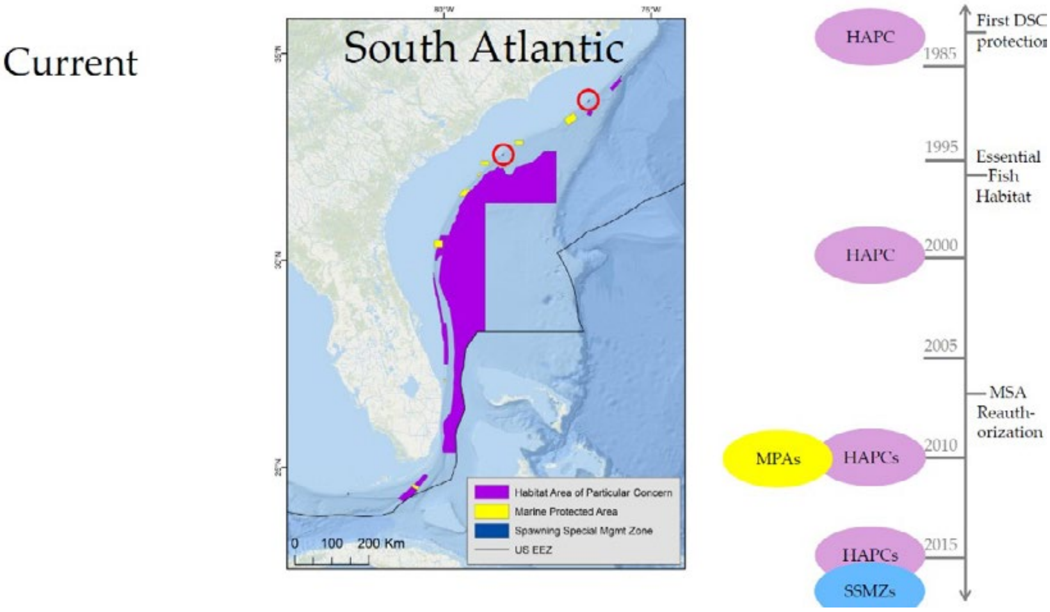


Figure 8. Protected areas in the South Atlantic Region. Source: Coleman *et al.* (2020).

Gulf of Mexico Region (Figure 9). Protection began with the designation of HAPCs through the joint Coral and Coral Reef Fishery Management Plan of 1984. Since the 1996 MSFCMA reauthorization, HAPCs have been established as particular areas within EFH to be taken into special consideration. Many of the Gulf's EFH and HAPCs date to the Council's 2006 EFH Amendment. On its own, designation of a HAPC does not provide any extra protection or regulations. However, areas such as East and West Flower Garden Banks, Stetson Bank, and McGrail Bank were designated Coral HAPCs to provide year-round prohibition of all bottom-tending gears and anchoring. In addition, East and West Flower Garden Banks and Stetson Bank are managed as the Flower Garden Banks National Marine Sanctuary. Other areas are protected as Marine Reserves that are closed to fishing seasonally or all year[93].

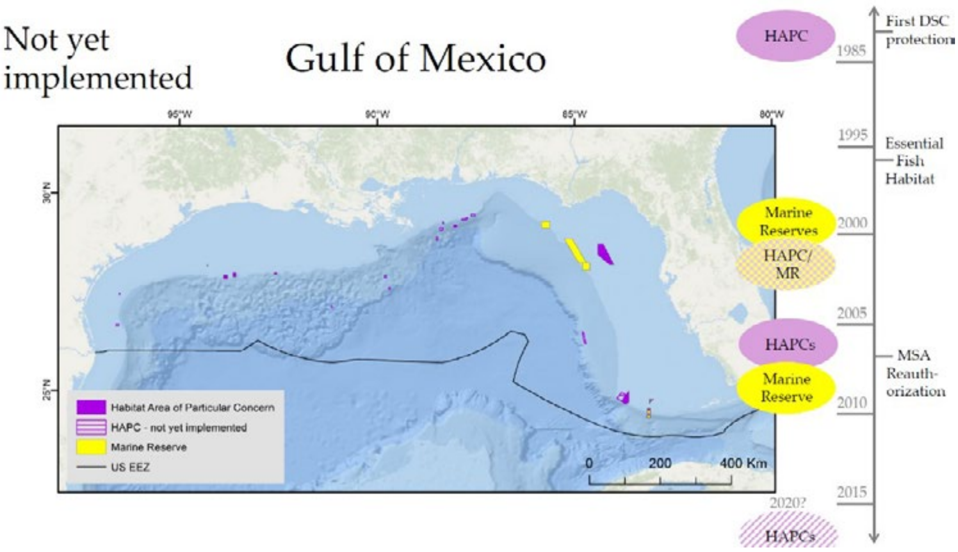


Figure 9. Protected areas in the Gulf of Mexico Region. Source: Coleman *et al.* (2020).

[93]In November 2020, 21 new HAPC were established. 13 of these areas, include regulations to protect deep-sea corals from damaging fishing gear. Boundaries include the first coral habitats deeper than 200 m to be protected in the Gulf. In March 2021, the Flower Garden Banks National Marine Sanctuary expanded to protect 14 new reefs and Banks. https://www.un.org/depts/los/bfw/United-States__2022.pdf

Caribean Region (Figure 10). Protection began in various areas in the late 1990s led by the CFMC, with gear restrictions implemented in all areas in 2005. Although none of these areas were designed to protect deep-sea coral and sponge habitats, the restrictions enacted benefit them.

Most areas are designated by means of EFH through Fishery Management Plans. Hind Bank Marine Conservation District, Navassa Island National Wildlife Refuge[94], the Virgin Islands Coral Reef National Monument, and Buck Island Reef National Monument are closed to all fishing activities year-round.

Original EFH closures served as a good tool not only to protect fish but also to protect deep-sea coral and sponge resources because they prohibit fishing activities seasonally. Fishermen have also been actively involved in deep-sea coral protection by proposing the closure of Hind Bank Marine Conservation District.

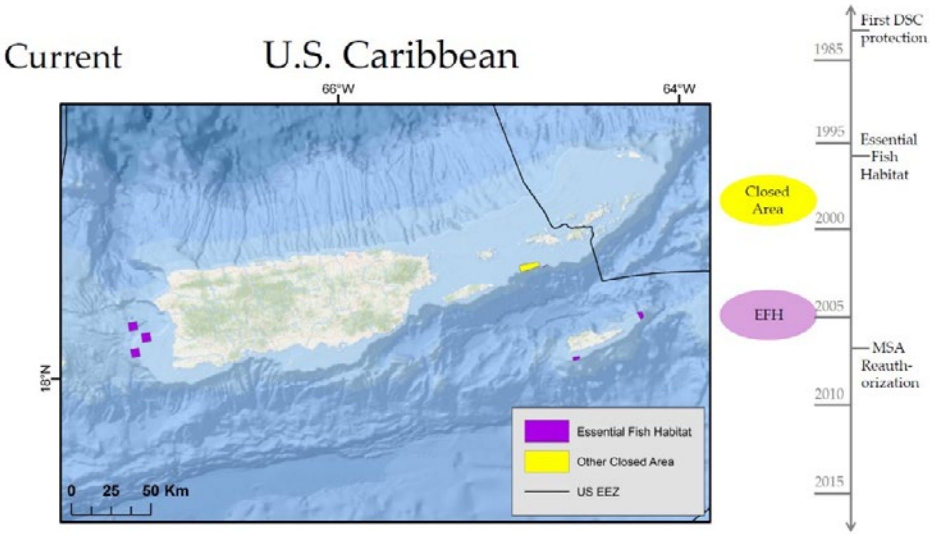


Figure 10. Protected areas in the Caribbean Region. Source: Coleman *et al.* (2020).

Boundaries and attribute data (e.g. management authority, regulations, restrictions, etc.) for fishery management areas in both U.S. national waters and international waters, are accessible through the *Protected Seas database*[95] portal. It provides an interactive global map to explore protected areas, regulations, level of fishing protection and gear restrictions. Besides of U.S. regulations, it compiles detailed information on different types of high seas managed areas, including treaty areas, regulated management and protected areas (U.S. and other countries, RFMOs, OSPAR, etc.). In the high seas, bottom fishing may be permitted when authorized by international conservation and management measures recognized by the U.S. In the case of bottom fishing activity not subject to international measures recognized by the U.S., NOAA Fisheries may specify conditions to mitigate adverse impacts on VMEs (see details in section 1.3).

With regards of the management of other sectors, it is worth to note that the BOEM[96] was created in 2011 with the mission to manage development of U.S. outer continental shelf (OCS)[97] energy (i.e. oil and gas, renewable energy) and mineral resources in an environmentally and economically responsible way. BOEM ensures that environmental protection, informed by the best available science and law, is considered in decision making. BOEM functions include: (i) leasing, (ii) plan administration, (iii) environmental studies, (iv) *National Environmental Policy Act*

[94] Located outside of the U.S. EEZ approximately 55 km west of Haiti (there are competing claims of Haiti and the U.S. over the island). Since 1999, The Island is administered by the U.S. Fish and Wildlife Service.
[95] https://mpa.protectedseas.net/
[96] *Bureau of Ocean Energy Management*. See details in: https://www.boem.gov/
[97] OCS is all submerged lands lying seaward of state coastal waters which are under U.S. jurisdiction

analysis, (v) resource evaluation, (vi) economic analysis and (vii) the renewable energy program. Moreover, the *Energy Policy Act* of 2005 requires that BOEM coordinate with relevant Federal agencies and affected state and local governments. For example, wind farms could impact fishing in a variety of ways[98]. In this context, NOAA Fisheries provides information to help the BOEM make informed decisions about offshore wind energy development and operations. NOAA is focused on minimizing the impacts to ocean resources, critical habitats, and fishing opportunities throughout the planning, siting, and development stages.

As mentioned in section 1.1 the NOAA DSCRTP also supports resource management in aquaculture, renewable energy, and potential deep-sea mining. Each sector requires knowledge of deep-sea coral locations to mitigate damage to these valuable and vulnerable habitats. Managers in the U.S. have used the DSCRTP scientific findings to make informed decisions about fishing regulations, protected area boundaries, aquaculture planning, precious coral harvest management, etc.

In 2022, NOAA and BOEM signed also an interagency MoU[99] on responsible progress of offshore wind energy. Additionally, in 2019, NOAA Fisheries, BOEM and the Responsible Offshore Development Alliance (RODA)[100], an independent coalition of fishing industry, signed a 10-year MoU that brings local and regional fishing interests together with federal regulators to collaborate on the science and process of offshore wind energy development on the Atlantic OCS.

Despite that the authority of the RFMCs is focused on the development of fishing regulations, they also can provide input and guidance on the conduct of other marine activities, with the aim to promote compatibility with sustainable fishing. NOAA Fisheries and the RCFMs have the ability to provide recommendations to Federal or State agencies concerning proposed human activities that may affect the habitat, including EFH, of a fishery resource under their authority. In this context, some RCFMs (e.g. Mid-Atlantic and New England Councils) have developed a series of policies[101] that articulate its positions on activities other than fishing (e.g. oil and gas, submarine cables, renewable energy, etc.).

1.6 – Monitoring of VME impacts

Every two years, NOAA submits biennial reports to the U.S. Congress summarizing the results of the DSCRTP (e.g. identification, monitoring and protection of deep-sea corals. See section 1.4). The first biennial report was presented in 2008. Since that time, DSCRTP updated biennial reports[102] were submitted in 2010, 2012, 2014, 2016, 2018 and 2020.

The DSCRTP, is a management-oriented research program, and NOAA's National Centers for Environmental Information serve resource managers by maintaining and adding to the *National Database for Deep-Sea Corals and Sponges*. The Database (see Figure 4 in section 1.4) displays known deep-sea coral and sponge locations submitted by researchers located across the U.S. and internationally. In terms of number of records, the principal sampling method are Remote Operated Vehicles (ROV), following by submersibles and trawls. According to the 2020 biennial report, in the period 2018-2019, 31 research teams contributed information and almost every region of the U.S. has used DSCRTP data to inform management of deep-sea coral resources. As mentioned in section 1.4, the DSCRTP complements the OER[103]

[98] https://www.fisheries.noaa.gov/topic/offshore-wind-energy#fishing-community-impacts
[99] https://www.boem.gov/newsroom/press-releases/boem-and-noaa-announce-interagency-collaboration-advance-offshore-wind
[100] https://www.fisheries.noaa.gov/feature-story/noaa-boem-fishing-industry-sign-new-memorandum-understanding
[101] https://www.mafmc.org/northeast-offshore-wind;https://www.mafmc.org/actions/offshore-energy
[102] https://deepseacoraldata.noaa.gov/sitemap
[103] NOAA Ocean Exploration: https://oceanexplorer.noaa.gov/about/welcome.html

(the federal research program focused on deep ocean exploration), working closely with the RFMCs and sponsoring field research programs. NOAA fishery surveys and NOAA observers (see details in section 1.3) are also important for deep-sea coral and sponge monitoring, particularly in Alaska and the U.S. West coast (see section 1.4). Specific identification guides for deep-sea corals and sponges supported by DSCRTP, OER and others are available for some RFMC regions. As the DSCRTP is mainly focused in the U.S. EEZ, the primary clients for the National Database are the RFMCs. The number of records in a given RFMC region is primarily a measure of sampling and data reporting efforts, not a reflection of the abundance of deep-sea corals or sponges within a region (Figure 11).

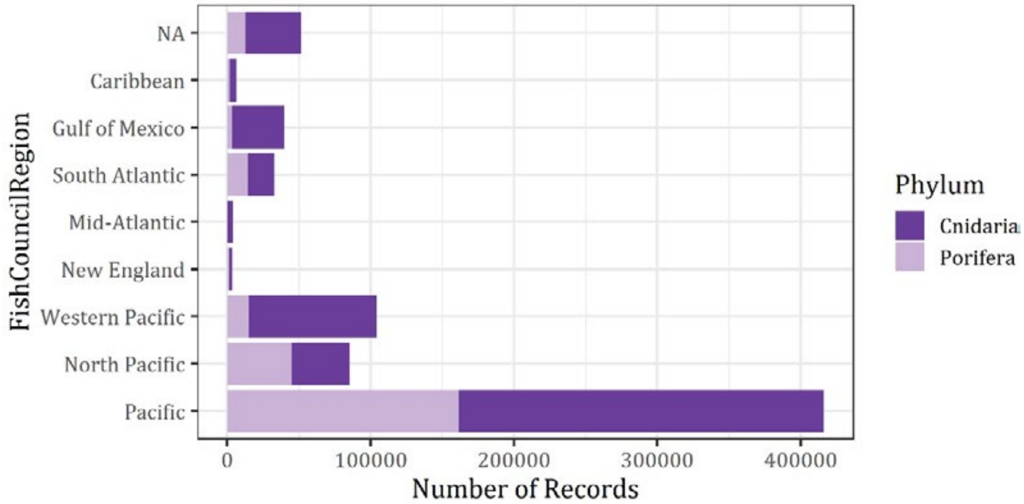
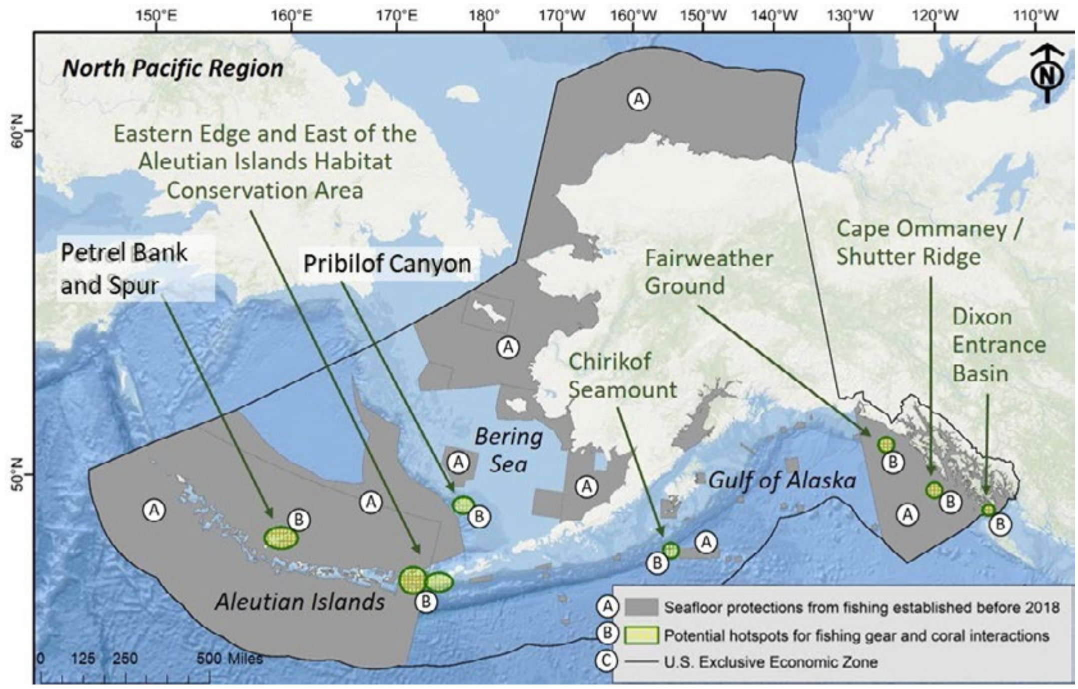


Figure 11. National Database for Deep-Sea Corals and Sponges: Coral and sponge occurrences by RFMC region. (NA) records outside the U.S. EEZ. Source: NOAA's National Database for Deep-Sea Corals and Sponges: 2020 Status Update. *NOAA Technical Memorandum NMFS-OHC-007*.

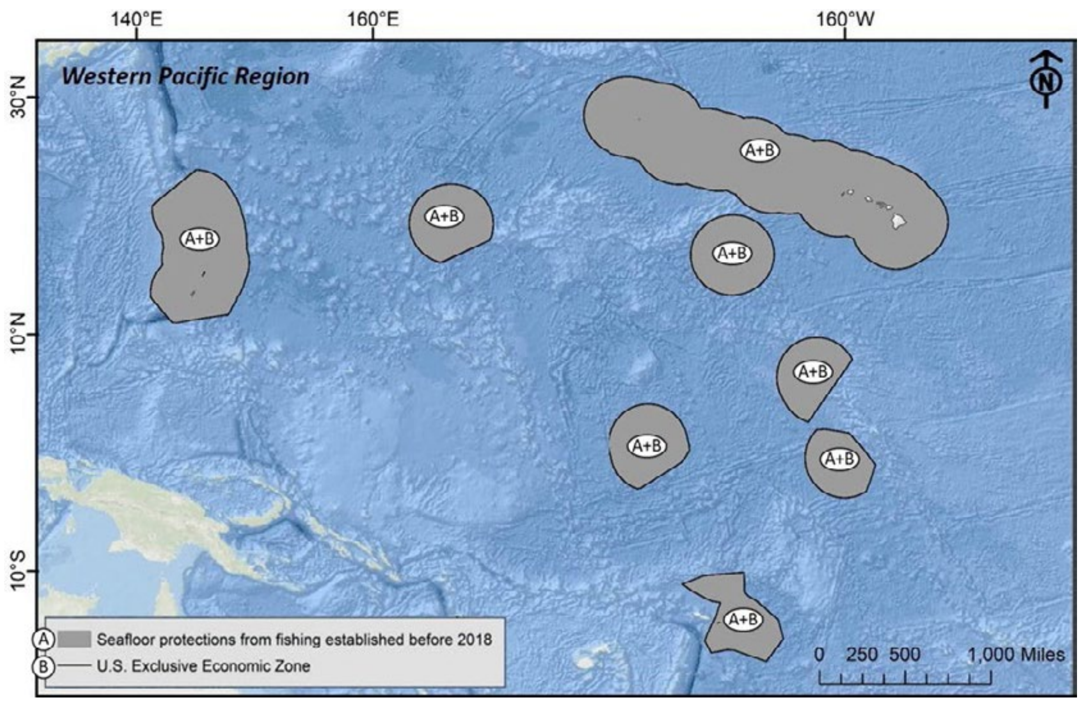
The last DSCRTP report (2020) highlights locations in U.S. waters that are open to seafloor trawling and have a documented presence of VMEs (corals and sponges), showing potential areas of interaction with fishing:

North Pacific Region (Figure 12a) NOAA Fisheries and the NPFMC have established extensive conservation areas to protect EHF. The green/yellow areas on the map are particular hot-spots of coral density or bycatch, but interactions are not limited to these areas. In the Gulf of Alaska, substantial red tree coral habitats exist outside currently protected areas and in places closed to seafloor trawling, but vulnerable to bottom longline and traps. The Aleutian Islands Habitat Conservation Area and Coral Habitat Protection Areas provide important protections. However, high-density coral gardens in these areas may still be vulnerable, and relatively high levels of coral bycatch are reported in surrounding areas from trawl and other fisheries.

Western Pacific Region (Figure 12b) NOAA Fisheries and the WPRFMC have prohibited seafloor-contact trawls, longlines, and gillnets throughout the U.S. Pacific Islands since 1983. Thus, there is little potential for these gears to damage deep-sea corals. Analyses of recent surveys continue to reveal important deep-sea coral communities, including in marine national monuments and sanctuaries in the region.



(a) North Pacific Region



(b) Western Pacific Region

Figure 12. North Pacific and Western Pacific Regions: protections and areas of high potential for seafloor-contact fishing gear interactions. Source: NOAA DSCRTP 2020 report to Congress.

Pacific Region off California, Oregon, and Washington (Figure 13) The proportion of federal waters off Washington, Oregon, and California that is protected from seafloor trawling nearly doubled in January 2020. Expansions and new protections addressed seven of the ten former west coast sites identified for relatively high coral bycatch and documented presence of coral aggregations, as described in the 2018 DSCRTP

Report to Congress (sites outlined in purple in the map). Green/yellow areas have commercial trawl fishery reports of standardized coral bycatch in the top 1 percent coast-wide, based on data from the West Coast Groundfish Observer Program.

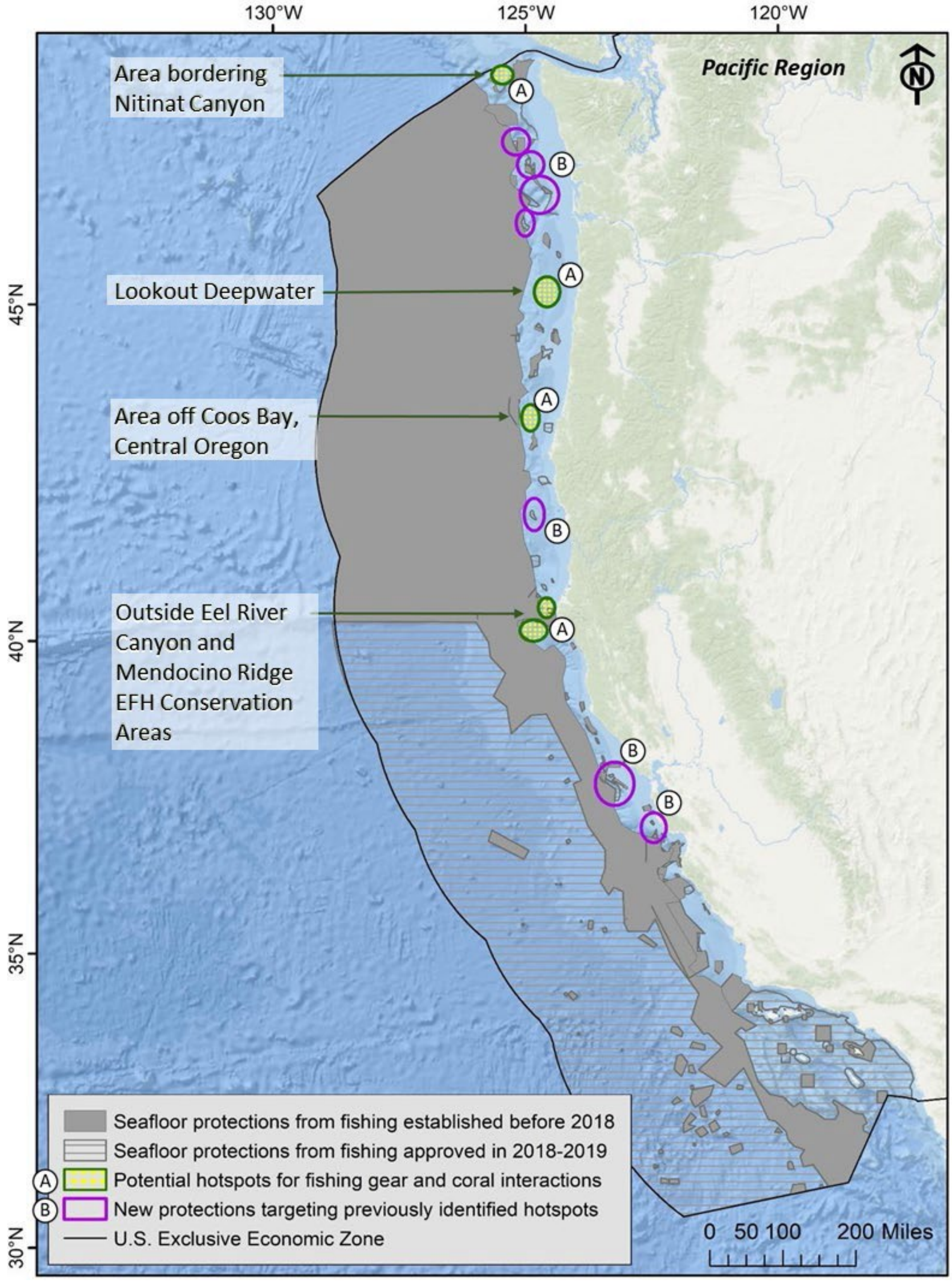


Figure 13. Pacific region: Protections and areas of high potential for seafloor-contact fishing gear interactions. Source: NOAA DSCRTP 2020 report to Congress.

New England and Mid-Atlantic Regions (Figure 14). Since 2015, both the New England and Mid-Atlantic Fishery Management Councils have taken great strides to protect deep-sea coral habitat, particularly in canyons and on deep slopes. New

England canyons and slopes deeper than 600 meters and several areas in the Gulf of Maine are hotspots that the Council has voted to protect from most seafloor-contact fishing gear. Documented areas of dense coral gardens still remain unprotected from seafloor-contact fishing, most notably in the Western Jordan Basin and Lindenkohl Knoll areas of the Gulf of Maine (outlined in green/yellow in the map).

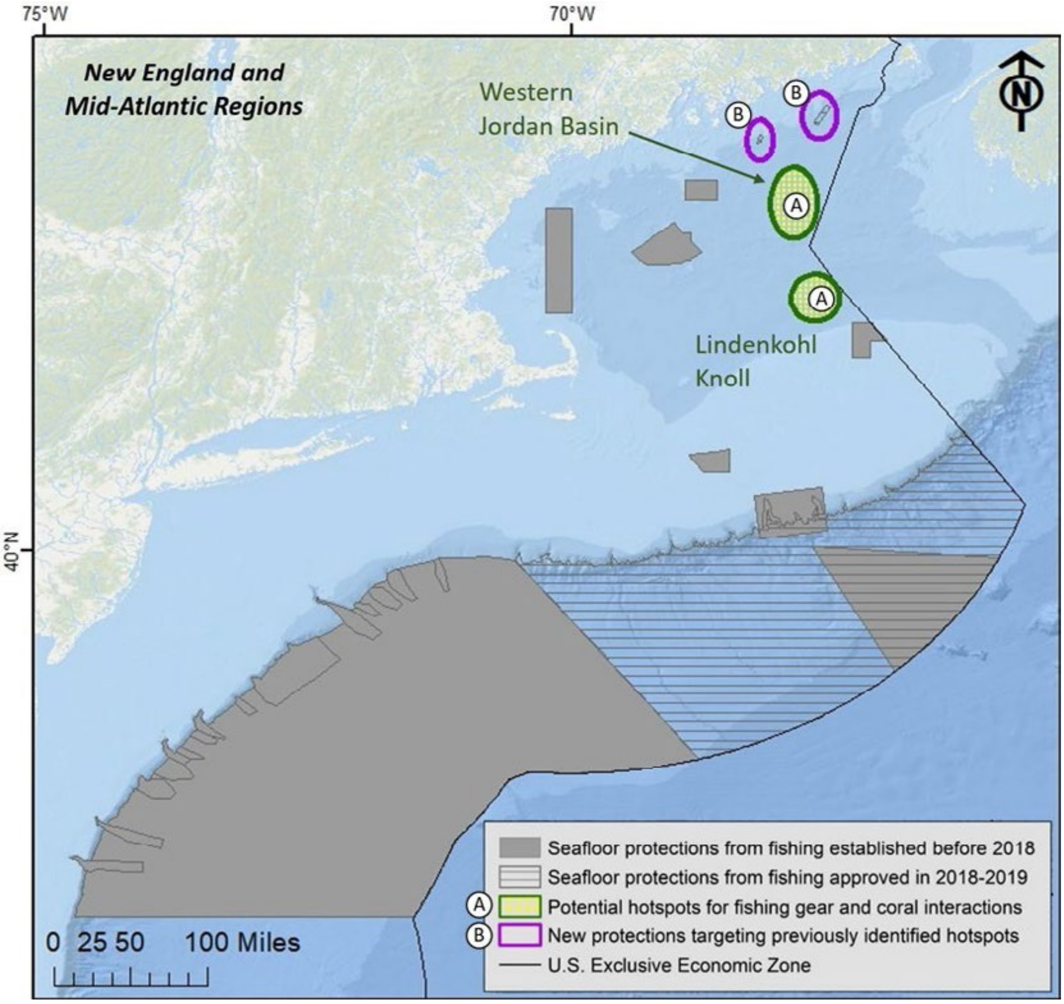


Figure 14. New England and Mid-Atlantic regions: Protections and areas of high potential for seafloor-contact fishing gear interactions. Source: NOAA DSCRTP 2020 report to Congress.

South Atlantic and Caribbean Regions (Figure 15)**.** NOAA Fisheries and the SAFMC have closed a number of areas to seafloor-contact fishing to protect deep-sea coral habitats since the 1980s. The SAFMC now has a substantial amount of new information from recent years available to inform upcoming decisions. The most vulnerable areas of coral aggregations are outlined in green/yellow in the map. Research on deep-sea habitats in the U.S. Caribbean to date is limited, and specific locations of deep-sea corals are not well-known. The west coast of Puerto Rico (outlined in green/yellow in the map), has areas of important deep-sea coral habitat. Risks to these habitats from fishing are likely low, as fishermen do not use the most damaging seafloor-contact fishing gears.

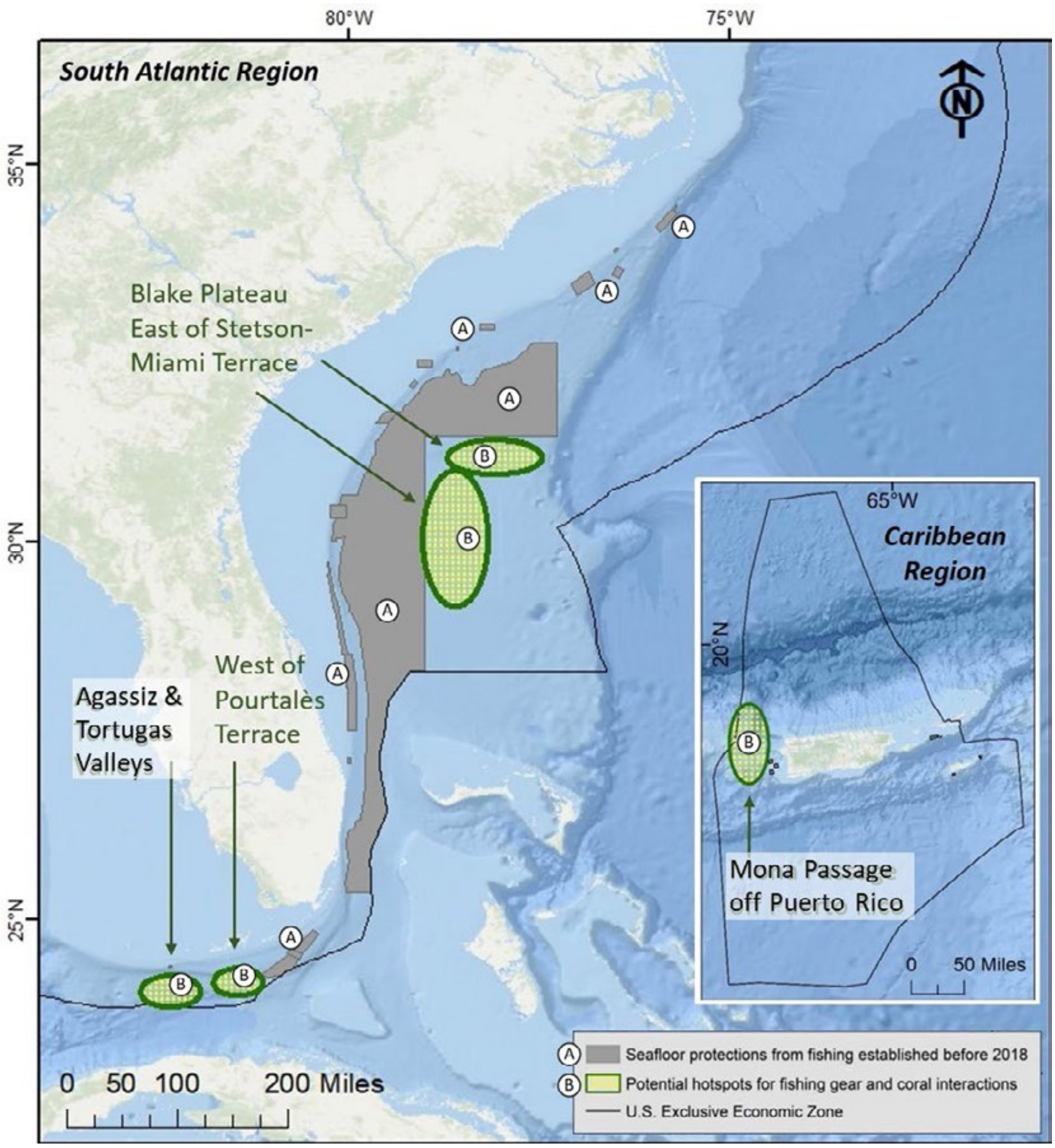


Figure 15. South Atlantic and Caribbean region: Protections and areas of high potential for seafloor-contact fishing gear interactions. Source: NOAA DSCRTP 2020 report to Congress.

Gulf of Mexico Region (Figure 16) Many areas approved for seafloor protections by the GMFMC in 2018 had been identified in the past as vulnerable deep-sea coral habitat (outlined in purple). In October 2020, NOAA Fisheries approved seafloor protections for 13 areas containing deep-sea corals. Areas that are still considered vulnerable to seafloor-contact fishing are outlined in yellow/green on the map. These include deepwater coral habitats, as well as mesophotic and shelf-edge banks.

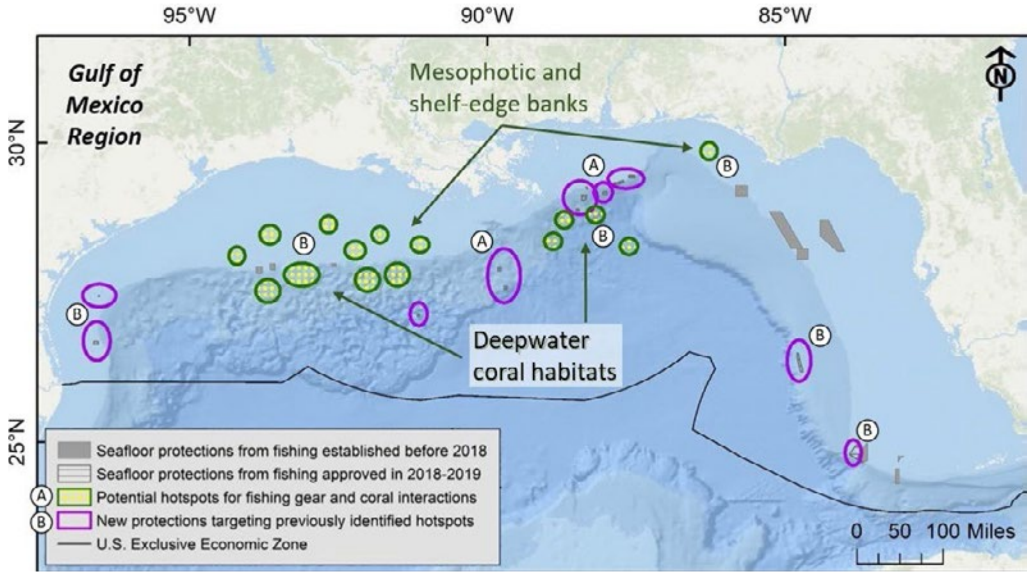


Figure 16. Gulf of Mexico region: Protections and areas of high potential for seafloor-contact fishing gear interactions. Source: NOAA DSCRTP 2020 report to Congress.

With regards to monitoring of impacts of activities other than fishing on VMEs, the *BOEM's Environmental Studies Program* develops, funds, and manages scientific research specifically to inform policy decisions on the development of energy and mineral resources on the U.S. Outer Continental Shelf (OCS). BOEM works together with partners such as USGS and NOAA on VME research[104] (e.g. deep-sea coral and sponges, seamounts, chemosynthetic communities, etc.) with the aim to collect baseline information on benthic ecosystems to inform and support environmental risk assessments, environmental impact statements, and other decision documents related to the offshore energy and mineral developments in the OCS. Information from ongoing and completed studies is available from the BOEM *Environmental Studies Program Information System (ESPIS)*[105] portal.

In addition, the *MarineCadastre.gov*[106], an integrated marine information system developed by BOEM and NOAA, provides public access to data and tools for marine spatial planning. It contains data on jurisdictional boundaries, marine infrastructure, transportation and energy, as well as physical and biological data (e.g. deep-sea coral and sponge records) needed to support planning, management, and conservation of submerged lands and marine spaces in the U.S. For example, data obtained from MarineCadastre.gov allowed the assessment of areas potentially impacted by offshore drilling (e.g. EFH).

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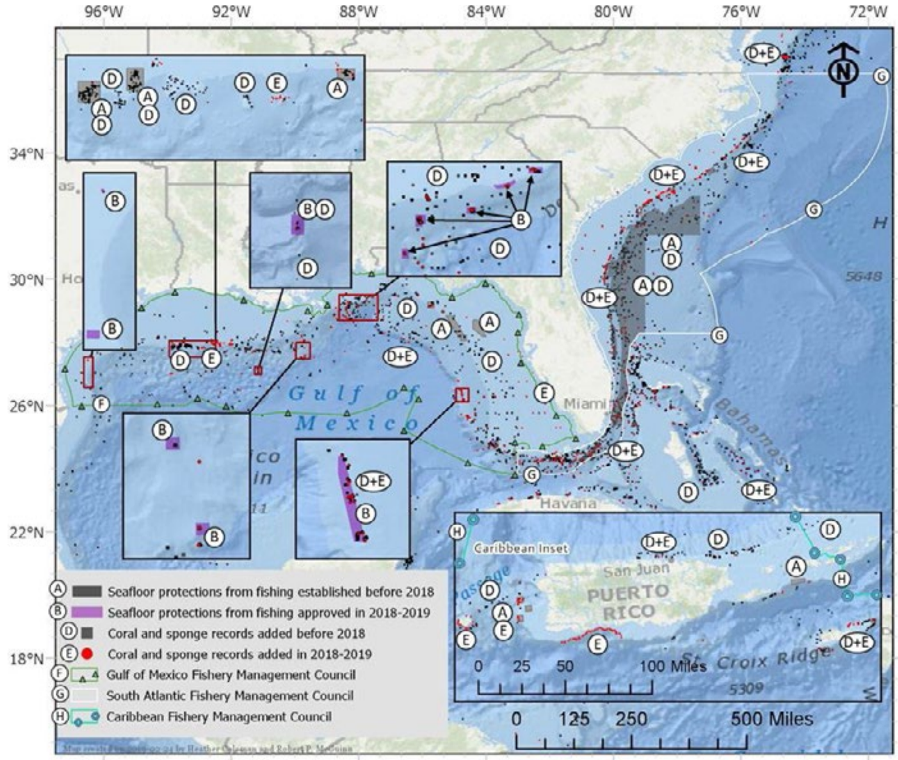
[104] Goyert HF, Bassett R, Christensen J, Coleman H, Coyne M, Etnoyer PJ, Frometa J, Hourigan TF, Poti M, Enrique S, Williams B, J. WA (2021) Characterizing spatial distributions of deep-sea corals and chemosynthetic communities in the US Gulf of Mexico through data synthesis and predictive modeling. New Orleans (LA): US Department of the Interior, Bureau of Ocean Energy Management OCS Study BOEM 2021-027 317 p.

[105] https://marinecadastre.gov/espis/#/

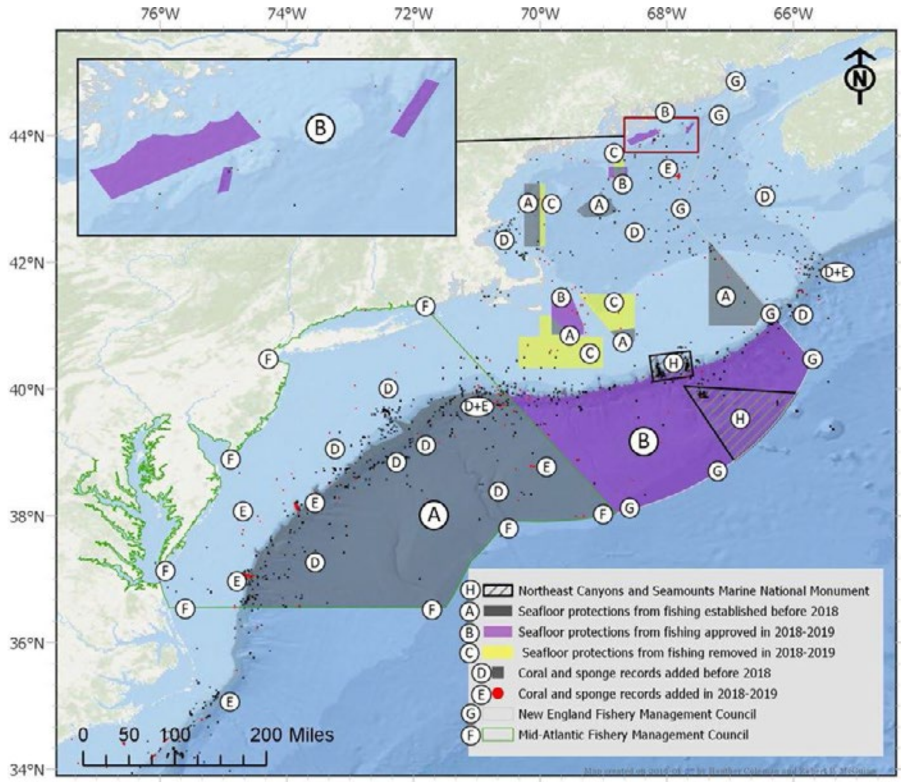
[106] https://marinecadastre.gov/

CASE STUDY 1 - SUPPLEMENTARY MAPS

Locations of deep-sea coral and sponge taxa in the U.S. EEZ[107]



(a) Gulf of Mexico, South Atlantic, and the Caribbean regions



(b) New England and Mid-Atlantic regions

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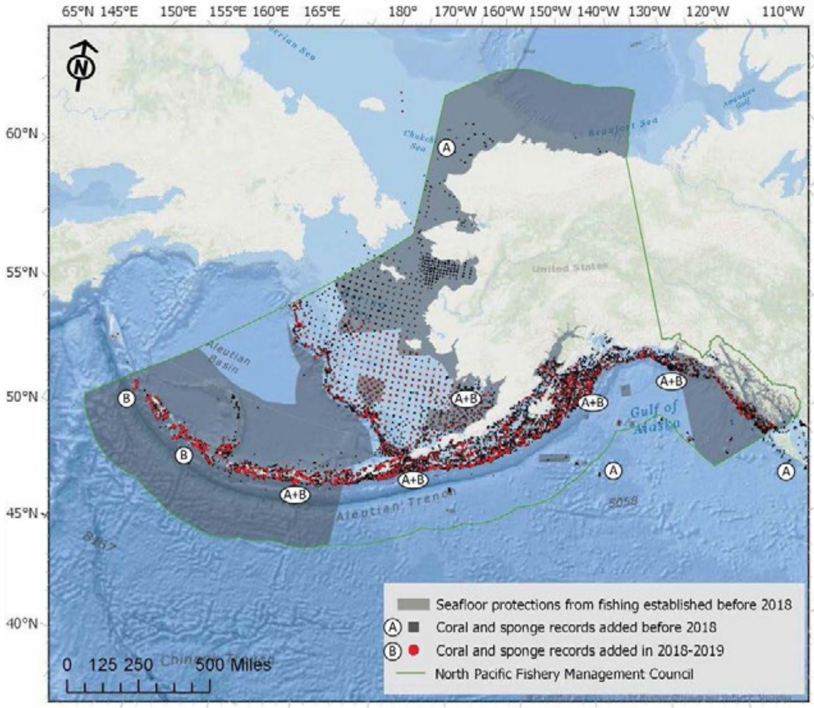
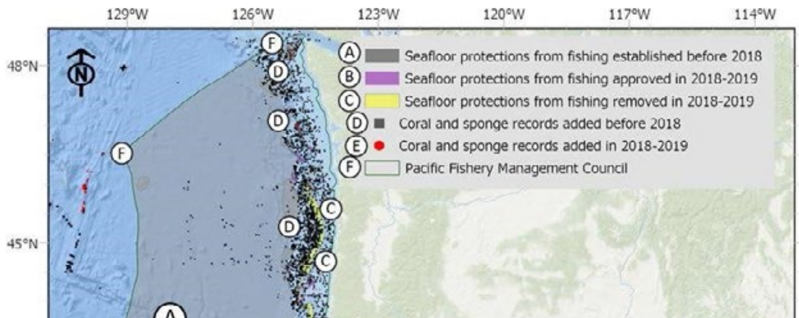
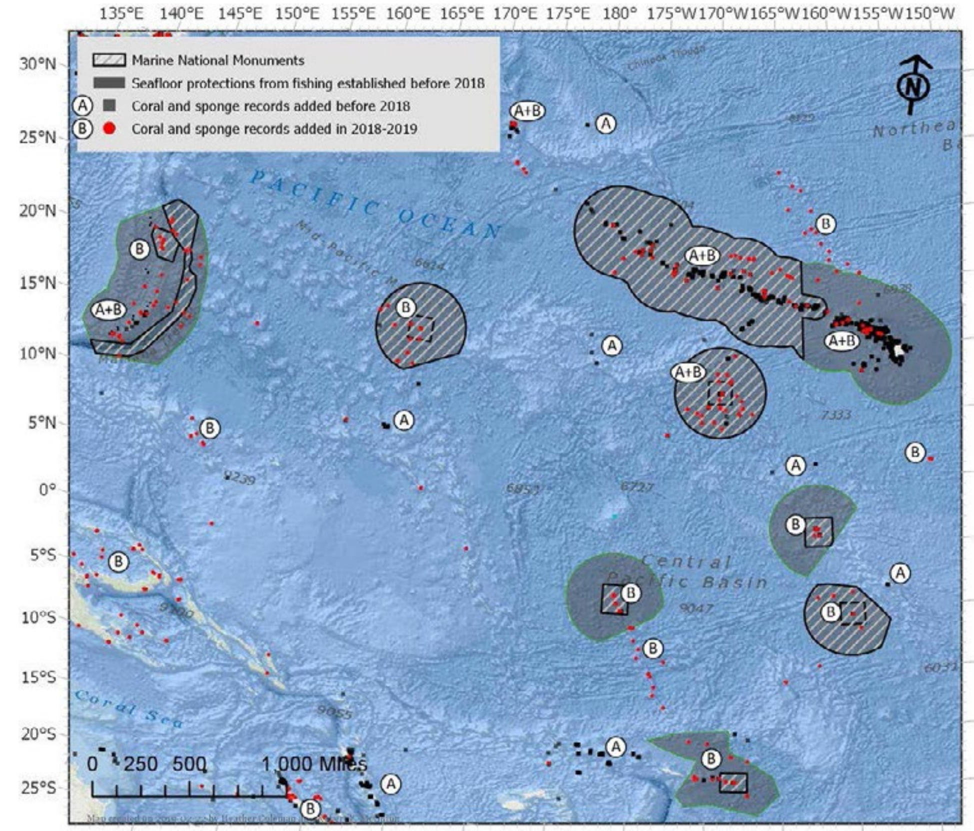
107 Source: NOAA (2020) DSCRTP 2020 report to Congress. https://deepseacoraldata.noaa.gov/2020-dsc-report-to-congress/



(c) North Pacific region



(d) Pacific region



(d) Western Pacific region

List of Acronyms

AUVs	Autonomous Underwater Vehicles
BOEM	Bureau of Ocean Energy Management
CEM	Conservation and Enforcement Measures
CFMC	Caribbean Fishery Management Council
DSCRTP	Deep Sea Coral Research and Technology Program
DSF	Deep-sea Fisheries
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
ESPIS	Environmental Studies Program Information System
FAO	Food and Agriculture Organisation of the United Nations
FEPs	Fishery Ecosystem Plans
FMPs	Fishery Management Plans
GMFMC	Gulf of Mexico Fisheries Management Council
HAPCs	Habitat Areas of Particular Concern
HSFCA	High Seas Fishing Compliance Act
IFCs	Interstate Fishery Commissions
MAFMC	Mid-Atlantic Fishery Management Council
MoU	Memorandum of Understanding
MPAs	Marine Protected Areas
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
NAFO	Northwest Atlantic Fisheries Organisation
NEFMC	New England Fishery Management Council
NMFS	National Marine Fisheries Service
NPFMC	North Pacific Fishery Management Council
NOAA	National Oceanic and Atmospheric Administration
NS	National Standards
OCS	Outer Continental Shelf
OER	Ocean Exploration and Research
PFMC	Pacific Fishery Management Council
RFMCs	Regional Fishery Management Councils
RFMOs	Regional Fisheries Management Organisations
RODA	Responsible Offshore Development Alliance
ROV	Remotely Operated Vehicle
SAFMC	South Atlantic Fishery Management Council
VME	Vulnerable Marine Ecosystem
VMS	Vessel Monitoring System
WPRMFC	Western Pacific Regional Fishery Management Council

CASE STUDY 2 - CANADA

2.1 – Data availability and governance frameworks

Canada's fisheries are managed by the ***Fisheries and Oceans Canada*** (DFO), a federal institution responsible for both domestic and international commercial fisheries (among other things), including Deep-sea fisheries (DSF). It was founded on 1st July 1887 and received its legislative authority on 22nd May 1868. It is organised into seven administrative regions[108] which cover all the provinces and territories of Canada (Figure 1). One of the international priorities is stated as protecting "…vulnerable marine ecosystems (VME) beyond our national waters, including seamounts and deep-sea/cold-water corals".

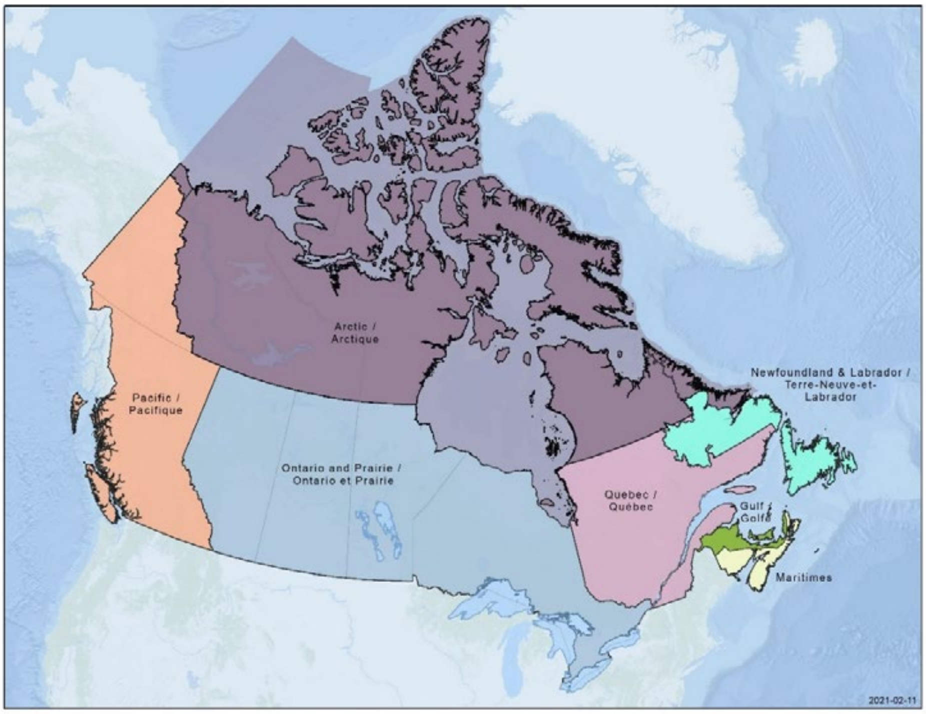


Figure 1. DFO Regions.

It is made up of a number of branches, including a ***Science Branch*** that provides information to the ***Oceans Management Branch*** to help manage various aspects of their fisheries, including DSF. The Science Branch has been undertaking work to develop an evaluation, based on certain ecological criteria, to identify representative seamount areas in the *Offshore Pacific Area of Interest* (AOI) with the aim of developing an Offshore Pacific MPA (DFO, 2021b).

Regulations (acts and orders) under which Canada's fleet operate can be found on their site[109], most relevant to this study includes the ***Fisheries Act and Oceans Act*** which outline the requirements for sustainable fisheries and marine protected areas respectively. DFO enforces the *Fisheries Act* and other regulations and legislation. The DFO also work closely with a number of RFMOs, most relevant for this study are NAFO and NPFC which operate DSFs in waters to the east and west of Canada. Canada's presence in NAFO is more significant than NPFC where it has not fished in recent years (Canada currently have 13 vessels registered to fish in NAFO waters targeting a number of different species, including shrimp, halibut, cod, haddock, pollock, plaice and flounder). Within NAFO it has been instrumental in setting up measures to protect VMEs, including closing around 15% of the fishable area within

108 https://www.dfo-mpo.gc.ca/about-notre-sujet/organisation-eng.htm
109 https://www.dfo-mpo.gc.ca/acts-lois/regulations-reglements-eng.htm

NAFO in 2016 and closing the last mid-water trawl fishery on seamounts in 2019 (Hutchings *et al.*, 2020).

All vessels wishing to fish, including those operating in DSF, must apply on an annual basis for a fishing license. The fisheries are broadly divided into three categories, Indigenous Fisheries, Atlantic and Arctic Fisheries and Pacific Fisheries.

In 2012 the ***Royal Society of Canada*** (RSC) assessed the challenges faced by Canada in achieving sustainable fisheries and concluded that it fell behind other countries in its international obligations to sustain biodiversity. As a result of this it formed a committee to track development regarding marine biodiversity policies, identify challenges and lead implementation options. This led to the strengthening of key statutes including the *Fisheries Act* to rebuild depleted fisheries and the *Oceans Act* that outlined the means to create a network of marine protected areas and set a target of protecting 10% of coastal and marine areas by 2020 (Hutchings et al., 2020). While progress has been made, as of 2019 some problems are still apparent. These include regulatory conflict with DFO, decreasing ministerial discretion under the *Fisheries Act,* the role of science in sustainable fisheries policy and the effects of climate change. As a result a number of policy challenges have been identified:

- Climate change impacts should be incorporated into future decision making and planning processes;
- Resolution of DFO's regulatory conflicts;
- Limiting ministerial discretionary power in fisheries management decisions;
- Clarifying how the precautionary approach should be applied to developing a sustainable fisheries policy; and,
- Advance in implement marine spatial planning.

The DFO is based in Ottawa, the national headquarters is organized into various sectors[110], as shown in Figure 2.

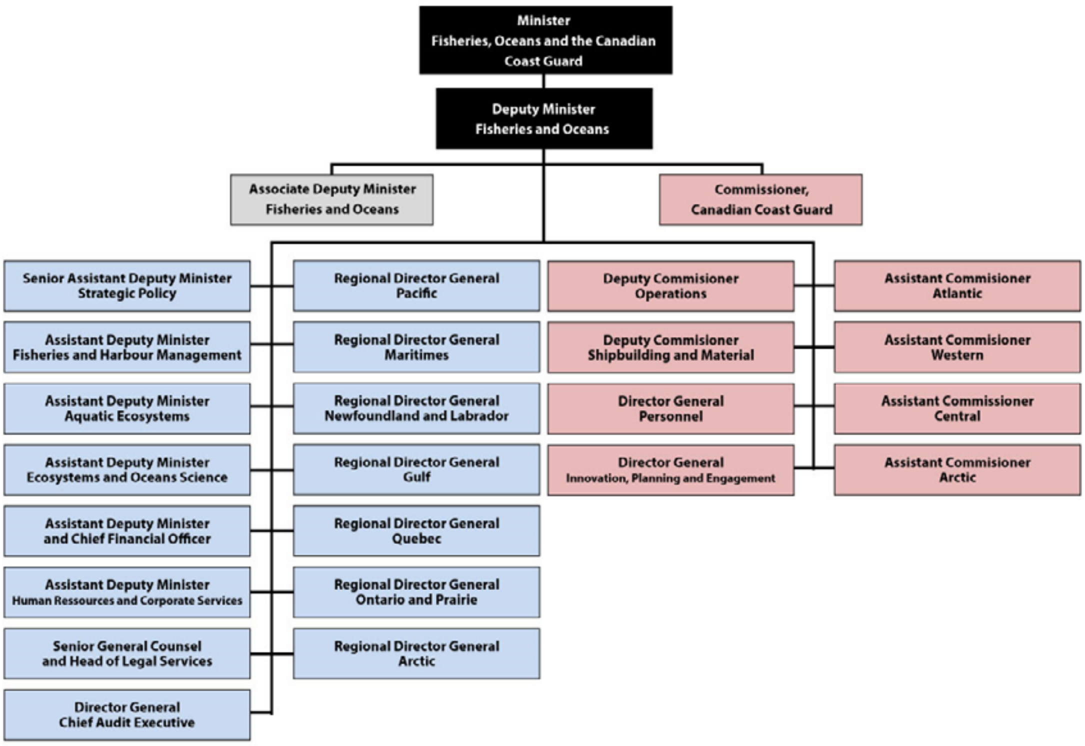


Figure 2. Structure of the DFO.

110 https://www.dfo-mpo.gc.ca/about-notre-sujet/organisation-eng.htm

The ***Canadian Coast Guard*** (CCG) operates under the DFO and is also headquartered in Ottawa and in common with the DFO several of its regions range from coast to coast (Figures 1, 3 and Figure 4). CCG plays a key role in ensuring the sustainable use and development of Canada's oceans and waterways. The head of the department is the Minister of Fisheries, Oceans and CCG and the Deputy Minister of Fisheries reports directly to the Minister. In turn, reporting to the Deputy Minister are the Associate Deputy Minister, the Commissioner of the CCG and the heads of the different DFO sectors and regions (Assistant Deputy Ministers and Regional Directors General). Reporting to the Commissioner of the CCG are the Deputy Commissioners, two Directors General and heads of the various CCG regions (Assistant Commissioners). A map of the various offices related to the DFO and CCG is shown in Figure 2.

Figure 3. CCG Regions.

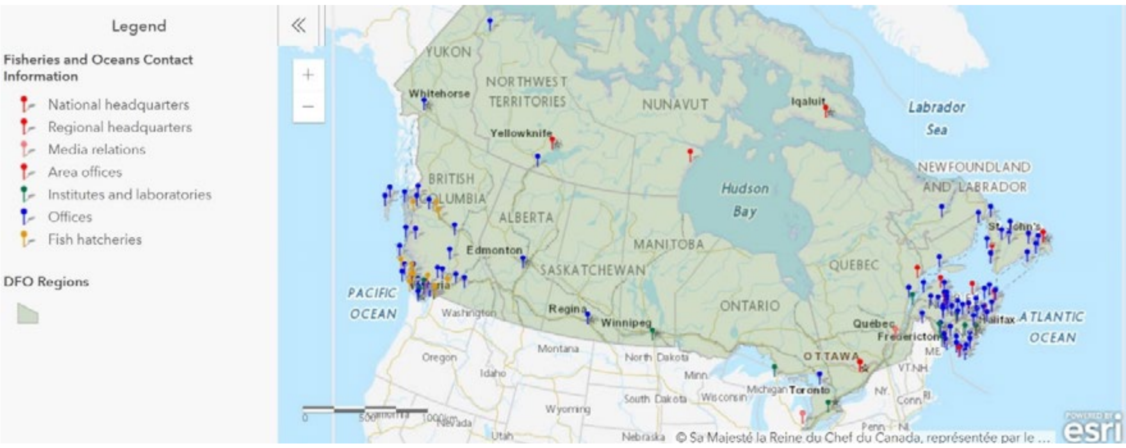


Figure 4. Regional offices and other organisations related to the DFO[111].

The Canadian DSF utilising bottom fishing operates in two main RFMOs, NPFC and NAFO and as full members are bound by their Conservation Measures.

[111] https://www.dfo-mpo.gc.ca/contact/regions/index-eng.html

Under NPFC, the 2021 Sustainable Use and Conservation Handbook[112] lists the Conservation and Management Measures (CMM) in place as of the 10th July 2021. In total 13 CMMs are listed[113].

NAFO publish their Conservation and Enforcement Measures (NCEMs) annually in a handbook, the latest (for 2022) is available on their website [114]. There are more measures published than for NPFC and are divided into a number of categories including Research Vessels, Catch and effort Limitations, Bycatch Retention, Species and areas specific NCEMs, Conservation and Management of Sharks, Gear Requirements and Minimum Fish Size Requirements. All measures are binding. Within NAFO landed DSF species are listed in Annex 1.A., along with a quota allocated by country and area. With the exception of Alfonsino, Canada has been awarded quota for all these species, which include cod, redfish, plaice, witch, hake, skate, halibut and alfonsino. Procedures for bycatch species are covered and Article 6, which include the species listed in Annex 1.A. above, when caught in an area where no quota has been set for the Contacting Party or a moratoria has been placed on a particular stock. It outlines the bycatch limits by haul by species and area as either a proportion of the total catch (depending on species and area 4% to 15%) or total weight (1,000 kg to 2,500 kg). Once these limits are reached a move on rule requires the vessel to move away at least 10 nautical miles from the line of tow, it must leave the division for a minimum of 60 hours if a subsequent tow, once moved, again triggers the bycatch limit. The vessel can only return once trial hauls have been undertaken and bycatch falls below the trigger levels. In addition, discarded species are required to be recorded and reported to the Secretariat under Article 5, who will monitor both catches and discards and close areas when certain limits are reached. The recoding and reporting requirements for both target and discard species (including VME) for the vessel are outlined under Article 28. The recording and reporting requirements for the observer are under Article 30 (Chapter V). VME indicators, protection and encounter procedures are covered under Articles 15 to 24 (Chapter II) of the NCEMs. These go through the main definitions, the map of the existing fishing footprint (including coordinates), areas closed to bottom fishing (seamounts, coral areas and VME areas), exploratory fishing procedures including assessment and management of proposed activities, encounter procedures and finally the requirement to conduct a review of these measures in 2023. The encounter procedures include the threshold levels (varied according to species group) and the actions to be taken once a threshold has been reached, the vessel must move away a minimum of 2 nm and the Secretariat shall immediately close the area.

Canada operate a number of inspectors in the NAFO area under the at-sea inspection and surveillance scheme, defined under Chapter VI of the NCEM. This allows and contacting party to board another contracting parties' vessel and check their compliance with the conservation measures. Once an infringement is detected it is notified to NAFO flowing the procedures in Articles 39 and 40, it then relies on the Flag State of the vessel to follow up with a full investigation and act accordingly. Domestic vessels are also monitored by fisheries officers to ensure they are

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[112] Sustainable Use and Conservation Handbook, 2021. Available at: https://www.npfc.int/sustainable-use-and-conservation-handbook-0. Last accessed 01/09/2021.

[113] CMM 2016-03: CMM Interim Transshipment; CMM 2016-04: CMM Vessels without Nationality; CMM 2019-02: CMM Identification of Illegal, Unreported and Unregulated Activities; CMM 2019-06: CMM Bottom Fisheries and Protection of Vulnerable Marine Ecosystems in the Northeastern Pacific Ocean; CMM 2019-07: CMM Chub Mackerel; CMM 2019-10: CMM for Sablefish; CMM 2019-13: CMM Compliance Monitoring Scheme; CMM 2021-01: CMM NPFC vessel registry / vessel markings / general; CMM 2021-05: CMM Bottom Fisheries and Protection of Vulnerable Marine Ecosystems in the Northwestern Pacific Ocean; CMM 2021-08: CMM Pacific Saury; CMM 2021-09: CMM High Seas Boarding and Inspection Procedures; CMM 2021-11: CMM Japanese Sardine, Neon Flying Squid and Japanese Flying Squid; CMM 2021-12: CMM Vessel Monitoring System.

[114] https://www.nafo.int/Portals/0/PDFs/COM/2022/comdoc22-01.pdf

complying with the Fisheries act. Reports of the inspections undertaken and fines imposed (for domestic fleets only) can be found on their site[115].

Fishing effort within NPFC has been relatively light and restricted to the Northeastern Pacific Ocean. They target sablefish on a series of seamounts using longline hook or trap gear, although no vessels have participated in this since around 2019. This of covered under CMM 2019-10. This limits the fishing effort to historical levels except through exploratory fishing, defines the gears that can be used and the requirement for observer coverage. Bottom fishing, including protection of VMEs, is covered for this area under CMM 2019-06. Restriction of the impacts on by-catch (and target) species are limited to placing precautionary effort limits on exploratory fisheries if reliable assessments are not available. Encounter rules for VMEs are triggered when a threshold level is reached for cold water corals, the vessel must move away at least 2 nautical miles, although it is unclear what will happen after that.

The NPFC Technical and Compliance Committee (TCC) is responsible for handling compliance matters[116]. Each Commission Member is expected to report to the TCC regarding monitoring, investigation and penalization of violations to the convention. In a circumstance of infractions, or non-compliance Members are able to take action; if deemed 'serious' vessels may be placed on the 'Illegal, Unreported or Unregulated' (IUU) vessel list. The IUU list is shared with other RFMOs for consideration. In addition, each Member must submit an annual compliance report (under CMM 2019-13), requiring them to show their compliance with CMMs, specifically CMM 2019-05 on bottom fishing and CMM 2019-08 on pacific saury. As Canada did not participate in the fishery, there is no submission from them.

On an international scale, Canada cooperates internationally with a number of organisations:

- UN Convention on Biodiversity (UNCBD) – Through which they had committed through Aichi target 11 to have 17% of terrestrial inland waters and 10% of marine waters to be designated as protected areas by 2020.
- International Union for the Conservation of Nature (IUCN).

In 2019 the Oceanic Partnership Declaration was signed at the Canada-EU summit in Montreal. This was a declaration acknowledging the previous cooperation between the parties and committing to future collaboration on oceanic research and observation, combatting IUU and building on commitments made during the 2018 G7 Leader's Summit. These included the Charlevoix Blueprint for healthy oceans and seas and the Ocean Plastic Charter.

National collaborations have also been developed to set up and maintain protected areas:

- *Canadian Council of Fisheries and Aquaculture Ministers* (CCFAM) – Coordinates policies and programmes in support of a sustainable Canadian oceans sector.
- *Canadian Council on Ecological Areas* (CCEA) – Provides advice and assistance to various groups on matters dealing with protected areas and marine protection.
- *Federal-Provincial-Territorial Conservation, Wildlife and Biodiversity Steering Group* – Works together with relevant government departments to help Canada meet its biodiversity goals and targets.

The ***Canadian Oceans Strategy***[117] (published 2002) outlined a number of initiatives encouraging cooperation between different sectors involved in offshore activities. This includes the Atlantic Ocean: Eastern Scotian Shelf Integrated Management

[115] https://www.dfo-mpo.gc.ca/fisheries-peches/enf-loi/index-eng.html
[116] https://www.npfc.int/compliance
[117] https://waves-vagues.dfo-mpo.gc.ca/Library/264675.pdf

(ESSIM) Initiative, which looked at developing an integrated oceans management plan between key industries. This includes "*fisheries, offshore oil and gas, shipping, maritime defense operations, submarine cables, science, research and development, recreation and tourism, potential offshore minerals development, and marine conservation".* As part of the strategy for managing MPAs, created under the *Oceans Act*, DFO has worked with the *Canada-Nova Scotia Offshore Petroleum Board*. This was to develop protocols and policies to assess the environmental impact of oil and gas activities occurring outside an MPA but that may have an effect on the MPA.

Science advice is provided through the ***Canadian Science Advisory Secretariat*** (CSAS) and published in *Science Advisory Reports, Research Documents* or *Science Responses*[118]. The reports contain advice and information on a number of items, including:

- estimates of past, present, and future stock abundance;
- estimates of fishing pressure;
- estimates of catch and fishery performance;
- estimates of current stock status;
- life history information, such as growth and maturity;
- estimates of reference points;
- information on the ecosystem and environmental conditions affecting the stock, like:
    - oceanographic factors
    - ecological factors
    - climate factors
- options for management measures;
- key uncertainties or factors that are not known that may affect the science advice; and,
- recommendations for future work

CSAS is made up of experts from DFO, organisations such as environmental and NGOs, stakeholders (from the fishing industry, shipping industry, oil and gas), indigenous groups and academia.

Reports and publications are also available from DFO site[119].

Canada currently use a single species approach for most of the stocks they manage but are moving towards a more comprehensive approach through adopting ecosystem based management. This considers the effect of the fishery on a wider set of factors, including impacts to the sea floor.

As mentioned previously, Canada also participates scientifically in a number of RFMOs and provides advice through them. Previously they had provided representatives for NPFC and although still a Member they do not currently actively participate. Within international science organisations they play a key role in the *North Pacific Marine Science Organisation* (PICES) and *International Council for the Exploration of the Sea* (ICES). According to their site the key areas of research and international science cooperation relate to:

- aquaculture;
- oceans health and stressors;
- promoting researcher mobility;
- ocean observation and prediction;
- characterization of the seafloor and the sub-surface;
- data management and information sharing, including oceans literacy; and,
- working with and coordinating around infrastructures, such as measurement buoys and research vessels.

[118] https://www.isdm-gdsi.gc.ca/csas-sccs/applications/Publications/index-eng.asp
[119] https://www.dfo-mpo.gc.ca/science/publications/reports-rapports-eng.html

In 2015 Canada also signed the ***Galway Statement on Atlantic Ocean Cooperation with the EU and the U.S.*** to provide science for the sustainable management of the Atlantic and gain a better understanding of it and its bordering Artic region.

Fishery dependent data are collected through self-reporting by fishers, at-sea observers, dockside monitoring and at-sea electronic monitoring systems and the requirements for data collection can be found on the DFO site[120]. They are used primarily to conduct stock assessments, provide scientific advice and to track in general the health of Canada's fish stocks. Data are available through the Government Open Data Portal[121] and also through the RFMOs (NAFO and NPFC). VME data are routinely collected and submitted to NAFO and, previously, NPFC where they are assessed by the Scientific Committee and used for area management of the fishery, where necessary extending closures, or updating identification guides.

Canada have been conducting regular multi species surveys in NAFO Division 3LN using bottom trawl surveys. While this is a multi-species survey it does take part in a VME closed area and allow some assessment of the species and densities present. These data are submitted on an annual basis and an evaluation is underway to assess any impacts this will have on the VME itself, other non-destructive methods will be considered. Due to other commitments no work on this has been done since 2019 (NAFO, 2021a).

Although not strictly DSF, research on cold water corals sponges has also been ongoing in the Maritimes (an area to the northeast of Canada), including areas of the Scotia Shelf and Gulf of Maine. These started in 1998 with a coral research programme conducting four surveys on the Scotia Shelf and Slope between 2000 and 2003. These used underwater video and photographs to document the distribution. Further work has been undertaken by DFO in the Pacific region, under the *Pacific Region Cold-Water Coral and Sponge Conservation Strategy* (2010-2015) which collected limited through underwater visual surveys.

Data are also collected through Scientific Observers from the commercial fishery on a haul-by-haul basis and submitted to their flag state FMC on a daily basis, which is then forwarded on to the Executive Secretary. Observer trip reports are submitted and forwarded onto the Executive Secretary within 30 days of return to work.

Within Canada, scientific advice is provided by CSAS which is made up of a number of stakeholders including the oil and shipping industry. This work is mainly focused around stock assessments, the effects of climate change and other ecological and oceanographic factors rather than VMEs.

VME protocols for NAFO are outlined in the NCEM under Article 15 to 24 (Chapter II) and in NPFC under CM 2019-10. Threshold levels set by NAFO are group dependent and are set at 7kg for sea pens and/or 60 kg for other live coral and /or 300kg of sponges. This should be reported to the flag State "without delay". Catch and effort data, including VME species are also recorded by the vessel on a haul-by-haul basis. Catch report (CAT), including discards, are reported to its FMC on a daily basis, before 12:00 UTC.

NPFC also operate a move on rule with threshold levels set at 50kg, in total, of cold-water corals or other indicator species with the encounter reported to the Secretariat as soon as possible.

VMEs and VME management are explicit in the management strategy of the two RFMOs that Canada operate in, or have operated in. Canada do operate a number of strategies to protect cold water corals and sponges without specifically referring to VMEs. This has been the basis for the establishment of most of their series of MPAs.

[120] https://www.dfo-mpo.gc.ca/fisheries-peches/sdc-cps/index-eng.html
[121] https://open.canada.ca/en/open-data?_ga=1.34965857.1546288596.1392327917

Fisheries and Oceans Canada's National Vessel Monitoring System (VMS) manage the Canadian VMS and store the data and stored in a centralized database. As well as for compliance purposes, the data can be used for scientific purposes that support departmental activities as well as aid Canada's participation in RFMOs. The reporting intervals are pre-determined. Installation, registration and use of an approved vessel monitoring system is required by the licence conditions for certain Canadian and foreign fishing vessels. A list of approved units along with applications for registration is available from the DFO site[122]. No reports using VMS could be found, however reference to it is included in Canada's MPA management plan as a tool to be used for surveillance and enforcement. The data are publicly available, except on request. Canada has developed software to analyse VMS data which will provide "smart" information to patrol vessels or aircraft to help them identify high risk, non-compliant vessels. Requirements for VMS for Canadian vessels operating in NAFO are given in Article 29 NCEM and in CMM 2021-12 for NPFC.

Fisheries footprint maps[123] for bottom longlines and traps in the Maritimes Region are available (based on commercial logbook data and observer data), as well as fishing effort maps[124] for main bottom fisheries in the Scotian shelf (based on logbook information and VMS data).

Canada ratified the *Port State Measures Agreement* (PMSA) in 2019 which allows authorities to monitor vessels entering their ports and inspect them through trained inspectors, or if necessary, deny entry. Prior to this access policy was monitored through the Coastal Fisheries Protection Act and Regulations (2003).

2.2 – Description of sensitive species and habitats

Many studies have provided species richness and diversity estimates of VME taxa in Canadian waters. Some main studies are summarized below:

- During 2010, a CSAS meeting was held to identify ***Sensitive Benthic Areas*** (SeBAs)[125] (corals and sponges) in Canadian waters (DFO, 2010). At that meeting the KDE-based approach used by NAFO was presented (Kenchington *et al.,* 2010) and through that process, and with early support by a segment of the fishing industry, a unique population of glass sponges (*Vazella pourtalesii*) on the Scotian Shelf was identified. In 2013, two areas were closed to protect those sponges from the harmful effects of fishing and they became the first area closure under this policy. At the CSAS meeting, an alternative approach to identification of sensitive benthic areas was used by scientists in the Pacific Region. There, available data supported Maxent species distribution modelling (SDM) as a useful management tool for identification of the distribution of sensitive benthic taxa. Subsequently, species distribution modelling was explored on the east coast, first with sponge grounds from the Laurentian Channel to the eastern Arctic (Knudby *et al.*, 2013a), and latterly to black corals, sea pens and large gorgonian corals

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[122] https://www.dfo-mpo.gc.ca/fisheries-peches/sdc-cps/vessel-monitoring-surveillance-navire/index-eng.html

[123] https://publications.gc.ca/site/archivee-archived.html?url=https://publications.gc.ca/collections/collection_2019/mpo-dfo/Fs97-6-3293-eng.pdf

[124] https://www.dfo-mpo.gc.ca/csas-sccs/Publications/ResDocs-DocRech/2018/2018_015-eng.html

[125] Sensitive Benthic Area (SeBA) is defined as an area that is vulnerable to a proposed or ongoing fishing activity. SeBAs (not to be confused with SiBAs) are defined based on their exposure to fishing activities. The SiBAs, or portions thereof, that are likely to be exposed to proposed or ongoing fishing activities, are then considered SeBAs. Vulnerability is determined based on the level of harm that the fishing activity may have on the benthic area by degrading ecosystem functions or impairing productivity and is not addressed herein. See: DFO (2017b). In 2019, DFO acknowledged that there has been confusion in previous literature regarding the use of the terms Significant Benthic Areas and Sensitive Benthic Areas. According to DFO, in order to clearly differentiate these terms, the use of the acronym SBA has been waived. Therefore, in this document we will refer to Significant Benthic Areas as SiBAs, and Sensitive Benthic Areas as SeBAs (see Figure 5).

within the NAFO Regulatory Area on Flemish Cap and the Nose and Tail of Grand Bank (Knudby *et al.*, 2013b). SDMs have the added characteristic in that they can more broadly interpolate and extrapolate predictions to areas not surveyed by the trawls but are within the environmental domain of the occurrence data.

- Kenchington *et al.* (2019) used kernel density estimation (KDE) to create a modelled biomass surface for sponges (Porifera), large and small gorgonian corals (Alcyonacea), and sea pens (Pennatulacea), and applied a method to identify significant concentrations in various locations of Eastern Canada (following Kenchington *et al.,* 2010 and 2014). KDE utilizes spatially explicit data to model the distribution of a variable of interest. DFO research vessel trawl survey data (RV) was used for the KDE analyses and for the response data in the species distribution models. In some regions, data from scientific surveys with underwater cameras and commercial observer data were used to improve SDM performance. This study presents SDM of these taxa for five geographic areas based on DFO MPA planning boundaries: Maritimes Region, the Gulf Region (Gulf and Quebec DFO administrative regions), Newfoundland and Labrador Region, Hudson Strait and the Eastern Arctic.
- Kenchington et al. (2014) applied KDE to research vessel trawl survey data from inside the fishing footprint in NAFO to create biomass density surfaces for four VME indicator taxa: large-sized sponges, sea pens, small and large gorgonian corals. These VME indicator taxa were identified previously by NAFO using the fragility, life history characteristics and structural complexity criteria presented by FAO, along with an evaluation of their recovery trajectories. The study presents a novel approach of examining relative changes in area under polygons created from encircling successive biomass categories on the KDE surface to identify ''significant concentrations'' of biomass, which we equate to VMEs. This allows identification of the VMEs from the broader distribution of the species in the study area.
- Chu *et al.* (2019) modelled the environmental niche space and distributions of cold-water corals and sponges in the Canadian northeast Pacific Ocean (NEPC). The study used a diverse set of environmental data layers representing a range of bathymetric derivatives, physicochemical variables, and water column properties to assess the primary factors influencing the niche separation and potential distributions of six habitat-forming groups of cold-water coral and sponge (CWCS) in the NEPC (sponge classes: Hexactinellida, Demospongiae; coral orders: Alcyonacea, Scleractinia, Antipatharia, Pennatulacea).
- Kenchington et al. (2016) Delineated coral and sponge SiBAs in eastern Canada using kernel density analyses and species distribution models.

In the NAFO Convention Area, a list of VME species/ taxa are provided by VME area. General biology and a physical description of the environment is provided for each VME. The NPFC have developed a taxa ID guide for the Western North Pacific Ocean[126]: Physical descriptions, size information and locations are provided. Approaches for identifying VMEs is based on analysis of catches, direct analysis of visual data from cameras, and on predictions from SDMs. As an example, NAFO have previously analyzed catch data from KDE analyses to identify areas with significant concentrations of VME indicators (Kenchington *et al.,* 2014 – see below). For the NPFC, Annex 2 of CMM2019-05 and CMM2019-06 specifically identifies biological samples, visual data, and "other information that is relevant to inferring the likely presence of VMEs" to be used in defining VMEs (NPFC 2019 and 2021).

No specific definitions for VMEs are provided by DFO, they refer to cold water corals and sponges. The only definitions are provided by NAFO and NPFC.

[126] https://www.npfc.int/system/files/2020-09/NPFC%20VME%20taxa%20ID%20guide.pdf.

Although the processes towards protecting cold-water coral and/or sponge-dominated habitats have advanced differently in DFO and NAFO, and some of the details of these processes differ, the fundamental ecological features and key definitions are consistent across jurisdictions (DFO, 2017a)[127]. With respect to cold-water coral and sponge-dominated habitats, the concepts of ***Significant Benthic Areas***[128] (SiBAs) and VME are equivalents. Figure 5 shows the conceptual model showing the relationship of corals or sponges high concentration location (based on high research vessel trawl catch locations) to SiBAs, and where the overlap of a fishing activity leads to possible SeBAs.

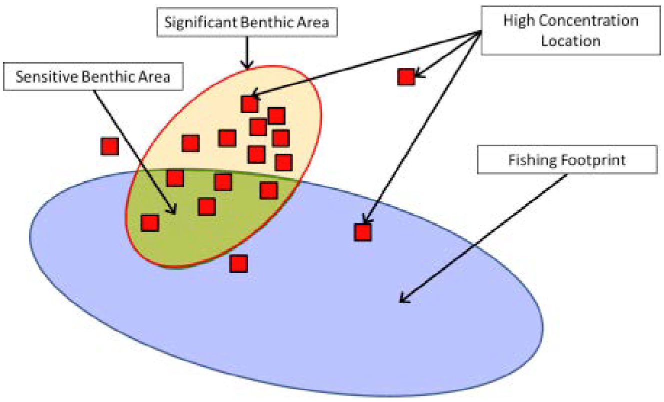

Figure 5. Conceptual model showing the relationship of corals or sponges high concentration location (based on high research vessel trawl catch locations) to SiBAs, and where the overlap of a fishing activity leads to possible SeBAs. Source: DFO (2017b).

Similarly, the notion of ***Serious or Irreversible Harm*** (SIH) used by DFO is analogous to *Significant Adverse Impact* (SAI) used by NAFO. Also, the functional groups used to define SiBAs and VMEs are consistent between DFO and NAFO. This consistency in principles and approaches provides a robust basis for coherent management practices at functional ecosystem scales, irrespective of legal boundaries, as well as cross applications and inferences from analyses done in both jurisdictions.

NAFO's description of a VME refers to paragraphs 42 and 43 of the FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas. NPFC has identified four orders of corals as indicators of potential VMEs but has not yet developed objective and quantitative definitions of VMEs based on catches, visual surveys, predictive models, or other sources of information (Curtis et al., 2020). Part of the reason that a process for identifying and protecting VMEs has not been established yet by NPFC Members, is the lack of clarity around the definition of what constitutes a VME.

The different types of VMEs found in Canadian waters as well as in the RFMOs which operate DSFs in waters to the east and west of Canada (NAFO and NPFC) are summarized in Table 1.

[127] DFO (2017a) Guidance on the level of protection of significant areas of coldwater corals and sponge-dominated communities in Newfoundland and Labrador waters. DFO Can. Sci. Advis. Sec. Sci. Resp. 2017/030.

[128] With respect to coldwater corals and/or sponges, a Significant Benthic Area (SiBA) is a regional habitat that contains sponges (Porifera), large and small gorgonians (Alcyonacea, formerly classed as Gorgonacea) and/or sea pens (Pennatulacea) as a dominant and defining feature. These habitats are structurally complex, characterized by higher diversities and/or different benthic communities, and provide a platform for ecosystem functions/processes closely linked to these characteristics. See: DFO (2017b).

Table 1. Summary of different types of VMEs found in Canadian waters as well as in the RFMOs which operate DSFs in waters to the east and west of Canada (NAFO and NPFC).

RFMO/ Specific Area of Canada	VME type and dominant species Use geomorphological characters (e.g. seamount flank) or others as appropriate.	Dominant VME habitat types	Depth	Life history characteristics of fish/ invertebrates	Other physical features	Reference/ source
NE Pacific region of Canada (within EEZ boundaries and adjoining high seas)	Cold-water coral and sponge communities (CWCS). CWCS identified as VME indicator species in other regions: four orders of corals ('soft corals' Alcyonacea, 'stony corals' Scleractinia, 'black corals' Antipatharia, 'sea pens' Pennatulacea) and two classes of sponges ('glass sponges' Hexactinellida, 'demosponges' Demospongiae)	>80% of Canada's seamounts	500-1400 m		Primary environmental gradients that influence niche separation among CWCS are driven by total alkalinity, dissolved inorganic carbon, and dissolved oxygen. The largest continuous area of potential CWCS habitat occurred along the continental slope with smaller, isolated patches also occurring at several offshore seamounts that have summits that extend into oxygen minimum zone depths.	Chu et al., 2019
Eastern Canada (various localities)	**Martimes region** Sponges (Porifera) *V. pourtalesi* Sea pens (Pennatulacea) Large Gorgonian corals Small Gorgonian corals **Gulf of St Lawrence** Southern portion of the Gulf Biogeographic Zones Northern portion of the Gulf Biogeographic Zones **Newfoundland and Labrador Shelves** Sponges (Porifera) Sea pens (Pennatulacea) Large Gorgonian corals Small Gorgonian corals **Hudson Strait** Sponges (Porifera) **Eastern Arctic** Sponges (Porifera)		Various			Beazley et al., 2018 Kenchington et al., 2019

RFMO/ Specific Area of Canada	VME type and dominant species Use geomorphological characters (e.g. seamount flank) or others as appropriate.	Dominant VME habitat types	Depth	Life history characteristics of fish/ invertebrates	Other physical features	Reference/ source
	Sea pens (Pennatulacea) Large Gorgonian corals Small Gorgonian corals					
Cobb seamount, NPFC CA	Comprehensive list of VME types that meet the FAO criteria (19 groupings in total): The taxonomic groups were soft corals (order Alcyonacea), black corals (order Antipatharia), stony corals (order Scleractinia), hydrocorals (family Stylasteridae), sea pens (order Pennatulacea), the crinoid Florometra serratissima, the giant scallop Crassadoma gigantea (presence only; individuals could not be confidently resolved from the continuous and encrusted mats of this taxon), and glass sponges (class Hexactinellida). General location was a mixture of seamount flanks and on the summit.	Seamounts	Various, ranging from 225 – 1200 m		Physical complexity Diverse VME taxa are fuelled by an upwelling of nutrient-rich deep water and a Taylor cone, enhanced primary productions, trapping of diurnally migrating deep scattering layers and *in situ* primary productivity (e.g. kelp forests on the pinnacle and encrusting algae to 200 m).	Du Preez et al., 2020
NAFO CA	**Beothuk knoll** Large gorgonians and sponges **Flemish Cap** Sea pens Gorgonian corals Sponges Camera surveys along the East of Flemish Cap showed high densities of the stalked crinoids *Gephyrocrinus grimaldii* together with several structure-forming sponges inside the closed area. **Flemish pass/ Eastern Canyon** The dominant sponge species in biomass are demosponges of the order Astrophorida. Geodiids (mostly *Geodia barretti*), *Stelletta normani* and *Stryphnus ponderosus* occur in the deeper water. These large-sized	Physical VME elements include the Beothuk Knoll, steep flanks, and canyons with heads greater than 400 m. Submarine canyons, steep cliffs, shelf-indenting canyons	>400 m 500 – 1200 m		Beothuk Knoll is a discrete steep-sided plateau that forms an abrupt projection from the southwest edge of Flemish Cap. The sediment drifts adjacent to Beothuk Knoll consist of sands. Knolls are recognized as VME Elements.	http://www.fao.org/fishery/vme/29740/171175/en

RFMO/ Specific Area of Canada	VME type and dominant species Use geomorphological characters (e.g. seamount flank) or others as appropriate.	Dominant VME habitat types	Depth	Life history characteristics of fish/ invertebrates	Other physical features	Reference/ source
	sponges, sometimes reach sizes of more than 25 cm in diameter. These sponge grounds have been shown to house high species diversity compared with non-sponge ground habitat at similar depths. The area was subsequently expanded to include protection for large gorgonian corals in Flemish Pass. Some sponge, large gorgonians and seapen VMEs have been identified outside the closure. **Northern Flemish Cap** Sea pens Crinoids and Cerianthids Black corals					
Flemish Cap, international waters off Newfoundland (3LMNO management division)	Large structure-forming demosponges, including *Geodia barretti, G. phlegraei, G. macandrewii* (Geodiidae), *Stryphnus fortis* and *Stelletta normani* (Ancorinidae).		50-2000 m		The Flemish Cap supports higher primary productivity and secondary production as a result of its hydrodynamic conditions (especially compared to adjacent Grand Banks) (Maillet et al. 2005).	Pham et al., 2019

2.3 – Assessment of bottom fishing impacts

The main bottom fisheries in the Case Study Area are the following:

Canadian fisheries in the Pacific

Pacific and Yukon commercial fisheries: There are seven distinct commercial groundfish sectors: Groundfish trawl, Halibut, Sablefish, Inside Rockfish, Outside Rockfish, Lingcod, and Dogfish fisheries that are managed according to the measures set out in this management plan. The management of these sector groups is integrated, with all groups subject to 100% at-sea monitoring and 100% dockside monitoring, individual vessel accountability for all catch (both retained and released), *individual transferable quotas* (ITQ), and reallocation of these quotas between vessels and fisheries to cover catch of non-directed species. There are approximately 250 active commercial groundfish vessels[129].

Rockfish: There are 37 species of rockfish that are caught in fisheries off the coast of British Columbia. Inshore rockfish species (which include yelloweye, quillback, copper, china, and tiger) are usually caught with hook and line gear in rocky reef habitats. Rockfish conservation strategy is designed to alleviate further rockfish population decline through catch restrictions, fishery monitoring, stock assessment programs, and *Rockfish Conservation Areas* (RCAs) are established throughout the BC coast. Within RCAs, inshore rockfish are protected from all mortality associated with recreational and commercial fisheries.

Canadian fisheries in the Atlantic

Groundfish species – NAFO Divisions 3Ps[130]. There are currently various directed and by-catch groundfish fisheries in Div.3Ps: American plaice, Atlantic halibut, cod, Greenland halibut (turbot), grenadier, haddock, lumpfish, monkfish, pollock, redfish, skate, white hake, winter flounder (blackback), witch flounder (greysole), and yellowtail. Several of these species are under moratorium.

There are seven distinct fleets sectors involved in the commercial groundfish fishery in Div. 3Ps. They include: Offshore (>100' in length overall), Midshore (65-100') fixed gear, Midshore (65-100') mobile gear, Nearshore (<65') mobile gear, Nearshore (40-65') fixed gear, Inshore (<40') fixed gear and commercial communal. The management of these sector groups is integrated, with all groups subject to at-sea and dockside monitoring. Most fleets and fisheries are subject to *Enterprise Allocation* (EA) or *Individual Quota* (IQ) management regimes. Where such regimes are not in place similar management tools such as trip limits, trip permits or harvest caps are often used. DFO is committed to working with industry to identify opportunities for moving towards IQs as a means of increasing economic viability for harvesters. There is a mixture of both fixed and mobile gear types used for 3Ps groundfish landings, with fixed gear accounting for approximately 74.4% of the landings from 2011-2015. In the <65' fixed gear fleets gillnets predominate, while in the offshore fleet bottom otter trawls are the predominant gear type (Table 2).

Table 2. 3Ps Groundfish landings by gear.

3PS Groundfish Landings (Tonnes) – by Gear Type and Year

	2011	2012	2013	2014	2015
Fixed Gear	5,467	4,747	3,429	5,489	4,339
Mobile Gear	2,306	1,535	993	729	2,525

[129] Fisheries and Oceans Canada. 2021. Groundfish Integrated Fisheries Management Plan 2021/22. https://publications.gc.ca/collections/collection_2021/mpo-dfo/Fs144-36-2021-eng-1.pdf

[130] https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-div3p-2016-eng.html#toc1.4

An *Integrated Fisheries Management Plan* (IFMP) for the division serves to identify main objectives and requirements for groundfish stocks in NAFO Divisions 3Ps. In terms of governance the fishery is managed by the following regulations and legislation:

- The *Fisheries Act* and the regulations made thereunder;
    - *Atlantic Fishery Regulations* (1985),
    - *Fishery (General) Regulations* (1993),
    - The *Aboriginal Communal Fishing Licences Regulations* (1993),
- The *Oceans Act*; and
- The *Species at Risk Act*.

Fishery renewal efforts on current initiatives aim to support sustainable fisheries across Canada under its Fisheries Renewal Initiative. Current Fisheries Renewal projects include:

- The expansion of efforts to manage fisheries using multi-year science advice and multi-year management plans incorporating harvest levels and other primary management measures;
- The requirement for all fishers to cover business costs related to tags and logbooks where they are deemed an ongoing requirement (in line with the policy that those who benefit from the use of the resource be required to assist in paying for the management of the resource);
- The implementation of a suite of services to the fishing industry including online purchasing and renewal of commercial fishing licensing services, issuance of licence conditions, approval of designations and quota transfers; and,
- Legislative and policy changes with regard to use of fish or fishing gear to fund joint project agreements (described further below).

Groundfish Newfoundland and Labrador region – NAFO Subarea 2 + Divs. 3KLMNO[131]. The groundfish fishery is primarily commercial, with recreational and Indigenous (Food, Social and Ceremonial) components.

The following species are currently taken in directed commercial groundfish fisheries or as bycatch: American plaice, Atlantic cod, Atlantic halibut, Greenland halibut (turbot), grenadier, haddock, lumpfish, monkfish, redfish, skate, white hake, winter flounder (blackback), witch flounder (greysole), and yellowtail flounder. There are eight distinct domestic fleet sectors involved in the commercial groundfish:

- offshore (vessels greater than 100′ in length overall)
- Scandinavian longliners (greater than 100′), fixed gear
- midshore (65-100′), fixed gear
- midshore (65-100′), mobile gear
- nearshore (less than 89′), mobile gear
- nearshore (40-89′), fixed gear
- inshore (<40′), fixed gear
- commercial communal

The management of these sector groups is integrated, with all groups subject to at-sea and dockside monitoring. Most fleets and fisheries are subject to *Enterprise Allocation* (EA) or *Individual Quota* (IQ) management regimes; however, where these management regimes are not in place, similar management tools are often used, such as:

- weekly limits;
- trip limits;
- trip permits; and

[131] https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/2020/groundfish-poisson-fond-2_3klmno-eng.htm#toc1.2

- harvest caps.

In 2017, there were a total of 2,543 commercial licensed enterprises for groundfish in 2+3KLMNO (all fleets). These harvesters were based primarily in northeastern and eastern Newfoundland coastal communities in Division 3L (52.6%) and 3K (41.8%), with a small number of harvesters based in Labrador in Divisions 2J (5.6%) and 2H (0.04%). Of the total number of licensed enterprises, 1,638 (65%) were active in 2017 (as defined by having landings), and operated 1,863 vessels. Groundfish is harvested in 2+3KLMNO using both fixed and mobile gear to target a number of species, with several stocks under moratorium[132]. The fixed gear fishery uses primarily gillnets, as well as handlines, longlines, and cod pots to a lesser extent. The mobile gear fishery uses primarily bottom otter trawl. The specific authorized gear used varies by fishery, and is specified in licence conditions provided to fish harvesters. Fleet sectors are based on vessel size and gear type. Several groundfish stocks in NAFO Subarea 2 and Divisions 3KLMNO are managed exclusively by Canada, with TACs and other management measures established by DFO. Some other groundfish stocks that straddle Canada's 200-mile limit and discrete stocks on the Flemish Cap (3M) are managed by NAFO.

Most independent surveys focus on identifying VMEs, which will ultimately be used to inform potential bottom fishing impacts. The DFO, Newfoundland Region, has undertaken stratified-random surveys since the early 1970's. Research vessel (RV) bottom trawl surveys are carried out annually for the assessment of fish stocks by Canada and EU/Spain/Portugal. Pham *et al.* (2019) utilized data from these surveys to examine SAIs on the removal of deep-sea sponge by bottom trawling in the Flemish Cap.

In the eastern coast of Canada, annual research vessel trawl surveys provided distribution and diversity data to underpin the *Coral and Sponge Conservation Strategy* (DFO, 2015). Trawl data was used to delineate concentrations of sea pens, gorgonian corals and sponges applying the NAFO methodology as well as to predict VMEs distributions (Durán Muñoz *et al.*, 2020).

Moreover, there are several successful examples about international collaboration between NAFO contracting parties to address the study and protection of VMEs within the NAFO Regulatory Area: (i) sharing and multiple use of groundfish survey data (Kenchington *et al.* 2014), (ii) collection of ecosystem data through the NEREIDA programme lead by Spain with contribution from Canada, UK and Russia (https://www.nafo.int/About-us/International-Cooperation), (iii) ATLAS (www.eu-atlas.org) and SPONGES (http://www.deepseasponges.org) international research projects funded by the EU, which provided results, based on groundfish survey data, supporting the advice on VMEs.

The At-Sea Observer Program provides independent third-party verification of fish harvesting activities. Observers are assigned to fishing vessels operating in the offshore, inshore and near-shore areas. The program provides accurate and timely information on fish harvests. It also provides scientific catch and sampling data. The fishing industry and the department use this information for fisheries management and scientific research purposes. Commercial fishers make agreements with service providers qualified by the Canadian General Standards Board and designated by Fisheries and Oceans Canada.

Most studies in the literature do not attempt to quantify consequences of SAIs on VMEs, but rather identify and define VMEs and determine whether the impacts of fishing gear to VMEs they create qualify as a SAI (e.g. Du Preez *et al.* 2020). Thus requiring actions be taken to prevent these impacts—requires consideration of six factors identified by FAO (2009), the NPFC (2017, 2018) and NAFO.

[132] https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/2020/groundfish-poisson-fond-2_3klmno-eng.htm#tab-1

DFO carried out a Canadian Science Advisory peer-reviewed science meeting to document the pathways of effect and benthic impact of all non-mobile fishing gear used across Canadian waters[133] (DFO 2010). In terms of methods and analysis of Significant Adverse Impacts (SAI) assessment on VMEs, preliminary assessments are often undertaken to address (a) the intensity or severity of the impact at the specific site being affected; (b) the spatial extent of the impact relative to the availability of the habitat type affected, and; (c) the sensitivity/vulnerability of the ecosystem to the impact.

For NPFC and Canada methods used in impact assessments are summarized below for the Cobb seamount (see NPFC, 2009):

(a) The intensity or severity of the impact at the specific site being affected For the years 1995-2011 the sablefish fishery (a long-lined trap fishery) on Cobb Seamount was carried out at depths ranging from 300-1600 m. Locations, depths, longline length, and trap size from each fishing event (sets; n = 611) were recorded in logbook and observer programs and obtained from Fisheries and Oceans Canada databases (PacHarv and GFFOS; 1995 - 2011). These metrics were used to determine the area impacted by the fishery under two scenarios. The total length of the long-line string was used in the analysis, as the long-line is also capable of impacting VMEs through entanglement and by shearing actions during retrieval. The two scenarios were:
Scenario 1: area impacted = string length * trap size
Scenario 2: area impacted = string length * (trap size * 1.5) – this assumes a moderate degree of gear dragging during the retrieval process.

(b) The spatial extent of the impact relative to the availability of the habitat type affected. The spatial extent of the impacts were calculated for each 100 m depth range by dividing the total area impacted for that depth range by the total area available in that depth range.

(c) The sensitivity/vulnerability of the ecosystem to the impact. Ecosystem components for which sensitivity/vulnerability are to be assessed are corals and sponges that meet some or all of the criteria outlined for VMEs in the *FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas* (FAO, 2009) and the *Canadian Policy for Managing the Impact of Fishing on Sensitive Benthic Areas* (DFO, 2013; DFO, 2014). Any dislocation or damage to the organisms considered in this report is assumed to cause mortality and have a significant adverse impact (as defined by FAO and the guidance document for this RFMO).

On the Atlantic coast, specifically Newfoundland and Labrador region, NAFO conducted its first assessment on VMEs in 2016 (FAO, 2009). This was guided by the six criteria[134] for significance and scale of impacts described by the FAO guidelines (FAO, 2009). The NAFO SAI-VME assessment mostly addressed FAO criteria i-iii, which together characterize the direct impacts of fishing. Criteria iv-vi address functionality of VMEs and were of secondary focus in the assessment due to data and knowledge limitations, including the difficulty of properly quantifying VME ecological functionality. However, these function-focused criteria were still considered with

[133] A Canadian Science Advisory Secretariat (CSAS) science advisory process to examine the impacts of trawl gears and scallop dredges on benthic habitats, populations and communities was held in March 2006. An additional science advisory process was held in January 2010 to examine the impacts of other fishing gears (excluding bottom trawls and dredges), to assemble available information on their uses and to provide scientifically-based conclusions and advice regarding their potential impacts on marine habitats and biodiversity. This science advisory report contains the conclusions and advice from that meeting. https://www.dfo-mpo.gc.ca/csas-sccs/publications/sar-as/2010/2010_003-eng.htm

[134] (i) The intensity or severity of the impact at the specific site being affected; (ii) The spatial extent of the impact relative to the availability of the habitat type affected; (iii) The sensitivity/vulnerability of the ecosystem to the impact; (iv) The ability of an ecosystem to recover from harm, and the rate of such recovery; (v) The extent to which ecosystem functions may be altered by the impact; (vi) The timing and duration of the impact relative to the period in which a species needs the habitat during one or more of its life-history stages.

qualitative data such as descriptions of communities associated with VMEs, transitions in VME communities with depth, comparisons with non-VME areas, observations of specific associations between fish and VMEs, observations of lack of recovery in specific locations within the study period, and available studies on coral growth rates.

A central piece of the NAFO SAI-VME analysis[135] was the identification of areas considered to be at low risk of SAI (i.e. portions of VMEs currently protected by closures or outside the NAFO footprint), areas at high risk of SAI (portions of VMEs exposed to levels of fishing effort which are still consistent with the occurrence of VME taxa with higher biomass densities), and impacted areas (portions of VMEs exposed to high enough levels of fishing effort so that occurrence of VME taxa is characterized by very low biomass densities; NAFO, 2016). The discrimination between high risk and impacted areas was based on the analysis of cumulative VME biomass curves as a function of average fishing effort within delineated VMEs using a 1x1 nautical mile grid, and where the effort cut-off point between high risk and impacted was defined by the 95th percentile of the cumulative biomass curve (Fig. 1, NAFO 2016). In addition to this characterization, the NAFO SAI-VME analysis also considered the spatial arrangement of VME units within the ecosystem and the level of protection provided to the entire VME distribution, the co-occurrence of multiple VME types in a given area, the relative tolerance of different VME types to fishing, and the stability/variability of fishing impacts on VMEs (NAFO, 2016).

2.4 – Mapping of sensitive species and habitats

While not specific to VMEs, Canada has a programme in place to coordinate cold-water coral and sponge conservation. This is managed by the ***Centre of Expertise (CoE) in Cold Water Corals and Sponge Reefs***[136], established in 2008 and funded through the DFO.

The *Pacific Region Cold-water Coral and Sponge Conservation Strategy*[137] codifies existing and future activities and management measures for cold-water coral and sponge conservation by the Department. It helps regional partners and stakeholders understand how our existing programs and activities are aligned with cold-water coral and sponge conservation by presenting objectives, strategies and actions in a transparent manner. It also aligns with the Department's Sustainable Fisheries Framework and the Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas. The strategy includes the Strait of Georgia and Howe Sound Glass Sponge Reef Conservation Areas.

The *Coral and Sponge Conservation Strategy for Eastern Canada*[138] has been developed to outline the current state of knowledge of corals and sponges, to provide the international and national context for coral conservation, and to outline new and existing research and conservation efforts in eastern Canadian waters. The Strategy identifies conservation, management, and research objectives common to all five Fisheries and Oceans Canada management regions in eastern Canada (Central and Arctic, Quebec, Gulf, Maritimes, and Newfoundland and Labrador) consistent with existing legislation and policy through a shared focus on ecosystem-based management. Benthic mapping has also been extensively to develop the series of MPAs.

Data on corals and sponges in this region has primarily been collected opportunistically from three main data sources:

[135] For more detailed information on SAI assessments see DFO (2017a).
[136] https://www.dfo-mpo.gc.ca/oceans/ceccsr-cerceef/info-eng.html
[137] https://publications.gc.ca/site/eng/9.693309/publication.html
[138] https://www.dfo-mpo.gc.ca/oceans/publications/cs-ce/index-eng.html

- annual DFO multispecies research vessel surveys conducted by the the Science Branch;
- fisheries observer data, collected onboard commercial fishing vessels operating within Canadian waters; and,
- the northern shrimp survey (DFO and industry collaboration).

These mainly rely on trawling and will be prone to bias towards certain types of sea floors. Fisheries observer data will be taken from commercial fishing vessels and biased towards areas considered 'good fishing grounds', whereas survey data may be biased towards more 'trawlable areas' (i.e. flatter seabeds). Non-intrusive data techniques are also employed including multibeam sonar, video footage and drop cameras, acoustic sub-bottom profiling and dedicated ROV deployments (Fisheries and Oceans Canada, 2015). Data collected from these types of surveys are used to characterise the geological basis on the occurrence of different types of coral habitat, a quantification of the coral and sponge diversity and a comparison between coral and sponge diversity in fished and unfished areas (Fisheries and Oceans Canada, 2015). Examples of this include a number of studies into the distribution of corals off the eastern coast of Canada and the biotic and abiotic features associated with them, using ROVs (e.g. Baker *et al.* 2012).

Within NAFO Canada conduct an annual multi-species trawl survey within a VME closed area (map coordinates are given within the CMMs). The effects of the trawl survey on the VME are still under assessment by the Scientific Council, under consideration is how switching to a non-destructive methods will impact the series of data and subsequent assessments. Canada operates an at sea observer programme funded through the industry who since 2013 have assumed the full costs of the programme. Observers monitor fishing activities, collect scientific data and monitor industry compliance. They do not specifically collect VME data, except when operating within an RFMO as described above, but will collect data on benthic bycatch.

DFO, in collaboration with university, NGO and industry partners began collecting information on corals and sponges in 1998 to map out their distributions in the Maritimes. This became a full four-year research plan between 2000 and 2003 and was funded by the *Environmental Research Fund* (ESRF).

Maps of the location of significant concentrations of corals and sponges on the east coast of Canada[139], were produced by the DFO (Kenchington *et al.,* 2016) through quantitative analyses of research vessel trawl survey data, supplemented with other data sources where available. Sponge reef areas of the Pacific Region[140] are available, derived from sponge data mapped by Natural Resources Canada (NRCan) and DFO.

Cooperation with the oil and gas industry comes under the *Oceans Act* which describes the strategy for managing MPAs. Through this works with the Canada-Nova Scotia Offshore Petroleum Board to assess the potential damage to, among other things, benthic species, from oil and gas activities outside the MPA. There are no surveys specifically looking at impacts to VME species, although all offshore construction work including the oil and gas industry must submit an environmental impact statement[141] which includes an assessment on the impact on vulnerable marine ecosystems. The data and information are password protected.

Canada does not recognize VMEs as such within its waters but instead cold-water corals and sponges. The extent of VME species by the NAFO and NPFC are mapped out by the RFMO.

[139] https://www.dfo-mpo.gc.ca/csas-sccs/Publications/ResDocs-DocRech/2016/2016_093-eng.html
[140] https://open.canada.ca/data/en/dataset/8ba7bced-b63f-462a-a8a1-7c7c8a7bcfa4
[141] https://iaac-aeic.gc.ca/050/evaluations/index?culture=en-CA

2.5 – Impact mitigation and protection measures

Canada has an EEZ of 5,599,077 km^2 divided into thirteen bioregions[142]. Canada's full ocean estate extend beyond 200 nm to encompass the extended continental shelf (7.1 million km^2). A number of Ecologically and Biologically Significant Areas (EBSAs)[143] have been identified for large portions of Canada's Atlantic, Pacific and Arctic oceans. In addition, there are 34 marine refuges[144] (Figure 6) in place representing approximately 283,365 km^2, or just under 5% of the EEZ area. The DFO set a goal of protecting 10% of Canada's marine and coastal areas by 2020 to meet the Aichi target. By the end of 2015 they had reached 1% which had increased up to 13.8% (772,672 km^2) by the end of 2020. The current target is set at 30% by 2030 (DFO, 2021c).

Figure 6. Marine refugees in Canada (Source: https://www.dfo-mpo.gc.ca/oceans/maps-cartes/conservation-eng.html).

Regarding the high seas, VME closures and VME encounter rules are in place in the NAFO and NPFC areas (see section 2.1). In addition, encounter thresholds and move-on rules were voluntarily adopted in two domestic fisheries for compliance with MSC certification (Walmsley *et al.,* 2021).

Within Canadian waters, DFO have a policy in place for identifying and managing the impacts from fishing on *Sensitive Benthic Areas* (SeBAs) contained within their *Sustainable Fisheries Framework* (SFF). Fishery closures to protect SeBAs can also considered to be other Effective *Area-Based Conservation Measures* (OEABCM), or area-based measures that are put in place, other than MPAs, to protect areas that meet certain criteria. SeBAs are established through first identifying *Significant Benthic Areas* (SiBAs), while these are defined as VMEs they are areas that would be considered intrinsically sensitive to fishing impacts, made up of sponges and corals,

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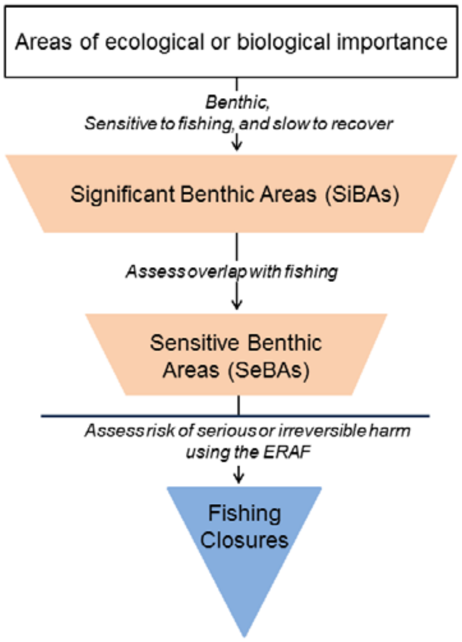
[142] Spatial units in Canada's waters that are defined by their attributes and similarities, and which inform marine planning exercises (e.g. MPA network development). https://www.dfo-mpo.gc.ca/oceans/maps-cartes/bioregions-eng.html

[143] https://open.canada.ca/data/en/dataset/d2d6057f-d7c4-45d9-9fd9-0a58370577e0

[144] Fisheries area closures that meet *"other effective area-based conservation measures"* criteria are known as "marine refuges". Marine refuges help protect important species and their habitats, including unique and significant aggregations of corals and sponges. They have specific conservation objectives and fishing gear restrictions. See the list of marine refugees in: https://www.dfo-mpo.gc.ca/oceans/oecm-amcepz/refuges/index-eng.html. See OECM definition in: https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/conserved-areas.html#definitions

assessed using criteria based on the FAO guidelines. Areas within a SiBA likely to be exposed to proposed or ongoing fishing activities are identified as SeBAs (see section 2.2). The criteria to identify a SiBA are taken from a number of different frameworks and cover species, habitats and communities. They are those defined under VMEs, EBSAs, *Ecologically Significant Species* (ESS) and *Significant Ecosystem Components* (SECs) (DFO, 2019). The decision tree for identifying and creating a SiBA and the flowchart outlining the process used to identify SiBAs and SeBAs are given in



(b)

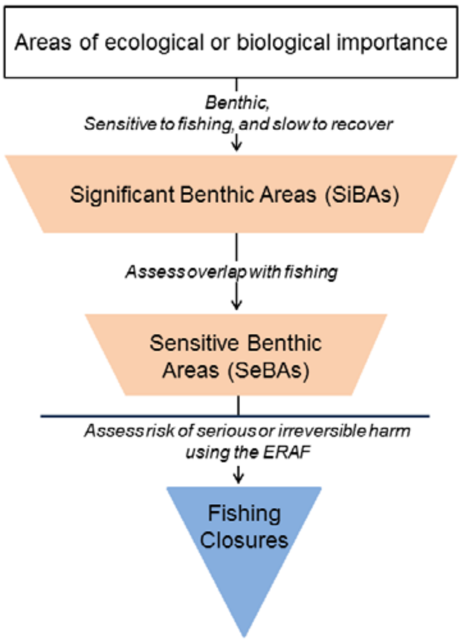
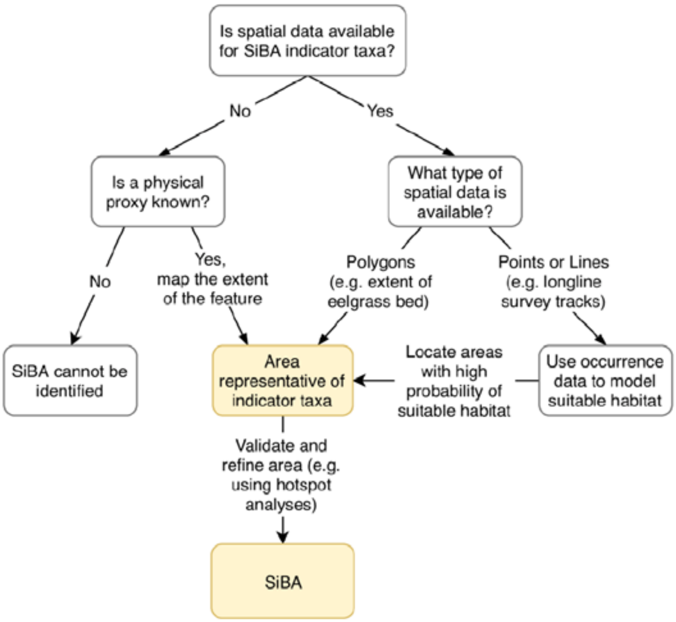


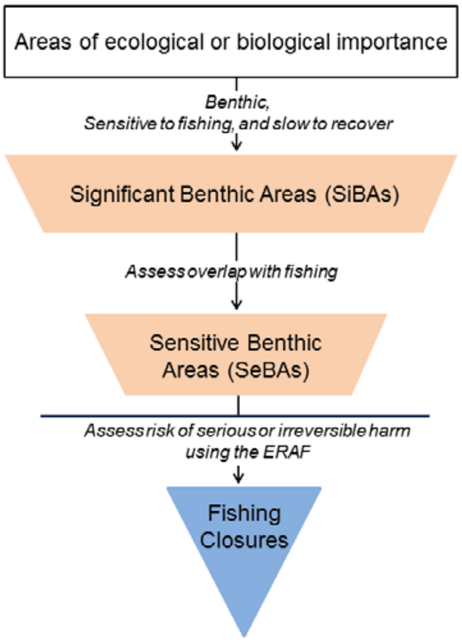
Figure 7a and

(b)

Figure 7b respectively.



(a)



(b)

Figure 7. (a) Decision tree used to facilitate the creation of Significant Benthic Areas (SiBAS) with a range of input data types. SiBA indicator taxa are species or groups of species identified by relevant frameworks (VME, EBSA, ESS or SEC) and that are benthic and sensitive to fishing. **(b)** Flowchart outlining the process used to identify SiBAs and SeBAs. Important areas identified by applicable frameworks are screened through a 'benthic' filter to identify those that contain benthic features, and then through a filter to determine whether they are sensitive and slow to recover from fishing impacts. The resulting areas are considered SiBAs. Overlap with fishing is then determined, resulting in SeBAs. Finally, the coral and sponge ERAF (DFO 2013) is applied to SeBAs to determine the risk of serious or irreversible harm by fishing. DFO Science is responsible for all parts of the process in orange (above the horizontal line), while Fisheries Management is responsible for the process in blue (Source: DFO, 2019).

With respect to the Canadian waters located within NAFO Divisions 3LNO, SiBAs have only been developed for four of the seven VME taxa included in the NAFO VME list. Of these four, large gorgonians, sea pens and small gorgonians have received similar protection through closures in Canadian and NAFO waters. Conversely, with the exception of *Vazella pourtalesii* in a small area of the Scotian shelf (Table 1), sponges are not currently protected by Canadian closures in NAFO Divisions 3LNO. This means a lower level of protection for sponges and other VMEs in domestic waters, compared to the greater protection that exists in international waters (NAFO Regulatory Area), thanks to the protection measures implemented by NAFO.

There are 14 MPAs designated by DFO within the Canadian EEZ, covering an area of 350,000 km^2 or just over 6% of the EEZ, these are shown in Figure 8. These are designated under the *Oceans Act* using three criteria (DFO, 2021c): (i) The area must be clearly described, including by boundaries, size, and depth (if necessary); (ii) The area is legally recognized and managed by a jurisdiction having the legal authority to determine which activities can take place in the area and which are prohibited; and (iii) The area is established for the long term, and managed to deliver ongoing benefits to the ecosystem and to human communities. Prior to being designated as an MPA the site must first be identified as a candidate site by an interested party (e.g. government, environmental institution or industry). While there may be many reasons for identifying a candidate site, to date these have mainly been areas of biological or ecological significance or conservation networks developed by DFO. Once identified research will focus on the ecological, social, cultural and economic context in the area and how these will be used to define the boundaries of the MPA. Thing considered include the ecological values of the area, how it is currently used, oil and gas facilities in or nearby.

Figure 8. MPAs in Canada (Source: DFO, 2021c).

In addition there are a further three *National Marine Conservation Areas* (NMCAs) established by the Parks Canada Agency (PCA) under the *National Marine Conservation Areas Act* (NMCA Act) and a further one established by Environment and *Climate Change Canada* (ECCC) under the *Canada Wildlife Act*. The status of the MPAs in this network is shown in Table 3. An interactive map of Canada´s marine protected and conserved areas, including MPAs and marine refuges, is available on-line[145]. Marine refuges and MPAs across Canadian waters protect cold-water corals and sponges, sponge reefs, seamounts, hydrothermal vents and the ecosystems they support.

Table 3. MPAs: Stage of Establishment and management plan status (Source: CPAWS, 2021).

MPA name	Federal agency	Date est.	Stage of establishment	Management plan publication
Anguniaqvia niqiqyuam	DFO	2016	Designated	Under development
Banc-des-Américains	DFO	2019	Designated	Under development
Basin Head	DFO	2005	Actively Managed	2016
Eastport	DFO	2005	Actively Managed	2013
Endeavour Hydrothermal Vents	DFO	2003	Implemented	2010
Gilbert Bay	DFO	2005	Actively Managed	2013
Gwaii Haanas	PCA	2010	Actively Managed	2018
Hecate Strait Glass Sponge Reefs	DFO	2017	Actively Managed	Under development
Laurentian Channel	DFO	2019	Designated	Under development
Musquash Estuary	DFO	2006	Actively Managed	2017
Saguenay-St. Lawrence	PCA	1998	Actively Managed	2016 (2010)**
Scott Islands	ECCC	2018	Designated	Under development
SGaan Kinghlas-Bowie Seamount	DFO	2008	Actively Managed	2019
St. Anns Bank	DFO	2017	Designated	Under development
Tallurutiup Imanga	PCA	-	Proposed/Committed	-
Tarium Niryutait	DFO	2010	Actively Managed	2013
The Gully	DFO	2004	Actively Managed	2017
Tuvaijuittuq	DFO	-	Interim (Designated)	-

These are distributed throughout the three oceans surrounding Canada with the largest area of protection (although smallest number of MPAs) being located in the Arctic, as shown in Table 4.

145 https://www.dfo-mpo.gc.ca/oceans/conservation/areas-zones/index-eng.html

Table 4. Distribution of MPAs around Canada (Source: CPAWS, 2021).

Region	National	Arctic	Atlantic	Pacific
Ocean estate (km^2)	5,750,000	3,240,909	384,322	351,060
Number of federal MPAs	18	4	9	5
Approximate MPA coverage (km^2)	457,900	431,590	20,616	23,665

With the Canadian EEZ an ***Ecological Risk Assessment Framework*** (ERAF) for corals and sponges was developed under the SeBA policy, outlined above, by the DFO (DFO, 2013). This is a process for identifying both the level of risk associated with fishing activity and the actual impacts of different types of fishing activity on SeBas. It provides guidance on how to conduct a risk assessment for sponges and corals based on determining the risk on exposure to fishing. This is then used to provide management advice to avoid Serious or Irreversible Harm (SIH) to cold water coral and sponge communities (Figure 7b). The ERAF looks at the historical, current and anticipated future fishing footprints for different gear types and the consequence of the gear type interacting with the benthic environment. The consequence describes the anticipated degree of impact on the significant benthic areas resulting from an overlap between it and the fishing footprint of the gear type and is rated on four levels: none, low, moderate and high. The ratings are based on previous studies undertaken by DFO (DFO, 2006, DFO, 2010) and are summarised in Table 5. It acknowledges that the impact of fixed fishing gear (moderate) may extend far beyond the relative size if the gear, depending on the manner and environmental conditions in which the gear is deployed and retrieved (for example pots being dragged across the seafloor).

Table 5. Consequence of gear impacts – Levels and Descriptors (Source: DFO, 2013).

Level	Descriptor
None (1)	Gear is not known to interact with the benthic environment under normal operations. Examples of potential gear types include harpoon and diving.
Low (2)	Gear is known to have minimal interaction with the benthic environment as part of normal operations. Examples of potential gear types include pelagic longline and purse seine.
Moderate (3)	Gear is known to interact with the benthic environment regularly as part of normal operations. Area of impacts is roughly equal to the size of the gear itself, as the gear is generally fixed in place once it is deployed (i.e. bottom contact fixed gear). Examples of potential gear types include pots, bottom set gillnets, and bottom set longline.
High (4)	Gear is known to interact with the benthic environment regularly as part of normal operations. Area of potential impact is significantly larger than the relative size of the gear, as the gear is moved over the benthic environment as part of normal operations (i.e. bottom contact mobile gear). Examples of potential gear types include bottom trawl and scallop dredge.

The likelihood of an event happening is also applied. This describes the probability that the fishing footprint of the gear type will overlap with areas identified as SiBAs, this again is categorised into four levels: never, rarely, occasionally and regularly, as described in Table 6.

Table 6. Likelihood of gear interactions – Levels and Descriptors (Source: DFO, 2013).

Level	Descriptor
Never (1)	Overlap between fishing footprint and significant benthic areas never occurs; the fishing activity does not occur in or adjacent to locations identified as significant benthic areas.
Rarely (2)	Overlap between fishing footprint and significant benthic areas is rare; occurring only in exceptional circumstances.
Occasionally (3)	Overlap between fishing footprint and significant benthic area occurs occasionally under normal fishing practices, but not on a regular basis.
Regularly (4)	Overlap between fishing footprint and significant benthic areas is expected to occur on a regular basis under normal fishing practices.

The final risk is then calculated using a function of the consequence and likelihood of an impact, ranging from 1 o 16, the risk levels are described in Table 7. Once the risk level has been identified DFO will work with other stakeholders to develop any necessary management options to avoid or mitigate serious or irreversible harm to the SiBA(s).

Table 7. Risk categories and subsequent management requirements (Source: DFO, 2013).

Risk Level	Descriptor
1-6	**Low Risk** – The fishing activity presents a negligible risk of serious or irreversible harm to the significant benthic areas. No additional management measures required. If future changes to fishing methodology and/or area are considered, potential impacts to benthic ecosystems should be re-evaluated.
8-9	**Moderate Risk** - The fishing activity presents a moderate risk of serious or irreversible harm to the significant benthic areas. Management measures may be required to mitigate or avoid serious or irreversible harm to significant benthic areas, depending on the specific circumstances of the fishery and the significant benthic areas in question. Examples of potential management options include gear modifications and/or changes to deployment/retrieval practices.
12-16	**High Risk** – The fishing activity presents a high risk of serious or irreversible harm to the significant benthic areas. Management measures are required to mitigate or avoid the risk of serious or irreversible harm to significant benthic areas. Examples of potential management options include closed areas and/or gear modifications (e.g. using lower impact gear types) or restrictions.

Within the Canadian EEZ exploratory fisheries are managed through *the Emerging Fisheries Policy*[146] developed in 1996. This lays out the requirements that must be met and the procedures that should be followed for any new fishery and applies to all new fisheries undertaken in marine or freshwater areas. Licenses for it are issued under Section 7 of the *Fisheries Act* but primarily related to ensuring that the stock being targeted can sustain commercial exploitation. As part of the application process, proposals should include a summary of the current knowledge about the target species, and provide an indication of how other species and/or the ecosystem might be affected by the proposed activity. In terms of the ERAF process outlined above, the development of an exploratory fishery is one of the recommendations in place should there be a data deficiency in the area being assessed or should the anticipated future footprint go outside the current footprint. Figure 9 shows the ERAF

[146] https://www.dfo-mpo.gc.ca/reports-rapports/regs/efp-pnp-eng.htm

process with an exploratory fishery being recommended where there is insufficient information available to make an assessment.

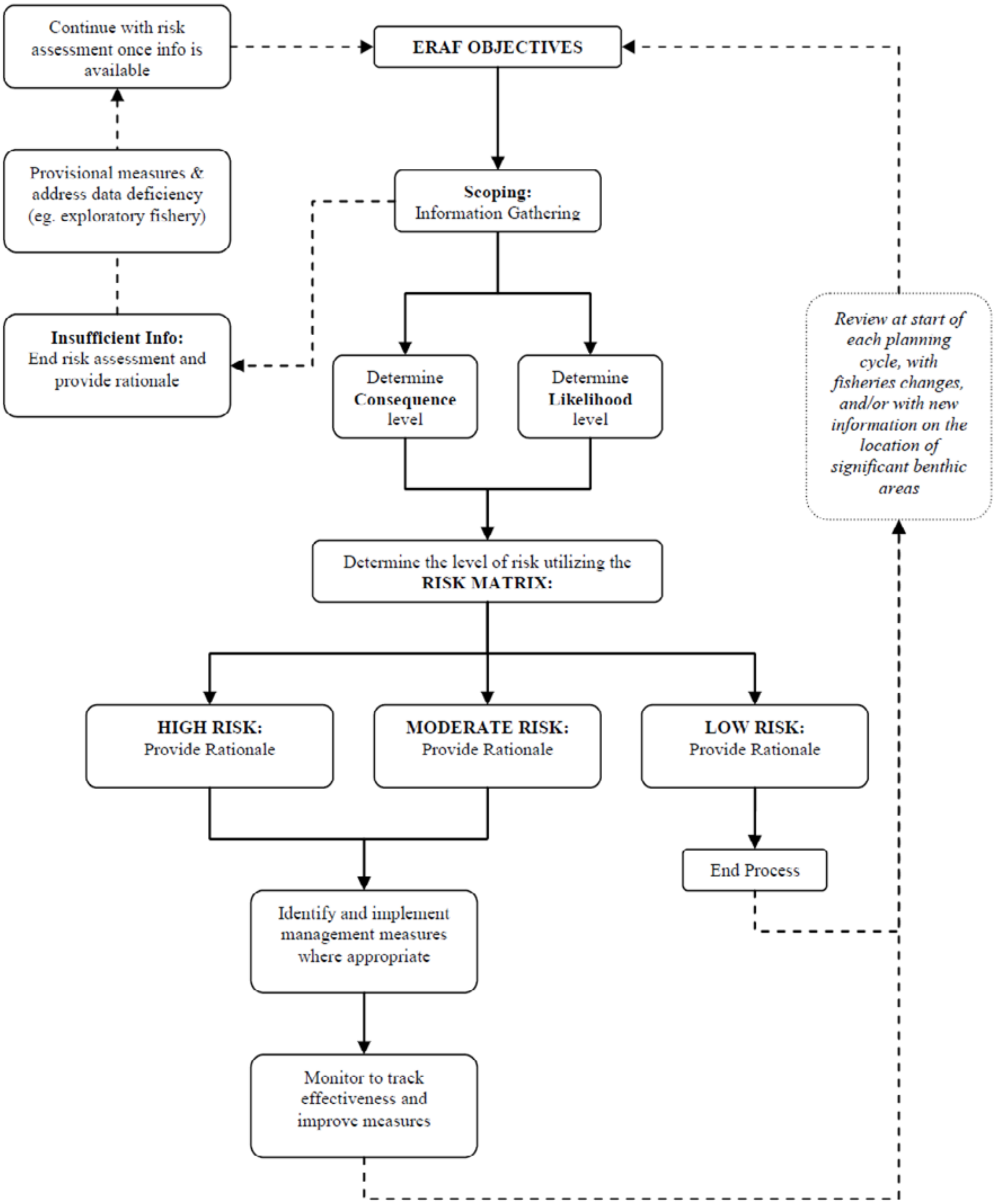


Figure 9. ERAF process for cold-water corals and sponge dominated communities (Source: DFO, 2013).

Gear restrictions will be license dependent, any new gear or areas fished will be subject to exploratory fishery requirements. For example, the scallop trawl fishery (in-shore) switched from being a commercial to exploratory fishery in 1999 once DFO determined there were limited data and management controls on the target species. It has remained exploratory since 2000 and restrictions on gear types mean a maximum width of trawl net of two meters.

Gear restrictions or modifications are also recommended as part of the ERAF process, where the risk is considered Moderate or High (Table 7).

The offshore drilling industry is subject to impact assessments, all proposed works are evaluated by the *Fish and Habitat Protection Program* (FFHPP) of the DFO. There are currently measures in place related to exploratory drilling programs in the Newfoundland and Labrador region (DFO, 2021a). The objectives are to eliminate or minimise impacts on corals and sponges though ensuring that any activities do not overlap SiBAs and VME habitats. This includes a "zone of influence" meaning any drilling activity must be sited at least 2 km from any significant densities of sponges or corals identified during pre-drill surveys.

The protocol goes on the recommend best practice approaches for developing dispersion modules, pre-drill (acoustic and visual) surveys as well as follow up monitoring to assess the effects the drilling has had on benthic communities. The decision making framework prior to the commencement of drilling at a site is shown in Figure 10.

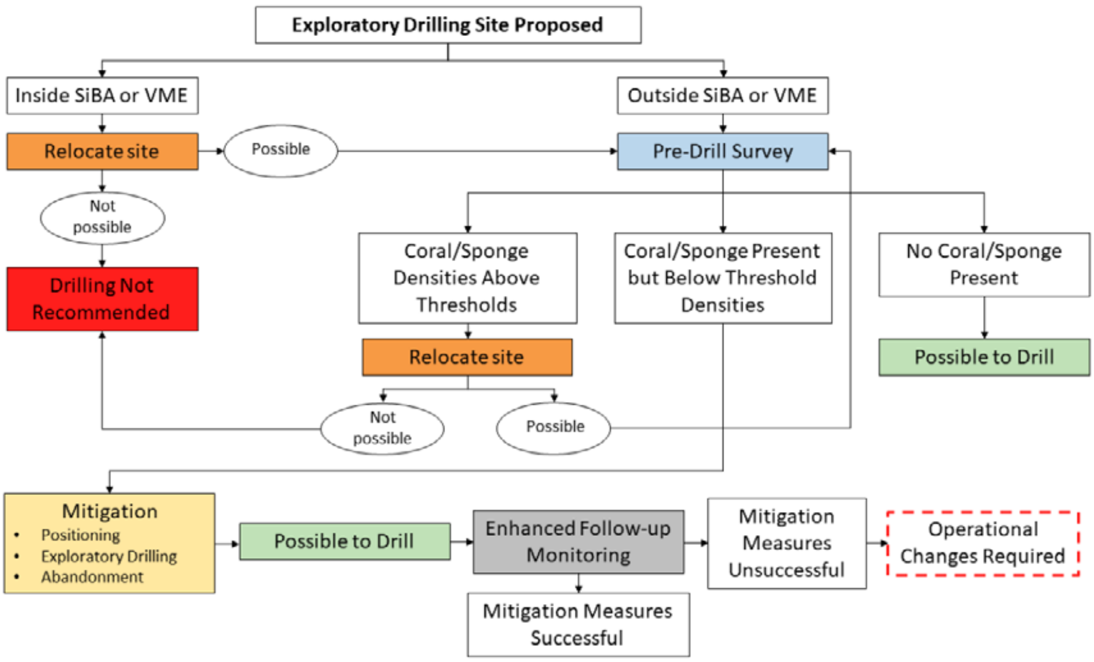


Figure 10. Decision making process for the avoidance/mitigation of corals and sponges at proposed exploratory drill sites.

Of the 18 designated MPAs, three expressly allow or fail to prohibit dumping and the most recently five established MPAs fail to contain language expressly forbidding it or define exactly what dumping is or is not allowed. Allowed and prohibited activities within each MPA are shown in Table 8.

Table 8. Allowed or prohibited activities within each MPA.

Site	Zones	Size (km^2)	Allowed/Exempt activities
Eastport		2.1	Moderate fishing activity
Gilbert Bay	Zone 1a	12.88	No regulation of anchoring
	Zone 1b	12.03	No regulation of anchoring
	Zone 2	17.87	Trawling, anchoring, infrastructure
	Zone 3	19.62	Trawling, anchoring, infrastructure
Laurentian Channel	Zone 1a	1,495.00	
	Zone 1b	611.47	
	Zone 2a	4,039.89	Anchoring, small scale infrastructure
	Zone 2b	5,414.92	Anchoring, small scale infrastructure
St. Anns Bank	Zone 1	3,309.13	Anchoring
	Zone 2	719.76	Moderate fishing activity, anchoring
	Zone 3	113.26	Moderate fishing activity, anchoring
	Zone 4	221.63	Moderate fishing activity, anchoring
The Gully	Zone 1	475.45	Anchoring
	Zone 2	1,431.69	High impact fishing activity
	Zone 3E	181.69	Dumping, high impact fishing activity
	Zone 3W	275.10	Oil & gas*, dumping, high impact fishing
Basin Head	Zone 1	0.24	Low impact fishing
	Zone 2	0.35	Small scale infrastructure, low impact fishing
	Zone 3	8.65	Anchoring, infrastructure, low impact fishing
Musquash Estuary	Zone 1	1.54	Low impact fishing
	Zone 2a	4.67	Dredging, infrastructure, anchoring, fishing
	Zone 2b	0.27	Infrastructure, moderate fishing
	Zone 3	0.95	Trawling
Banc-des-Américains	Zone 1	126.47	
	Zone 2a	570.24	Moderate fishing activity
	Zone 2b	303.05	Moderate fishing activity
Saguenay-St Lawrence	Zone 1	34	Trawling and dumping, not zoned
	General	1212	
Gwaii Haanas	Restricted Access	0.11	
	Strict Protection	1,428.18	
	Multiple Use	2,055.09	Trawling
Hecate Strait Glass Sponge Reefs	CPZ	1,502.37	
	AMZ/VAMZ	907.57	Anchoring permitted

Site	Zones	Size (km^2)	Allowed/Exempt activities
Scott Islands		11,565.33	Trawling, oil & gas*, mining*, not zoned
SGaan Kinghlas-Bowie Seamount		6,109.96	
Endeavour Hydrothermal Vents		97.07	Dumping
Tarium Niryutait	Kitigaryuit	464.46	Dredging
	Niaqunnaq	1,035.48	Dredging
	Okeevik	243.02	Oil & gas exemption*, dredging
Anguniaqvia niqiqyuam	Zone 1	2,315.56	Dredging, moderate anchoring, low impact fishing
	Zone 2	38.46	
Tuvaijuittuq		319,411.3	Cables and pipelines by foreign states

It is worth to note that since the last years, the potential impacts of activities other than fishing is a matter of concern for the NAFO contracting parties. According to Cordes *et al.,* (2016), routine oil and gas activities can have detrimental environmental effects during each of the main phases of exploration, production, and decommissioning. In this context, NAFO Commission is requesting NAFO Secretariat and the Scientific Council (SC) about such impacts in the NAFO Convention Area. In this regard, in 2022 the NAFO SC[147], based on the mapping work developed by the Working Group on Ecosystem Science and Assessment (WG-ESA)[148], reiterated its prior advice that there are oil and gas activities (regulated by Canada) occurring in the NAFO Area, which appear to have significant spatial overlap with NAFO bottom fisheries, NAFO closures and VMEs, and have the potential to impact fisheries resources and the ecosystems (Figure 11). These activities have increased in recent years. The SC reported that information on activities other than fishing (e.g. trends, spatial location, overlapping with fisheries, VMEs and closed areas, and potential impacts) will continue to be included in the NAFO Ecosystem Summary Sheets. SC noted that geographical location of oil and gas activities in the NRA is publicly available from several sources, but conversely, information on the assessment of potential impacts of such activities (e.g. routine operations, accidental events, unauthorized discharges, exploratory drilling on VME closed areas, etc.), as well as mitigation measures, is scarce or difficult to obtain.

Based on the available information[149], it is observed that offshore oil and gas activities in NAFO Divs. 3LNM clearly increased in recent years, including drilling activities on closed areas established by NAFO to protect VMEs (Areas 2 and 10). Some of these activities, particularly wells and licences, overlap fishing grounds (e.g. Greenland halibut fisheries), VME polygons (e.g. sponges, sea pens and black corals) and VME closures. Moreover, a number of different types of "incidents" have occurred in the northwest Atlantic during the period 2015-2020 (e.g. a major oil spill in 2018 of 250,000 L, and the Hibernia oil spill in 2019 that occurred into the EEZ of Canada but extended outside the EEZ into the NRA). SC also noted that VMEs inside NAFO VME area closures or outside the NAFO footprint are currently protected against SAI from bottom fishing, thanks to the management measures implemented by NAFO (e.g. closed areas and freezing of the fishing footprint), but they are unprotected regarding potential threats from activities other than fishing (e.g. drilling activities

[147] NAFO (2022) Report of the Scientific Council Meeting. 03 -16 June 2022 Halifax, Nova Scotia, Canada. NAFO SCS Doc. 22/18. Serial No. N7322. Northwest Atlantic Fisheries Organization. 241 pp.
[148] NAFO (2021b) Report of the 14th Meeting of the NAFO Scientific Council Working Group on Ecosystem Science and Assessment (WG-ESA). Northwest Atlantic Fisheries Organization. 16-25 November 2021, By WebEx. NAFO SCS Doc. 21/21. Serial No. N7256. Northwest Atlantic Fisheries Organization. 181 pp.
[149] Durán Muñoz and M. Sacau (2021). Information on activities other tan fishing (offshore oil and gas) in the NAFO Convention Area: Implications for the development of the Ecosystem Summary Sheets (Divisions 3LNO and 3M). NAFO SCR Doc.21/051. Serial No. N195. Northwest Atlantic Fisheries Organization. 9 pp.

that are currently allowed by Canada inside NAFO VME closures, in Divisions 3L and 3M). In addition, there are other issues related with the use of the marine space e.g. potential conflicts between the activities in the water column (high seas) regulated by NAFO (e.g. bottom fisheries and fisheries research), and offshore oil and gas activities regulated by Canada on the continental shelf.

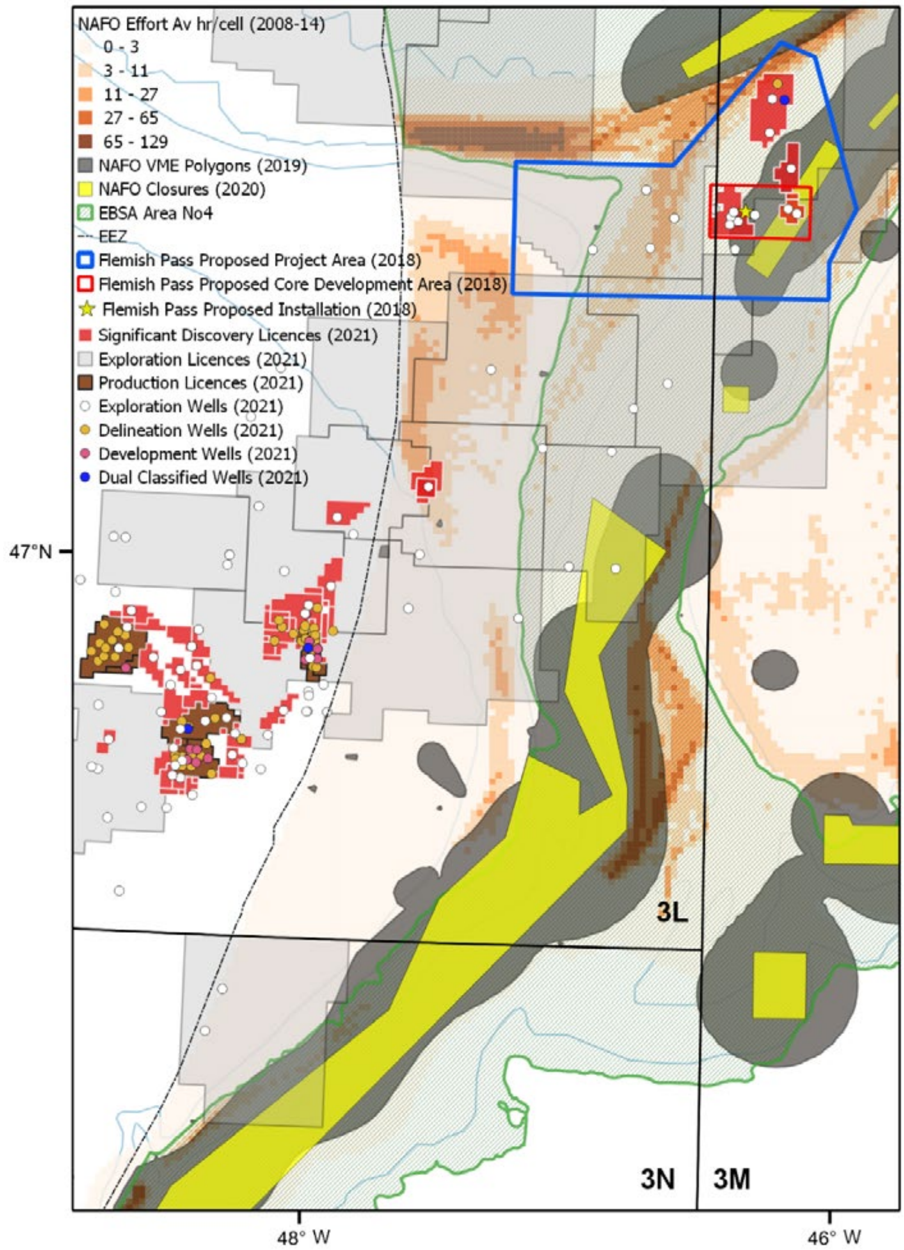


Figure 11. Map showing the geographical location of oil and gas activities in NAFO Divs. 3LNM. The map shows the potential conflicts between different users of the marine space (e.g. oil and gas vs. fisheries) and between users and the marine environment (oil and gas vs. VMEs). The yellow star indicates the location of the proposed production installation within the "Bay du Nord Development Project" in the Flemish Pass (outlined in blue). The yellow polygons represent the NAFO VME closures. Available spatial information on oil and gas activities – at the reporting date, November 2021 – is noted in brackets (2021). Map from the Report of the 2022 NAFO Scientific Council Meeting.

2.6 – Monitoring of VME impacts

There is a monitoring program in place for all the 14 designating MPAs with fisheries independent surveys being conducted on a regular basis. Funding for many of these surveys is available though the Government of Canada as a step towards it meeting its commitments to protect 25% of Canada's oceans by 2025 and 30% by 2030. Data from many of these surveys are available on the DFO site[150]. Other surveys are conducted through research institutes such as *Ocean Networks Canada* (ONC).

ONC and DFO have collaborated in developing remote monitoring tools for monitoring deep sea hydrothermal vents (between 2,200 and 2,400 meters). This includes the use of submersibles and permanent observatories. Other information from visual surveys, collected between 2017 and 2019, using both underwater video and stills images have been used to gather information on seamounts off eastern Canada, adding 580 taxa to the previous inventory including some new to science (DFO 2021b). Data are also available in some areas from trawl surveys.

Monitoring of VMEs (SiBAs) is ongoing and with regards to fisheries the impacts are monitored through the ERAF process. Within the RFMOs (NAFO and NPFC) data on VME are collected by research vessels and observers.

The Fish and Fish Habitat Protection Program (FFHPP) under the DFO, was set up to conserve and protect fisheries and their aquatic ecosystems. It does this through ensuring the *Fisheries Protection Program* (FPP) which administers the fisheries protection provisions of the *Fisheries Act,* specifically and activity that may lead to "the death of a fish or any permanent alteration to, or destruction of, fish habitat". The FPP is also responsible for administering certain provisions of the *Species at Risk Act* and as such has responsibilities under federal environmental assessment regimes under the *Canadian Environmental Assessment Act, 2012*. Through this the FPP will review any proposed activity that may affect fish populations or their habitats to ensure compliance with the relevant Acts, including offshore activities such as drilling. The process for decision making with regards to offshore drilling is outlined in Figure 10. Between 2015 and 2016 a total of 556 projects were monitored, a summary of some of these monitoring reports can be found in their implementation report (DFO, 2016).
Some of the MPAs where VMEs are thought to occur are very remote making monitoring and enforcement difficult.

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[150] Open Government Portal | Open Government (canada.ca)

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List of Acronyms

FFHPP	Fish and Habitat Protection Programme
DFO	Departmant Fisheries and Oceans Canada
C-NLOPB	Canada-Newfoundland and Labrador Offshore Petroleum Board
ECCC	Environment and Climate Change Canada
ERAF	Ecological Risk Assessment Framework
FPP	Fishery Protection Programme
IA Agency	Impact Assessement Agency of Canada
IAA	Impact Assessment Act
mNWAs	Marine National Wildlife Areas
NMCAs	National Marine Conservation Areas
ONC	Ocean Networks Canada
PCA	Parks Canada Agency
SeBA	Sensitive Benthic Area
SiBA	Significant Benthic Area
VME	Vulnerable Marine Ecosystem

CASE STUDY 3 – ARGENTINA

3.1 – Data availability and governance frameworks

All regulations referring to the management and protection of the seabed and benthic invertebrates of the **Argentine Continental Shelf (ACS)** date from after 1990. The first reference to the seabed was the **Law on Maritime Spaces Nº 23.968**[151] passed in 1991, which established the limits of the ACS as the first reference to the seabed (Table 1).

Argentina acceded to the **United Nations Convention on the Law of the Sea (CONVEMAR) (Law Nº 24.543**[152]**)**, which establishes the legal framework within which all activities in the oceans and seas must be carried out. It defines the Territorial Sea, the Contiguous Zone, the Exclusive Economic Zone and the Continental Shelf, as well as the rights of States therein.

The boundaries of the ACS were redefined in 2017 by the **National Commission on the Outer Limit of the Continental Shelf (COPLA)**[153] and the recommendation of the **Commission on the Limits of the Continental Shelf (CLCS)**, created by CONVEMAR and based at the United Nations (UN). Through this new outer limit of the ACS, Argentina acquires sovereignty over the seabed, subsoil and benthic living resources in an area comprising 1,785,000 km^2 (Figure 1).

Figure 1. Map of the Maritime Spaces of the Argentine Republic. (Source: COPLA, 2017).

The **Federal Fisheries Law 24.922**[154] **(LFP)** of 1997 establishes the **Undersecretariat of Fisheries and Aquaculture (SSPyA)** under the **Ministry of Agriculture, Livestock and Fisheries (MAGYP)** as the competent body for the application of the LFP and creates the **Federal Fisheries Council (CFP)** to regulate fishing activity in accordance with measures based on the conservation of resources, sustainable fishing and the protection of the ecosystem. The LFP, with its

[151] https://www.argentina.gob.ar/normativa/nacional/ley-23968-367/actualizacion
[152] https://www.argentina.gob.ar/armada/intereses-maritimos/espacios
[153] http://www.plataformaargentina.gov.ar/es/el-l%C3%ADmite-m%C3%A1s-extenso-de-la-argentina-y-nuestra-frontera-con-la-humanidad
[154] https://cfp.gob.ar/wp-content/uploads/2017/09/LeyPesca.pdf

modifications and its Regulatory Decree 748/99, were the legal basis on which the **CFP has designed Argentina's fisheries policy.**

The **federal character** of the law stems from the extension of the jurisdiction of the maritime provinces over the territorial sea adjacent to their coasts. The Provinces have jurisdiction over the living resources in the territorial sea adjacent to their coasts **up to 12 nautical miles** from the coast, while the remaining areas within the EEZ are under the jurisdiction of the **federal government of Argentina**. The legal design of the CFP, the governing body of the national fisheries policy and the main regulator of the activity, also marks this federal character by its collegiate composition of five provincial representatives and five from the National State.

The **LFP** covers the various aspects relevant to marine fisheries: research, conservation and management of the sea's living resources, and a fishing regime that has imposed management by **Individual Transferable Catch Quotas (ITCQs)**, with its corresponding regime of infractions.

The **CFP** is advised by technical committees for the different fisheries, with the participation of scientists and technicians, mainly from the **National Institute for Fisheries Research and Development (INIDEP)** and the provinces. The Law establishes that INIDEP must "*determine annually the maximum sustainable yield*" of various species (Article 12, Law 24.922) and recommend the **Biologically Acceptable Catch (BAC)**. Based on this information, the CFP establishes the **Total Allowable Catch (TAC)** and the set of regulations related to resource sustainability and fisheries management, including the effects of fishing on the marine ecosystem.

In 2002, the **General Environmental Law**[155] **(Nº 25.675)** was passed, establishing funding to achieve sustainable management of the environment, with an impact on the preservation and protection of biological diversity.

As a part of the State policy oriented towards the Argentina sea, the Government created the "**Iniciativa Pampa Azul**" (www.pampazul.gob.ar). This is an interministerial initiative that articulates scientific research, technological development and innovation actions to provide scientific bases for national ocean policies (including strengthening of national sovereignty over the sea, strengthening of industries linked to the sea, economic development of the Argentina maritime regions, conservation and sustainability and implementation of MPAs). From the **Pampa Azul**[156] initiative came laws related to the creation of Marine Protected Areas (MPAs) such as Law Nº 26.875 on the **Namuncurá-Banco Burdwood Marine Protected Area** and Law Nº 27.037 on the **National System of Marine Protected Areas**, as well as Law 27.167 on the **National Programme for Research and Productive Innovation in Argentine Maritime Areas (PROMAR)**, which establishes the necessary funding to carry out research on the sustainable use of marine resources in these areas.

In 2018 and in the context of the National System of Marine Protected Areas, the creation of two new MPAs was approved: **Burdwood Bank II and Yaganes** (Law Nº 27.490).

According to Gaitán[157] (2020), Argentina has ratified several **international treaties** related to the conservation and sustainable use of benthic marine resources. At the regional level, Argentina and Uruguay have established a Common Fishing Zone in 1973 that is regulated by the **Comisión Técnica Mixta del Frente Marítimo (CTMFM)** in conjunction with the **Comisión Administradora del Río De La Plata (CARP)**. The setting of the TAC for these resources is carried out under the

[155]https://www.researchgate.net/publication/344788597_Legislacion_e_instrumentos_de_manejo_existentes_para_la_proteccion_de_los_fondos_marinos_en_la_Plataforma_Continental_Argentina_MAFIS
[156]https://www.pampazul.gob.ar/
[157]Gaitán, E. (2020). Legislación e instrumentos de manejo existentes para la protección de los fondos marinos en la plataforma Continental Argentina. *Marine and Fishery Sciences*, 33(2): 247-263. doi: 10.47193/mafis.3322020301104.

jurisdiction of the **Treaty of the Río de la Plata and its Maritime Front** (Law Nº 20.645[158]), with the **CTMFM** being in charge of adopting measures on the conservation, preservation and exploitation of aquatic resources, including the protection of the marine environment. The **CTMFM** is made up of technicians from INIDEP and the National Directorate of Aquatic Resources of Uruguay.

In 1994, through **Law Nº 24.375**[159], Argentina ratified the **Convention on Biological Diversity (CBD)**, promoted by the United Nations Environment Programme, in which the States commit themselves to monitor and plan the protection of biodiversity. In 1995, Argentina acceded to **CONVEMAR**, where the definition of the continental shelf was established, including sovereignty rights over the exploitation of natural resources.

In 2000, Argentina signed up to the **Convention on the Conservation of Antarctic Marine Living Resources**[160] **(CCAMLR)** as a signatory to the Antarctic Treaty, by means of **Law Nº 25.263**[161]. Conservation Measure 22/06[162] establishes a ban on all fishing activities within the southern shelf of the South Orkney Islands. CCAMLR includes within its area of influence the **South Georgia, South Sandwich and South Orkney archipelagos**, which are included in the outer limits of the PCA redefined in 2017 by COPLA (Figure 1).

Table 1. National measures related to the direct or indirect protection of the seabed and their current state of implementation in Argentina.

Regulation	Application	Scope of action	Status of implementation
Maritime Spatial Law (Nº 23.968)	National 1991	ACS limits	In forcé.
Federal Fisheries Act (Nº 24.922)	National 1997	Conservation of marine living resources and prevention of ecosystem damage. Closed areas for bottom trawling.	In force. The Secretariat of Agriculture, Livestock, Fisheries and Food (currently the Undersecretariat of Fisheries and Aquaculture) was designated as the Authority of Application. Decree Nº 248/99.
General Environmental Law (Nº 25.675)	National 2002	Sustainability of productive activities. Conservation of biological diversity.	In force. The Secretary of Environment and Sustainable Development was designated as the Authority of Application. Decree Nº 481/2003.
Creation of the Namuncurá-Burdwood Bank Protected Area Law (Nº 26.875)	National 2013	Protection and management of benthic marine ecosystems	In force. The Office of the Chief of Cabinet of Ministers was designated as the Authority of Application (Decree No. 720/2014). Currently included in the National System of Marine Protected Areas (Decree Nº 888/2019).
National System of Marine Protected Areas Law (Nº 27.037)	National 2014	Conservation of representative benthic ecosystems	In force. The National Parks Administration was designated as the Authority of Application (Decree Nº 402/17).
Law for the Creation of a National Programme for Research and Productive Innovation in Argentine Maritime Spaces. (Nº 27.167)	National 2015	Conservation, research, sustainable use of marine resources	In force. The Ministry of Science, Technology and Productive Innovation was designated as the Authority of Application (Decree Nº 604/2016).
Creation of two Marine Protected Areas (Burdwood Bank II and Yaganes). (Nº 27.490)	National 2018	Protection of benthic biodiversity and species of commercial interest	In force. Currently included in the National System of Marine Protected Areas.

[158]https://pesca.maa.gba.gov.ar/tramites/img/pdfs/ley20645TRP.pdf
[159]https://www.argentina.gob.ar/normativa/nacional/ley-24375-29276/normas-modifican
[160]https://www.ccamlr.org/en/organisation
[161]https://www.argentina.gob.ar/normativa/nacional/resoluci%C3%B3n-24-2021-348804/texto
[162]https://www.ccamlr.org/sites/default/files/s-22-06_2.pdf

Regulation	Application	Scope of action	Status of implementation
closed áreas [1]	National	Areas with permanent or temporary prohibition for bottom trawls	In force.

[1]https://www.magyp.gob.ar/sitio/areas/pesca_maritima/informes/pesquerias/_archivos//000001_Generales/210820_Normativa%20Geoespacial%20vigente%20en%20la%20ZEE%20y%20ZCP%20(2020).pdf

On **21 October 1977**, the **National Institute for Fisheries Research and Development (INIDEP)** [163] was created by Law 21.673 on the basis of the former Institute of Marine Biology. **INIDEP** advises the **Undersecretariat of Fisheries and Aquaculture (SSPyA)**, the **CFP and the Argentine Chancellery** on the design of management plans or the application of fisheries management measures and coordinates its scientific and technical activities with the provinces with a maritime coastline with regard to the **evaluation and conservation of marine living resources**[164].

Figure 2 shows the **organisation chart and management structure of INIDEP**, showing the existence of a National Research Directorate, as well as the directorates oriented to the development of **Fish Fisheries and Invertebrate Fisheries and Marine Environment[165]**, among others.

Figure 2. Organisation chart and management structure of INIDEP. (Source:https://www.inidep.edu.ar/images/adjuntos/memoria2020-comprimido.pdf)

INIDEP's main objectives are detailed below[166]:

1. **Advise government authorities** and the productive sector in order to contribute to the management of the living resources of the sea, in order to reach the **maximum levels of exploitation**, compatible with sustainable fisheries development, the maintenance or recovery of the respective fisheries, of the fishing ecosystems and of biodiversity.
2. To carry out **research to establish annually the potential of the fishery resources** of the Argentinean Sea and to generate the scientific, technical and economic bases advisable for their exploitation and sustainable management; all these objectives will apply to common hake, shrimp, Argentinean squid, Patagonian toothfish, Patagonian toothfish, Patagonian

[163]https://www.argentina.gob.ar/inidep/mision-funcion/nuestra-historia
[164]https://www.inidep.edu.ar/images/adjuntos/memoria2020-comprimido.pdf
[165]https://www.argentina.gob.ar/inidep/investigacion-cientifica
[166]https://www.argentina.gob.ar/inidep/mision-funcion

toothfish, Patagonian toothfish, corvina, whiting, sea bream, cartilaginous fish (sharks and rays), anchovy, mackerel, scallops and spider crab.

3. To achieve the relative goals of **quality in the results of research in areas understood as strategically key for INIDEP in the field of fisheries research**, which implies the discussion and peer review of the results of scientific and technical research through presentations at congresses, seminars and various academic meetings, as well as the permanent training of scientific and technical staff through courses and workshops in the institution, in the country or abroad, to update work methodologies and achieve the internationally required capabilities in fisheries research.
4. **Projecting an adequate institutional image before the productive sector, the scientific-academic community and society as a whole**, through the publication of the results of scientific-technical research in academic and general interest fields, the dissemination of institutional tasks in secondary education and mass media through articles or notes on particular scientific aspects with the intention of raising awareness in society about the need for preservation and sustainable use of marine resources and their environment, and participation in various advisory and transfer missions both in the country and abroad aimed at improving the quality of life of artisanal fishermen and processors of new small-scale products.
5. **Promote research for the development of alternative fisheries, aquaculture, sustainable fishing technologies and fishing indicators** for the formulation of sustainable development policies. In particular, research on the design and testing of selective fishing gear and its feasibility of application in various marine fisheries will continue to be developed.
6. **Actively participate in national and international commissions for the conservation and management of fishery resources** in support of the Undersecretariat of Fisheries and Aquaculture of the nation and the Argentine Chancellery, in the **CTMFM**, in the **CCAMLR**, in **the Argentina-Chile Binational Commission for Cooperation in Southern Marine Research, the China-Argentina Bilateral Commission on Fisheries** and the recently created **Commission for Oceans, Antarctica and Conservation**, among others.

INIDEP has its headquarters in **Mar del Plata** and administrative offices in the provinces of Chubut, Santa Cruz and Tierra del Fuego. The building consists of three areas with a total area of **10,650 m²**. The first is made up of three floors joined transversally where the **researchers' offices** and **laboratories** are located, which are equipped to carry out their tasks according to the requirements of each research project. The second area comprises the workshop area and sheds, where the **spare parts for the vessels and sampling equipmen**t used in the Institute's research campaigns are stored. From there, a gate communicates with the dock where INIDEP's research vessels moor, facilitating access and the transfer of material to and from the ships. The third area houses the **experimental aquaculture station**.

INIDEP's budget for 2022 is **1,492 million Argentinean pesos**[167] **(11,650,000 €).**

INIDEP has three research vessels of its own, the BIP "Eduardo Holmberg"[168], BIP "Victor Angelescu"[169] and BIP "Mar Argentino"[170]. The fleet is also composed of the trackers "Bernie" and "Willie", which are small but versatile vessels very useful for carrying out research activities in coastal areas and which do not require great autonomy of navigation or the operation of large equipment.

[167] https://www.economia.gob.ar/onp/presupuestos/2022
[168] https://www.argentina.gob.ar/inidep/mision-funcion/infraestructura/buque-bip-dr-eduardo-holmberg
[169] https://www.argentina.gob.ar/inidep/mision-funcion/infraestructura/buque-bip-victor-angelescu
[170] https://www.argentina.gob.ar/inidep/mision-funcion/infraestructura/buque-bip-mar-argentino

Research surveys[171] are the most important source of information available to INIDEP for advising on the sustainability of fishery resources and obtaining data on the abundance of target species, size structure, reproductive status and bycatch of target species. **During the year 2020**, despite the complexity due to COVID-19, **18 research surveys** could be carried out, of which 4 were on board INIDEP's larger vessels, with 81 days sailed; 4 on board INIDEP's smaller vessels with 18 days sailed. Seven surveys were carried out on commercial fishing vessels with 144 days sailed and two surveys on vessels of other institutions with 2 days sailed, of which the following surveys stand out:

- **3** shrimp (*Pleoticus muelleri*) surveys in the San Jorge Gulf, Chubut coast and adjacent national waters, on the **BIP vessel Victor Angelescu** and on the **commercial vessel Bogavante II**.
- **2** surveys of Patagonian scallop (*Zygochlamys patagónica*) in Management Units A and B for the year 2020, on the **BIP vessel Víctor Angelescu** and on a **commercial vessel**.
- **2** surveys to evaluate the spider crab resource (*Lithodes santolla*) in the central and southern areas, on **commercial vessels**.

Throughout 2021, INIDEP conducted **17 research surveys and 252 navigation days**[172]**.**

- **5** surveys in the **BIP "Eduardo Holmberg".** Argentine hake survey in the North Patagonian nursery area, evaluations of southern demersal fish and Patagonian scallop in Management Unit A, Argentine hake in the Argentine-Uruguayan Common Fishing Zone and demersal species in the El Rincón area.
- **8** surveys in the **BIP "Victor Angelescu".** Three surveys in COSTAL-EPEA; pre-recruits of the Patagonian hake stock; shrimp in Golfo San Jorge, Chubut coast and adjacent national waters; Patagonian scallop in Management Unit B; assessment of the northern anchovy stock; biological oceanography of the "**Agujero Azul"**.
- **2** surveys in the **BIP "Mar Argentino"**. Survey to study shrimp in the south of the province of Buenos Aires and the north of Río Negro and another to test fishing gear in order to assess the reproductive status of rocky reef species.
- **3** surveys on the **trackers "Bernie" and "Willie"**. Survey of "Population and ecosystem studies of shrimp in the province of Buenos Aires", they participated in an assessment of "sabalo" and accompanying species in the Río de La Plata, and also started tagging of "tiburones gatuzo", an activity that will be extended during the first months of 2022 and which is carried out within the scope of the **CTMFM**.

The **National Programme of Observers on board the commercial fleet**[173] **(OAB)** has the general objective of covering the activity of fishing vessels, in order to obtain information and biological data on target species, discards and bycatch of chondrichthyans, seabirds and marine mammals. Some observers[174] (e.g. scallop and prawn fisheries) also sample benthic fauna. The sanitary situation in 2020 implied a decrease in the number of observers available to embark, as well as the possibility of covering different vessels/fleets, nevertheless, **the total number of days sailed was 4923 and the number of trips was 141**. 167 biological samplings were carried out, in the Ports of Mar del Plata (73) and Necochea (94).

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[171] https://www.inidep.edu.ar/images/adjuntos/memoria2020-comprimido.pdf
[172] https://www.argentina.gob.ar/noticias/el-inidep-cierra-el-ano-con-17-campanas-de-investigacion-y-252-dias-navegados
[173] https://www.argentina.gob.ar/inidep/Programa-Adquisici%C3%B3n-de-Informaci%C3%B3n-Biol%C3%B3gico-Pesquera-y-Ambiental
[174] Escolar M., Diez, M., Hernández, D., Marecos, Á., Campodónico, S., Bremec, C. (2009). Captura incidental de invertebrados en bancos de pesca de vieira patagónica: un caso de estudio con datos obtenidos por el Programa Observadores a Bordo. Revista de biología marina y oceanografía. 44. 369-377.

During 2020, **INIDEP produced 449 scientific reports**[175], consisting of 35 Official Technical Reports, 88 Research Reports, 99 Advisory and Transfer Reports, 15 Survey Reports, 36 Commission Reports and 124 Tide Reports.

The Fish Fisheries and Invertebrate Fisheries and Marine Environment Directorates (Figure 2) are responsible for carrying out research activities on the main fishery resources related to demersal fisheries, pelagic fisheries and marine invertebrates as detailed below:

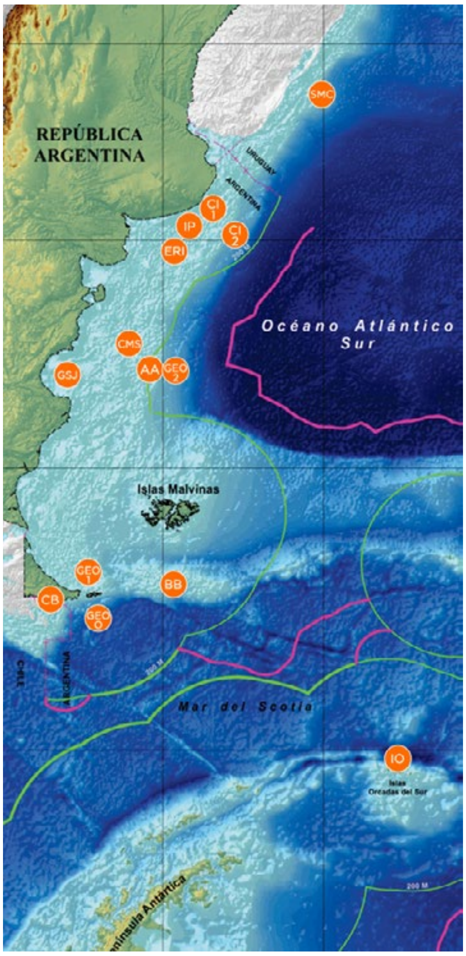
- **Prawn** (*Pleoticus muelleri*). From June to October, observers covered the prawn fishing season within the area closed to juvenile hake, in order to make areas available for prawn fishing.
- **Argentine squid** (*Illex argentinus*): fortnightly reports were made on the evolution of the squid fishing season in the northern and southern sectors.
- **Fish fisheries**. Advice was given on the optimum exploitation levels of the different fish species that are analysed annually: **"merluza común"** (*Merluccius hubbsi*), "**merluza de cola**" (*Macruronus magellanicus*), "**merluza negra**" (*Dissostichus eleginoides*), "**polaca**" (*Micromesistius australis*), "**anchoita**" (*Engraulis anchoita*), "**caballa**" (*Scomber collias*) and "**merluza austral**" (*Merluccius australis*).
- Meetings of the **Working Groups** of the fish species considered within the framework of the CTMFM were also held: "**gatuzo"** (*Mustelus schmtti*), "**peces ángel"** (*Squatina guggenheim*), **"merluza común"** (*Merluccius hubbsi*), **"corvina rubia"** (*Micropogonias furnieri*) and coastal and deep-sea skates and rays.
- The **hake recovery plan** was also continued and the foundations were laid for formalising the **recovery plan for the "gatuzo"**.
- **Workshops** were held in the framework of the certification of "anchoita" and "merluza de cola" fisheries, as well as the first advances of other resources that are pursuing a similar classification.

In addition to INIDEP's ships, other vessels are routinely used in marine research in Argentina[176].

The **National Council for Scientific and Technical Research (CONICET)** is the main organization dedicated to the promotion of science and technology in Argentina (www.conicet.gov.ar), including marine research (e.g. oceanography marine geology and marine biodiversity). Its website[177] offers an institutional repository on marine research papers and reports. The **CONICET** owns the research vessels "**Puerto Deseado**" and "**Austral**". The latter was re-equipped to carry out geological prospecting tasks. The **Naval Hydrography Service** owns the ship "**Comodoro Rivadavia**" and is in the process of building a "*swath"* type vessel (*Small Waterplane Area Twin Hull*) for river research. The **Argentine Naval Prefecture** owns the oceanic motor-sailing vessel "**Dr. Bernardo Houssay**", which was completely rebuilt in 2011. And the **Centro Austral de Investigaciones Científicas (CADIC-CONICET)** added the **BIC "Shenu"** to its fleet in 2021. Additionally, the **National Parks Administration** added the **"BIP Oca Balda"**, which is currently being repaired to continue research and management related to the conservation of MPAs. In addition to these ships, the icebreaker "**Almirante Irízar"** returned to service, which was fully refurbished and equipped.

[175] https://www.inidep.edu.ar/solicitud-de-informes-catalogo.html
[176] https://www.pampazul.gob.ar/investigacion-y-desarrollo/campanas-de-investigacion/plataformas-navales/
[177] https://ri.conicet.gov.ar/discover?filtertype=subjectClassification&filter_relational_operator=authority&filter=178

The **Pampa Azul** website shows the oceanographic surveys carried out by Argentina[178], as well as the survey report by selecting the points in the image or by clicking on the name of the survey (Figure 3).



BB – Burdwood Bank | 4 surveys
1. January/February – Vessel Prefecto Garcia
2. May – Vessel Puerto Deseado
3. July/August – Vessel Austral
4. November/December – Vessel Puerto Deseado

AA – Agujero Azul
5. October – Vessel Austral

ERI – El Rincón | 2 surveys
6. April/May – Motovelero B. Houssay
7. September/October – Motovelero B. Houssay

GSJ – Golfo San Jorge
8. October/November – Vessel Puerto Deseado

GEO – Geological prospecting | 3 surveys
9. GEO 0 – August – Vessel Austral
10. GEO 1 – September – Vessel Austral
11. GEO 2 – November/December – Vessel Austral

CMS – Cassis/Malvinas
12. June – Vessel Puerto Deseado

SMC – SAMOC (International cooperation)
13. September/October – Vessel Puerto Deseado

IO – Islas Orcadas
14. March – Vessel Puerto Deseado

CI – Instrumental training | 2 surveys
15. CI 1 – October – Wave Glider – Puerto Deseado
16. CI 2 – April – Multibeam echo sounder – Vessel Austral

CB – Canal Beagle
17. October – Motovelero B. Houssay

IP – Fisheries Research
18. May – Motovelero B. Houssay

Figure 3. Location of the oceanographic surveys carried out by Argentina in 2017. (Source:https://www.pampazul.gob.ar/investigacion-y-desarrollo/campanas-de-investigacion/campanas/)

The **LFP 24.922** establishes as primary sources of information for the administration of fishery resources, the **landing declarations** (fishing reports), the **landing reports** (drawn up by an inspector on the quay) and the **satellite monitoring of the fleet**.

In accordance with **SSPyA Provision 2/2003**[179], the fishing vessel positioning system was created, which obliges all fishing vessels, with the exception of the artisanal fleet[180], to have a marine transceiver with a built-in GPS receiver. The **Satellite Monitoring System (VMS)** allows the position of the various vessels, their course and speed of displacement to be known. The shipowner is obliged to contract a satellite communication service that allows the **SSPyA**, the **Argentine Naval Prefecture**, the **Argentine Navy**, the **INIDEP** and the **provinces with a maritime coastline** to access the data. The VMS system has been in force since 2005 to date. VMS has been used mainly for control and surveillance (e.g. closed areas and

[178] https://www.pampazul.gob.ar/investigacion-y-desarrollo/campanas-de-investigacion/campanas/
[179] https://www.argentina.gob.ar/normativa/nacional/disposici%C3%B3n-2-2003-87371
[180] Resolution 3/2000 of the Federal Fisheries Council (CFP) defines the artisanal fleet as that which carries out its activity with home-made boats and hulls of industrial construction, propelled by rowing, sailing or outboard motor and vessels with internal motor whose length does not exceed 10 metres, duly authorised by the Prefectura Naval Argentina (Argentine Naval Prefecture). The provinces are empowered to establish technically founded exceptions to the aforementioned length.

seasons). It is now also used to map the landings of the various fleets[181] as well as the fishing activity in the areas available for oil exploration[182].

The catch position data in the fishing reports, which are reported at an **area level of 0.5 degrees latitude by 0.5 degrees longitude**, allow for limited analysis of the spatio-temporal dynamics of fishing catches. However, in the case of **VMS data**, their **spatial resolution is in the order of tens of metres**, which represents a significant improvement for the spatial analysis of fisheries.

In order to improve the spatio-temporal resolution of the effort distribution of the different fleets operating in the Argentine Exclusive Economic Zone, Martinez Puljak *et al*. (2018)[183] developed **a software tool that allows processing data from different sources of information on landings and satellite monitoring** of the fishing fleet in order to generate a new interrelated database. Through its use, it will be possible to visualise and analyse the distribution of landed catches with a high-definition spatio-temporal resolution, by assigning catches to the positions of the satellite monitoring system where each vessel of the fishing fleet was actually operating.

The information needed for the analysis comes from three main sources: **fishery statistics**, **the fishery register** and **satellite monitoring**. The information is stored in a relational database (PostgreSQL version 10.0) with an extension for geographic data (POSTGIS version 2.4).

- **<u>Fishing statistics</u>.** The National Directorate for Fisheries Coordination and Control (DNCyFP) of the SSPyA developed the **"Integrated Fisheries Information System" (SIIP)**, which incorporates the information from the landing reports and records corresponding to the national jurisdiction and to the provincial jurisdictions that share information with the national administration. This system is used for the administration and generation of **fishery statistics**.
- **<u>Fishing Register</u>.** In accordance with the provisions of **Article 41 of the Fishing Law (N° 24.922)**, the **Fishing Register** is created and in which all natural and legal persons engaged in the commercial exploitation of the living resources of the sea must be registered under the conditions determined by the regulations. All information concerning the technical characteristics of the vessel is recorded in the SIIP. On the other hand, **Article 23 of the Fishing Law (N° 24.922)** establishes that in order to carry out the fishing activity, it is necessary to have the corresponding authorisation: **National or provincial fishing permit**. Fishing permits are authorisations granted to vessels only to access the fishing grounds, and it is necessary to have an assigned catch quota in order to fish.
- **<u>Satellite Monitoring System (VMS)</u>**. In accordance with the provisions of SSPyA No. 02/2003, the VMS service providers are responsible for implementing access to positioning data through web servers. The files are obtained in text format. The data provided refer to the **identification of the equipment, registration and name of the fishing vessel, date and time GMT, position in latitude and longitude coordinates** in degrees, minutes and hundredths of a minute, **course** in degrees, and **speed** in knots. The required information is available at all times and the **initial frequency programmed into the on-board equipment is one hour**.

The **satellite monitoring records (VMS)** are linked to the corresponding fishing reports through the date and time of the reports. This link allows the **fleet category**

[181] MAGYP (2020) Informe DPP Nº 16/2020 – Desembarques de la flota comercial argentina (2006-2019). 46pp.
[182] MAGYP (2022) Informe DPP Nº 02/2022 – Actividad de la flota comercial argentina, Cuenca Norte y Austral (2017-2020)
[183] https://www.magyp.gob.ar/sitio/areas/pesca_maritima/informes/pesquerias/_archivos//000001_Generales/000021_Informe%20Mejora%20de%20la%20resoluci%C3%B3n%20espacial%20(2018).pdf

assigned to the vessel and the main **fishing gear** used during the fishing trip to be known. For each year, each vessel with an active permit (provincial or national) is categorised into a particular fleet, which will be determined by the registration data defined in the **SIIP**, the fishing gear used and the **species landed** in the highest proportion that year (target species). The categories are assigned according to the classification detailed in Table 2 and create the "**Active Vessel Database**".

The next step in the "**Monitoring points database**", which has one record per hour for each vessel, is to classify the records by applying the 9 general classification criteria and 10 specific classification[184] criteria on the points in the database. Once all the data have been classified, the points that were classified as "fishery compatible" in the process are used for linking to the "**Fishery Report Database**".

Table 2. Fleet classification according to fishing gear and/or target species (Source: https://www.magyp.gob.ar/sitio/areas/pesca_maritima/informes/pesquerias/_archivos//000001_Generales/000021_Informe%20Mejora%20de%20la%20resoluci%C3%B3n%20espacial%20(2018).pdf)

Fresqueros	Rada o Ría	Rada o Ría Merluza *hubbsi*
		Rada o Ría Merluza *hubbsi* palangre
		Rada o Ría Variado costero
	Costeros	Costero Merluza *hubbsi*
		Costero Variado costero
		Costero Pelágicos
		Costero Trampas
	Flota amarilla	Flota Amarilla Rawson
	Tangoneros	Fresqueros a Langostino
	Altura	Fresquero Merluza *hubbsi*
Congeladores	Ramperos (arrastreros)	Congeladores Merluza de cola - Merluza Negra – Polaca
		Congeladores Merluza *hubbsi*
		Congeladores Vieira
	Tramperos	Congeladores Centolla
	Tangoneros	Congeladores Tangón
	Palangreros	Congeladores Palangre
	Poteros	Congeladores Poteros

As a result of the application of the tool, it is possible to generate **maps of catch distribution by species or fleet** with a higher level of detail than that of catch declarations by rectangles of 0.5 degrees latitude by 0.5 degrees longitude. Figure 4 shows a succession of maps with different levels of definition corresponding to the distribution of the catch of the deep-sea fishing fleet targeting Argentinean hake *Merluccius hubbsi*.

This tool has made it possible to obtain data on the activity of the Argentinean fleet in the EEZ from 2006 to 2019 [185]. The results are public and can be downloaded from the website of the Ministry of Agriculture, Livestock and Fisheries. (Source: https://www.magyp.gob.ar/sitio/areas/pesca_maritima/informes/pesquerias/index.php).

[184] https://www.magyp.gob.ar/sitio/areas/pesca_maritima/informes/pesquerias/_archivos//000001_Generales/000021_Informe%20Mejora%20de%20la%20resoluci%C3%B3n%20espacial%20(2018).pdf

[185] https://www.magyp.gob.ar/sitio/areas/pesca_maritima/informes/pesquerias/_archivos//000001_Generales/220209_Distribuci%C3%B3n%20espacial%20de%20los%20Desembarques%20de%20la%20flota%20argentina%202006-2019.pdf

The developed software tool **has proven to be efficient** in generating detailed information on the **distribution of catches and effort** (in fishing hours) of the different fleets. This information is very useful for resource management, particularly in consideration of area-based management and marine spatial planning.

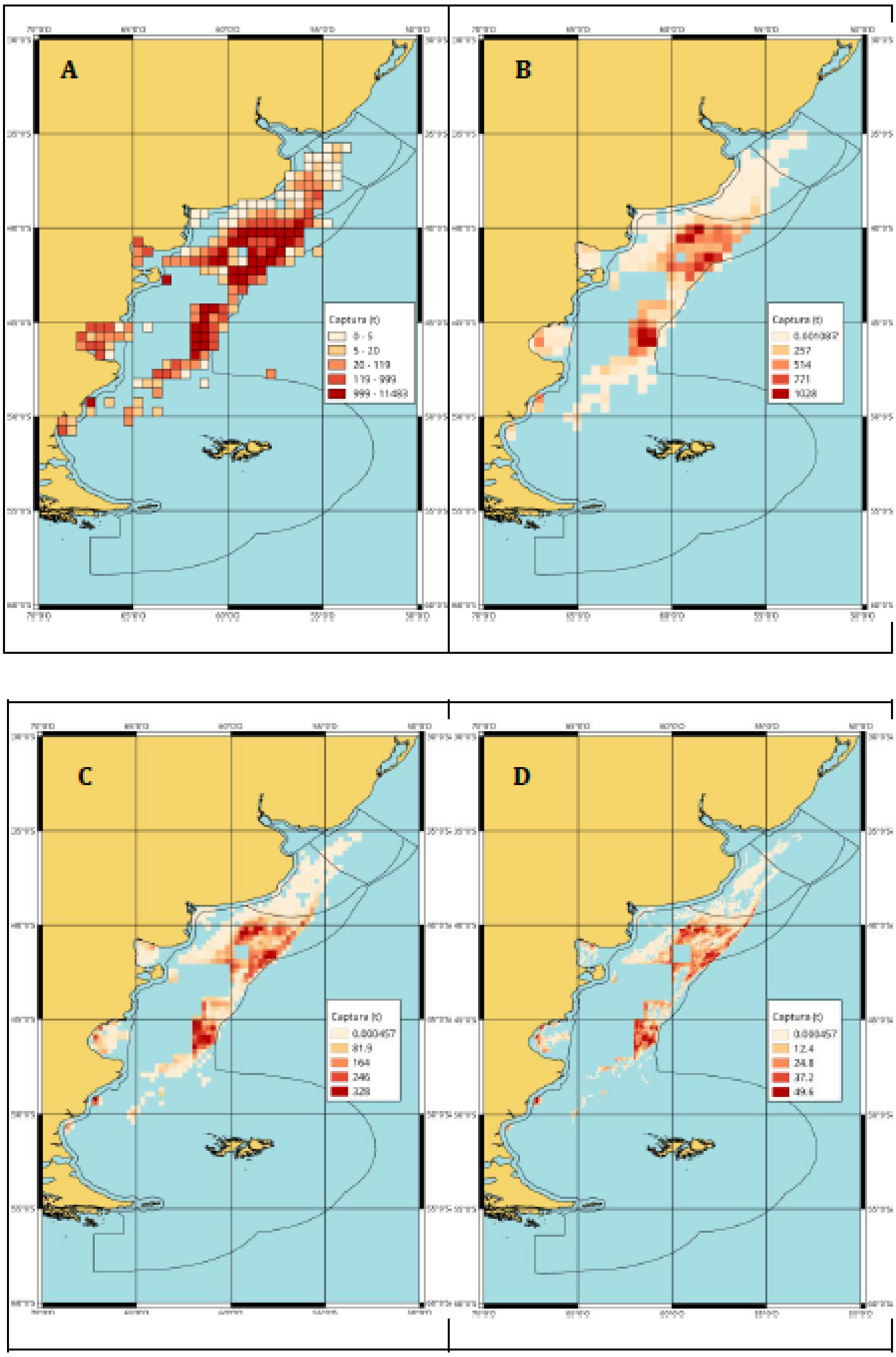


Figure 4. Distribution of catches of hake *M. hubbsi* for the deep-sea fishing fleet (2015). A) Fishing reports (0.5° x 0.5°) B) Monitoring (0.5° x 0.5°) C) Monitoring (0.25° x 0.25°) D) Monitoring (5'x5'). (Source:https://www.magyp.gob.ar/sitio/areas/pesca_maritima/informes/pesquerias/_archivos//000001_Generales/000021_Informe%20Mejora%20de%20la%20resoluci%C3%B3n%20espacial%20(2018).pdf)

The **satellite monitoring system (VMS)** makes it possible to visualise the positions of fishing vessels operating in real time, classified by fishing gear, through the website of the Ministry of Agriculture, Livestock and Fisheries. (https://www.magyp.gob.ar/sitio/areas/pesca_maritima/monitoreo/) (Figure 5).

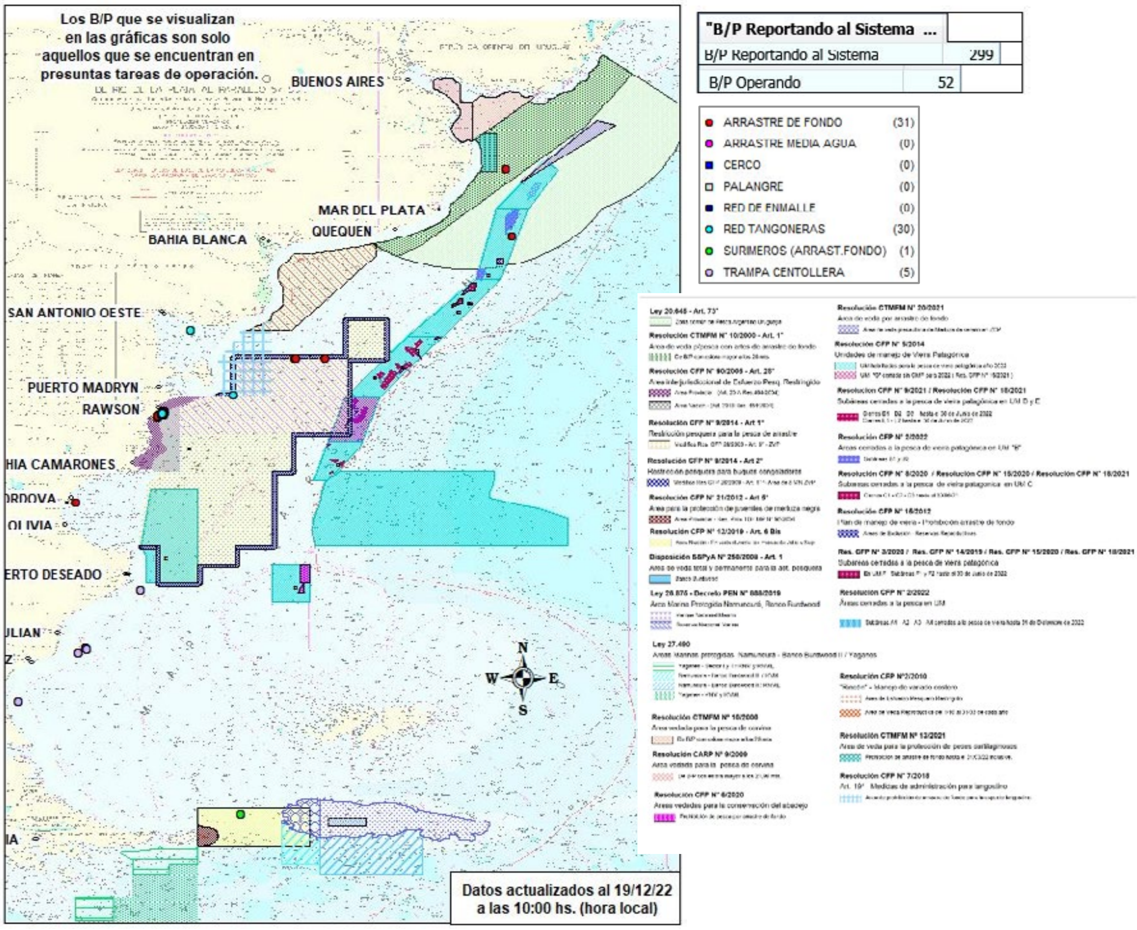


Figure 5. Satellite monitoring system (VMS) with the position of fishing vessels (operating) classified by fishing gear. Updated: 19/12/2022

(Source:https://www.magyp.gob.ar/sitio/areas/pesca_maritima/monitoreo/reportes/ZEE.jpg?12030601)

Regarding **offshore oil and gas activities** in the Argentine continental shelf, some spatial information (e.g. wells, offshore exploitation and exploration licenses, reservoirs and sedimentary basins) is publicly available through an online tool[186] on the website of the Ministry of Economy, but specific data on the assessment of the potential impacts of such activities on fisheries and ecosystems as well as mitigation measures are scarce or difficult to obtain. Moreover, the VMS has been used to map the fishing activity[187] in the areas available for oil exploration.

The competent environmental authorities are the **Ministry of Environment and Sustainable Development** (MESD), responsible for processing the Environmental Assessment (**Ley n° 25.675 General del Ambiente**) and issuing the Environmental Impact Statements of the oil and gas projects, and the **Secretariat of Energy**, in charge of controlling and supervising compliance with the Environmental Impact Statement and its corresponding Environmental Management Plan. MESD prepared the Protocol for monitoring marine fauna during the seismic exploration stage, a *"Communication Plan with the Fishing Area"*, an updated *"Environmental Management Plan"* and a *"Final Marine Fauna Monitoring Report"*. In the North

[186] https://www.argentina.gob.ar/economia/energia/hidrocarburos/mapas-del-sector-de-hidrocarburos
[187] https://www.magyp.gob.ar/sitio/areas/pesca_maritima/informes/pesquerias/index.php

Argentina Basin is the *Argerich Project*[188], the first offshore exploration well in deep waters (1,527 meters depth), which aims to explore 15,000 km^2 off the coast of Buenos Aires.

3.2 – Description of sensitive species and habitats

In the **northern Patagonian shelf** (41º S-48º S), including the regions of **Golfo San Jorge and the coast of the Province of Chubut**, a large amount of biological-fishing research has historically been carried out, mainly due to the presence of two of the most important fishery resources in the country: the common hake *Merluccius hubbsi* and the Patagonian shrimp *Pleoticus muelleri*, which has led to studies on the associated benthic communities.

The **Península de Valdés seasonal tidal front area** is characterised by a thermal front developed during the spring and summer months, which presents a **vertically homogeneous coastal region** (mixed by tidal currents), a weakly stratified transition region and another highly stratified region extending eastwards to the continental slope, with a pronounced thermocline due to the warming of the waters at the surface, as described by Acha (2009) [189]. This front is a region of high biological production, and the observed high nutrient concentrations are a consequence of the intense vertical mixing in the homogeneous region of the system, according to Carreto *et al*., (1986) [190].

Epifaunal benthic communities were sampled using a pilot net and **infaunal communities were sampled using a Day dredge** in a survey conducted in 2008. A total of 165 taxa were identified throughout the area (127 collected by dredges and 69 by fishing nets), forming a gradient of species that changes from an inshore zone (~ 60 m) in the homogeneous front region, then a transition zone and finally a group towards deeper zones in the frontal stratification region (~ 80 m). Polychaetes (48.8% of the total), molluscs (19.9%) and crustaceans (15.8%) numerically dominate the homogeneous zone, while in the stratified region polychaetes (43.2%), **cnidarians** (23.4%) and crustaceans (22.8%) are the most important groups. When considering the biomass values, the largest differences are observed. While in the homogeneous region brachiopods (52% of the total) and crustaceans (33%) are the most important groups, in the stratified region **porifera** (40%), polychaetes (20%) and echinoderms (11%) are the most important groups. The most important taxa were a species of the Order Actiniaria (average values per site of 101 ind/m^2 and 17.6 g/m2), the polychaetes *Cirratulus* sp. (54.5 ind/m^2 and 2/2 g.m2), Syllidae (41 ind/m2 and 0.09 g/m2) and *Nephtys* sp. (15 ind/m^2 and 0.08 g/m^2), the brachiopod *Magellania venosa* (14.3 ind/m^2 and 13.3 g/m^2) and several **sponge species** (74.4 g/m^2) of the Genus Tedania, among others, according to Gilberto *et al.,* (2012) [191].

According to Lonardi and Ewing (1971)[192], the **outer continental margin and slope** are cut by deep submarine canyons. In the region where the waters of the continental shelf converge with the waters of the Malvinas Current, a **thermohaline front** is generated that has **high primary production**, which sustains high levels of secondary production, constituting one of the most productive fronts in South

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[188] https://www.argentina.gob.ar/economia/energia/exploracion-costa-afuera
[189] Acha, E.M. 2009. Oceanografía biológica del frente de mareas de Península Valdés. Campaña CC-01/08. Inf. Camp. INIDEP N° 2/2009, 10 pp.
[190] Carreto, J.I., Benavides, H.R., Negri, R.M. & Glorioso, P.D. 1986. Toxic red-tide in the Argentine Sea. Phytoplankton distribution and survival of the toxic dinoflagellate *Gonyaulax excavata* in a frontal area. J. Plankton Res., 8:15-28.
[191] Giberto, D.A., Romero, M.V., Souto, V., Escolar, M., Bremec, C. & Machinandiarena, L. 2014. Fauna bentónica asociada a prerreclutasde merluza en la Zona Común de Pesca Argentino-Uruguaya y en la plataforma patagónica entre 44° y 47°S. Inf. Invest. INIDEP N° 49/2014, 18 pp.
[192]Lonardi, A.G. & Ewing, M. 1971. Sediment transport and distribution in the Argentine Basin. 4. Bathymetry of the continental margin, Argentine basin and other related provinces. Canyons and sources of sediments. Phys. Chem. Earth, 4: 81-121.

America, according to Acha *et al*., (2004)[193]. A frontal region also accumulates benthic invertebrate larvae that will later settle on the seabed. The high secondary production at the benthic community level due to the establishment of large aggregations of **Patagonian scallops (*Zygochlamys patagonica*)** along the slope front, especially in the 80-120 m range, is sustained by the input of energy in the form of food from the photic zone, according to Schejter *et al*., (2002)[194]. The basic assemblage of benthic invertebrates associated with Patagonian scallops in fished areas was analysed by Bremec and Lasta (2002) [195] and is composed of the sponge *Tedania* sp, the anemone *Actinostola crassicornis*, the echinoderms *Ophiactis asperula*, *Ophiacantha vivipara, Ophiura lymani, Sterechinus agassizii, Diplasterias brandti, Ctenodiscus australis, Psolus patagonicus* and *Pseudocnus dubiosus*.

The **Argentine continental slope** is cut by **deep submarine canyons** with the presence of VMEs. Spain conducted a series of surveys to identify VMEs and possible interactions with fisheries in international waters in the Southwest Atlantic[196].

Three MPAs, **Namuncurá-Banco Burdwood, Yaganes and Namuncurá-Banco Burdwood II**, have already been created. Four others MPAS have been proposed to be created in the near future: **El Rincón, Frente Valdez, Patagonia Azul** and **Agujero Azul.**

Regarding benthic communities, there are recent records of the presence of organisms mentioned as "**Indicator Taxa**" for the detection of **VMEs**. This type of community is represented by "true corals" (Hexacorallia), such as "soft corals" (Octocorallia) and "false corals", distributed from 120 m depth and more abundant on the slope, there are no studies in Argentina that report on their geographical distribution.

Among the arguments of some relevance used to justify the need to implement an MPA in the area known as the **Agujero Azul**, the particular topography of the seabed and the existence of cold-water corals and sponge fields that constitute VMEs have been mentioned. Such mention corresponds to the study made by Del Rio, *et al.,* (2012)[197] which was carried out in international waters, beyond 200 miles, outside the area proposed for the creation of the Agujero Azul MPA. The entire description of VMEs corresponds to the sector outside the Argentine EEZ, where fleets from different countries currently operate. In this regard, it should be recalled that the seabed and the benthic communities that inhabit it have recently become the property of Argentina as a result of the extension of the Platform approved by the UN. Therefore, the protection of the seabed up to mile 350 in those latitudes is Argentina's responsibility and it is exercising no control over bottom fishing operations that could affect the benthic fauna in the area. They therefore believe that if any area is to be protected with respect to benthic communities, it should be where VMEs have been proven to exist and there is no fishing regulation (beyond mile 200) and not within the Argentine EEZ, an area that is already regulated for the scallop fishery, where there is no proof of the existence of VMEs.

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[193] Acha, E.M., Mianzan, H.W., Guerrero, R.A., Favero, M. & Bava, J. 2004. Marine fronts at the continental shelves of austral South America. Physical and ecological processes. J. Mar. Syst., 44: 83-105.

[194] Schejter, L., Bremec, C., Akselman, R., Hernández, D. & Spivak, E.D. 2002. Annual
feeding cycle of the Patagonian scallop *Zygochlamys patagonica* (King and Broderip, 1832) in Reclutas bed (39° S-55° W), Argentine Sea. J Shellfish Res., 21: 553-559.

[195] Bremec, C. & Lasta, M.L. 2002. Epibenthic assemblage associated with scallop (*Zygochlamys patagonica*) beds in the Argentine shelf. Bull. Mar. Sci., 70 (1): 89-105.

[196] See section 3.4 – Mapping of sensitive species and habitats

[197] Del Río, J.L., Acosta, J., Cristobo, J., Portela, J.M., Parra, S., Tel, E., Viñas, L., Muñoz, A., Vilela, R., Elvira, E., Ibarrola, T., Pilar Ríos, P., Almón, B., Blanco, R., Murillo, J., Polonio, V., Fernández, J., Cabanas, J.M., Gago, J., González-Nuevo, G., Cabrero, A., Besada, V., Schultze, F., Franco, A., Bargiela, J. and García, X. (2012). Estudio de los Ecosistemas Marinos Vulnerables en aguas internacionales del Atlántico Sudoccidental. Temas de Oceanografía Nº 6. ISBN: 978-84-95877-24-6. Edita: Instituto Español de Oceanografía. Ministerio de Economía y Competitividad. 238 pages.

Burdwood Bank is part of the Scotia Arc, a group of islands and submarine platforms that connect South America and the Antarctic continent. It is a **submarine plateau** located 200 km south of the Falkland Islands and 150 km east of Staten Island. It comprises about 28,000 km^2 bounded by a 200 m isobath between 54° S-55° S and 56° W-62° W; it extends about 370 km in the east-west direction and varies between 50 and 100 km in the north-south direction. The depth of the plateau varies between 50 and 200 m and the seabed leads to a slope that reaches from 1,100 m to more than 3,000 m depth according to Zunino and Ichazo (1979) [198]. According to Piola and Gordon (1989)[199], the area is characterised by sub-Antarctic waters with surface temperatures between 4 and 5 °C, with mean salinity values of 34.

Burdwood Bank is included in the **southern shelf ecosystem** that extends from 47° S to 55° S and is characterised by **high productivity**, supporting several species of fish (the "polaca" *Micromesistius australis*, the "merluza negra" *Dissosticus eleginoides*, the "merluza de cola" *Macruronus magellanicus*, the "nototenia común" *Patagonotothen ramsayi* and the "sardina fueguina" *Sprattus fuegensis)* and commercially important squid (*Doryteuthis gahi, Illex argentinus*). It also constitutes both the **breeding area for fish species** and the trophic area for **elephant seals, birds and cetaceans**, according to Falabella (2017) [200].

The inventory of **benthic species of Burdwood Bank and more specifically of the Namuncurá MPA** was updated from a sampling carried out during an Antarctic survey on board the vessel "Puerto Deseado" in April 2013. Benthic taxa were collected with a **Pilot trawl and a square dredge (45 × 50 × 12 cm)** in the core (101 m) and buffer (113 m) areas of the MPA and on the west slope (236 m) of the bank and a total of **235 taxa** were identified according to Schejter *et al*., (2016) [201].

In the **Core**, 140 taxa were identified. Bryozoans and molluscs had the highest richness (47 and 25 taxa, respectively). Among crustaceans, the commercial species *Lithodes confundens* and *Paralomis granulosa* were recorded. Stylasteridae (false corals) were recorded, with lepas (Ornatoscalpellum gibberum) as epibionts. In the **Buffer zone**, brachiopods and calcareous tubes of serpulid polychaetes were conspicuous; 106 benthic taxa were identified here, of which 48 were bryozoans. In contrast, the **slope** was characterised by the highest contribution (in terms of relative biomass) of corals (Primnoidae, Flabellidae, Stylasteridae) and ophiuroids (*Ophiura lymanii, Gorgonocephalus chilensis*), out of a total of 86 taxa collected. According to Schejter *et al*., (2014) [202], many of the species collected at **Burdwood Bank**, especially those present in the Core and Buffer areas, are frequently recorded in the Patagonian scallop fishing grounds of the slope front.

Although the creation of the MPA was established by Law No. 26,875 of 2013, protection measures for the **Burdwood Bank** area and its surroundings began in 2004, when a **closed area for "merluza negra" (*Dissostichus eleginoides*)** fishing was established and bottom trawling was prohibited in the slope and western area of the bank; only vessels with an inspector or observer on board that caught less than 15% of the total number of juveniles of the species would be exempted

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[198]Zunino, G. & Ichazo, M.M. 1979. Los peces demersales del Banco Burdwood: distribución, abundancia de las especies y frecuencia de tallas (según datos de los B/I Walther Herwig y Shinkai Maru, campañas 1978-1979). Seminario de Oceanografía Biológica, Universidad de Buenos Aires, 66 pp.
[199]Piola, A. & Gordon, A.L. 1989. Intermediate waters in the southwest South Atlantic. Deep- Sea Res., 36 (1): 1-16.
[200]Falabella, V. 2017. Área Marina Protegida Namuncurá-Banco Burdwood. Contribuciones para la línea de base y el plan de manejo. Jefatura de Gabinete de Ministros, Buenos Aires, 76 pp.
[201]Schejter, l., Rimondino, C., Chiesa, I., Díaz de Astarloa, J.M., Doti, B., Elías, R., Escolar, M., Genzano, G., López-Gappa, J., Tatián, M., Zelaya, D.G., Cristobo, J.,
Pérez, C.D., Cordeiro, R.T. & Bremec, C.S. 2016 a. Namuncurá MPA: an oceanic hot spot of benthic biodiversity at Burdwood bank, Argentina. Pol. Biol., 39: 2373-2386.
[202]Schejter, L., Escolar, M., Marecos, A. & Bremec, C. 2014. Asociaciones faunísticas en las unidades de manejo del recurso "vieira patagónica" en el frente de talud durante el período 1998-2009. Inf. Invest. INIDEP Nº 13/2014, 29 pp.

from this prohibition. In 2008, both the **CFP** and the **SSPyA** also established an area of **Burdwood Bank** as a **total and permanent closed area for fishing**, according to Falabella (2017)[203].

South Georgia Islands is located in the South Atlantic Ocean, is also part of the Scotia Arc, lies towards its eastern end (approximately 54° S-37° W) and falls within **CCAMLR Subarea 48.3**. This archipelago is separated from the deep ocean by a shelf that varies in width from 50 to 150 km and is no deeper than 300 m; it is frequently traversed by **submarine canyons**, according to Meredith *et al*., (2003) [204]. The islands lie between two fronts of the Antarctic Circumpolar Current, the Polar Front and the Southern Front of the Antarctic Circumpolar Current. The northern and northwestern areas of South Georgia are affected by **intense annual phytoplankton blooms**, which are extensive (~145,000 km^2) and very long (>4 months) according to Borrione and Schlitzer (2013)[205]. The region is highly productive and supports important commercial fisheries, such as **krill** *Euphausia superba*, **"merluza negra"** *Dissostichus eleginoides* and **"pez de hielo"** *Champsocephalus gunnari*; the latter two are certified as sustainable by the Marine Stewardship Council [206].

Faunal information on **benthic organisms was obtained from research surveys** conducted on board the BIP "Dr. Eduardo L. Holmberg" during 1994 and 2013, jointly organized by INIDEP and the Argentine Antarctic Institute (IAA). The main groups were **echinoderms, porifera and cnidarians** in both periods studied and represent 77 and 71% of the total number of species collected in 1994 (82 taxa) and 2013 (96 taxa) respectively. The most frequently collected species were starfish *Labidiaster annulatus*, brittle stars *Astrotoma agassizii*, urchins of the genera *Ctenocidaris* and *Sterechinus*, as well as anemones *Actinostola* sp.

The determination of possible VMEs based on the presence of Indicator Taxa (IT) according to CCAMLR (2009) [207], was based on the analysis of material collected with a **biological "rastra"** (2.5 m frame opening) at 17 localities in the area during 2013 (Figure 6). The characterisation of an area as a VME was based on the determination of IT density values greater than 10 kg per 1,200 m^2, according to Lockhart and Jones (2009)[208]. The highest IT densities corresponded to sponges (Orders **Hexactinellida** and **Demospongiae**), Class **Ascidiacea**, echinoderms, specifically the Order Euryalida represented by the brittle stars *Astrotoma agassizii* and the long barbed urchins corresponding to the Class Echinoidea and the Order Cidaroida, and finally, the anemones grouped in the Order Actiniaria, the first two represented 86% of the total biomass of 12 IT collected. Six areas showed VME characteristics, as IT densities ranged between 15 and 19 kg 1,200 m^2. These areas corresponded to localities explored in the vicinity of **Rocas Cormorán**, **southwest and south platforms of Isla San Pedro**. In general, echinoderms dominated in biomass in areas north and west of San Pedro, while porifera dominated in the southern shelf of the island, according to Roux *et al*., (2002) [209].

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[203]Falabella, V. 2017. Área Marina Protegida Namuncurá-Banco Burdwood. Contribuciones para la línea de base y el plan de manejo. Jefatura de Gabinete de Ministros, Buenos Aires, 76 pp.
[204]Meredith, M.P., Watkins, J.L., Murphy, E.J., Ward, P., Bone, D.G., Thorpe, S.E., Grant, S.A. & Ladkin, R.S. 2003. Southern ACC Front to the northeast of South Georgia: Pathways, characteristics, and fluxes, J. Geophys. Res., 108 (C5), 3162. doi:10.1029/2001JC001227
[205]Borrione, I. & Schlitzer, R. 2013. Distribution and recurrence of phytoplankton blooms around South Georgia, Southern Ocean. Biogeosciences, 10: 217-231.
[206]https://www.msc.org/
[207] CCAMLR (Commission for the Conservation of Antarctic Marine Living Resources). 2009. CCAMLR VME Taxa Identification Guide Version 2009. Hobart, Tasmania, 4 pp.
[208] Lockhart, S.J. & Jones, C.D. 2009. Detection of Vulnerable Marine Ecosystems in the southern Scotia Arc (CCAMLR Subareas 48.1 and 48.2) through research bottom trawl sampling and underwater imagery. Document CCRVMA WG-EMM-09/32.
[209] Roux, A., Bremec, C., Schejter, L. & Giberto, D. 2005. Benthic invertebrates by-catch of demersal fisheries: a comparison between Subantactic and Antarctic shelf waters (45°S- 57°S). Berichte Zur Polar-Und Meeresforschung, 507: 179-181.

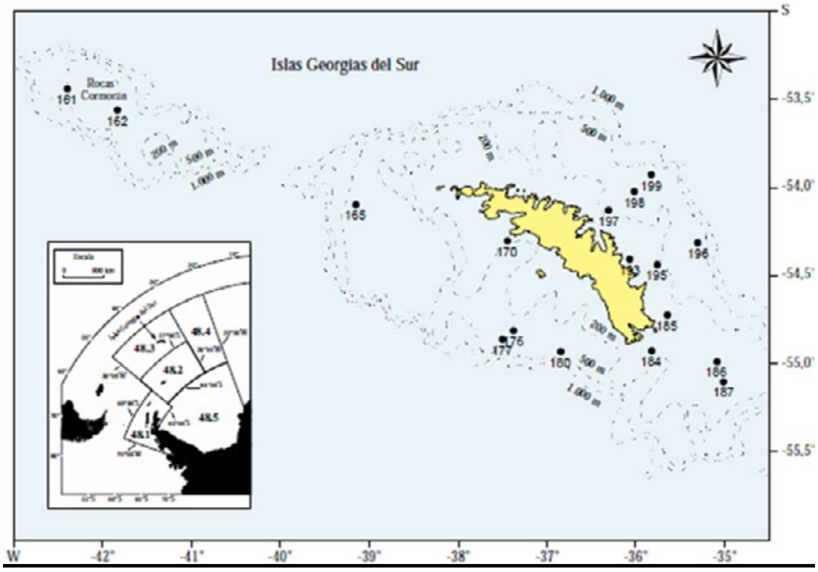

Figure 6. South Georgia Islands. Location of the benthic fauna sampling sites with "rastra" in the EH Survey 02/2013. The location of sub-area 48.3 of the CCAMLR Convention Area is shown in detail.

With regard to the main fisheries operating in the South Georgia Islands area under CCAMLR's jurisdiction[210]:

- The "**merluza negra" (*Dissostichus eleginoides*)** fishery has been operating since the mid-1980s. This fishery has been certified since 2004 and is managed through the **quota system**, which for the 2020/2021 season was 2,327 t. Patagonian toothfish fishing is only permitted using **longlines and pots**.
- The "**pez de hielo" (*Champsocephalus gunnari*)** fishery has less interaction with benthic communities at present due to regulations on permitted fishing gear. In this case, its fishery began in the early 1970s and reached a maximum catch of 170,000 t in 1983. Then began a steep decline in catches, not only in South Georgia but also in Shetland and South Orkney, which led to the **closure of the fishery in the 1990s and the prohibition of bottom trawling**. Currently and under CCAMLR regulations, in South Georgia the fishery is carried out with **pelagic nets** trying to avoid any kind of contact with the seabed and under the quota system, with a catch limit of 2,132 t for the period 2020-2021*.*
- For the ***Euphasia superba* kril**l fishery, the catch limit in sub-area 48.3 corresponding to South Georgia Islands is 279,000 t for **pelagic net fishing** in depths of 0 to 250 m, so there is little or no interaction of fishing gear with bottom communities. Vessels can use a **continuous fishing system** that hauls krill from the codend to the deck while trawling. Pumps can also be used to empty nets towed alongside the vessels.

During the Antarctic campaigns in the **Shetland Islands and the Antarctic Peninsula and Orkney Islands** conducted aboard the vessel "Puerto Deseado" **(CONICET)** in the summers of 2012, 2013 and 2014, studies of the benthic community collected with **bottom trawls and "rastas"** were carried out. The characterisation showed a predominance of **corals, sponges and echinoderms** in

[210]https://www.ccamlr.org/es/document/conservation-and-management/lista-de-las-medidas-de-conservaci%C3%B3n-vigentes-en-la-temporada-1

the sites studied, according to Schejter (2012) [211] and Gaitán *et al*., (2014) [212]. Gaitán *et al*., (2015) [213] conducted a characterisation of the relative biomass during the 2014 survey in the South Orkney Islands area. The most important groups in biomass (%) were **Holothuroidea** (29.7) and **Porifera** (28.1), followed by **Ascideacea** (13.6), **Asteroidea** (10.6) and **Bryozoa** (7.5), also detecting high contributions in IT biomass (50 to 75 % of the total biomass captured) in 5 of the 14 sites studied.

Gaitán *et al*., (2014) and Schejter *et al*., (2017) [214] describe **32 taxa corresponding to Demospongiae**, including new records for the area and one species new to science. Regarding **true corals (Order Scleractinia)** Schejter *et al*., (2016) [215] recorded a detailed inventory of the species collected during the Argentinian surveys and extended the geographic distribution of *Flabellum (Flabellum) areum* to 64° 53.63' S and the bathymetric distribution to 218 m.

Allega *et al.* (2020)[216] summarized the state of knowledge of benthic communities in relation to hydrocarbon exploration in the Argentine EEZ and adjacent areas. According to these authors, certain groups of benthic invertebrates (e.g. **sponges**, **cnidarians**, **tunicates**, **brachiopods**) identified in such areas are called indicator taxa (IT) and stand out for their ecological role and susceptibility to natural or anthropogenic changes. When biomasses greater than 10 kg 1,200 m^{-2} are detected in these groups, the habitats are included in the so-called VMEs.

3.3 – Assessment of bottom fishing impacts

Argentina[217] has an **Exclusive Economic Zone** of 1,530,500 km^2 and a coastline of 6,816 km. The sector of **PCA** waters in which fishing activities are carried out has an approximate surface area of 930,000 km^2. Due to the **relief of the seabed, its composition, and the type of resources** that inhabit it, the vast majority of which have demersal characteristics, fishing in Argentina is carried out almost entirely with **bottom fishing gear**, particularly **trawls**. Only a few pelagic fish species are caught with **mid-water nets or purse seines**, but they do not represent more than 3% of the annual catch. Other species are caught with specific fishing gear, such as jigging for the Argentine squid fishery, which can represent between 9% and 34% of the catch, depending on the year. On average, Argentina's marine fisheries produced approximately **830,000 tonnes of annual landings[218]** from 1990 to 2018 (Figure 7). The highest reported landings corresponded to the period 1995 - 1999 with an average value in the order of 1.2 M t, with the **historical maximum being recorded in 1997 with 1.35 M t**. The fishing activity is carried out in the **waters of the Argentinean continental shelf** with a varied fleet that is divided into several categories according to their size, autonomy, capacity and fishing gear used. The

[211] Schejter, L. 2012. Informe de Campaña Antártica de Verano 2011-2012. Buque Oceanográfico ARA "Puerto Deseado". Inf. Camp. INIDEP Nº 5/2012, 22 pp.

[212] Gaitán, E., Schejter, L. & Merlo Álvarez, H. 2014. Informe de la Campaña Antártica de Verano 2013-2014 Buque Oceanográfico A.R.A "Puerto Deseado". 2da etapa. Inf. Camp. INIDEP Nº 11/2014, 12 pp.

[213] Gaitán, E., Schejter, L. & Merlo Álvarez, H. 2015. Caracterización de las comunidades bentónicas en las Islas Orcadas del Sur durante la Campaña Antártica de Verano (CAV) 2013/ 14. En: IX Jornadas Nacionales de Ciencias del Mar, Ushuaia, Argentina, Resúmenes: 191.

[214] Schejter, L., Cristobo, J. & Ríos, P. 2017. South Orkney Islands: a poorly sponge-studied region of the White Continent. Results of Argentinean Antarctic Cruises 2012 and 2014. En: 10th International Sponge Conference, Galway, Irlanda, Resúmenes: 240.

[215] Schejter, L., Bremec, C. & Cairns, S.D. 2016. Scleractinian corals registered in the Argentinean Antarctic Expeditions between 2012 and 2014, with comments on *Flabellum* (*Flabellum*) *areum* Cairns, 1982. Pol. Res., 35 (1), 29762. doi:10.3402/polar.v35.29762

[216] Allega, L., Braverman, M.S., Cabreira, A.G., Campodónico, S., Colonello, J.H. et al. (2020) Estado del conocimiento biológico pesquero de los principales recursos vivos y su ambiente, con relación a la exploración hidrocarburífera en la Zona Económica Exclusiva Argentina y adyacencias. Mar del Plata Instituto Nacional de Investigación y Desarrollo INIDEP. 119p.

[217] 2018. FAO Fisheries and Aquaculture Department. Perfiles sobre la pesca y la acuicultura por países. La República Argentina (https://www.fao.org/fishery/es/facp/arg?lang=es)

[218] https://cepapesquera.org/wp-content/uploads/2020/05/La-Industria-Pesquera-y-las-Areas-Marinas-Protegidas-CEPA.pdf

geographical distribution of catches by quarter in the period 2013-2017[219] is illustrated in Figure 8.

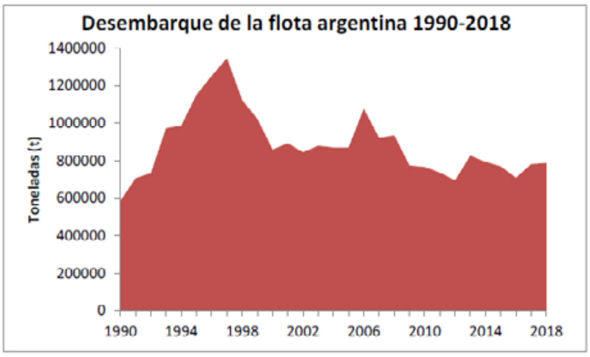

Figure 7. Total annual landings of marine fisheries in Argentina (period 1990-2018).

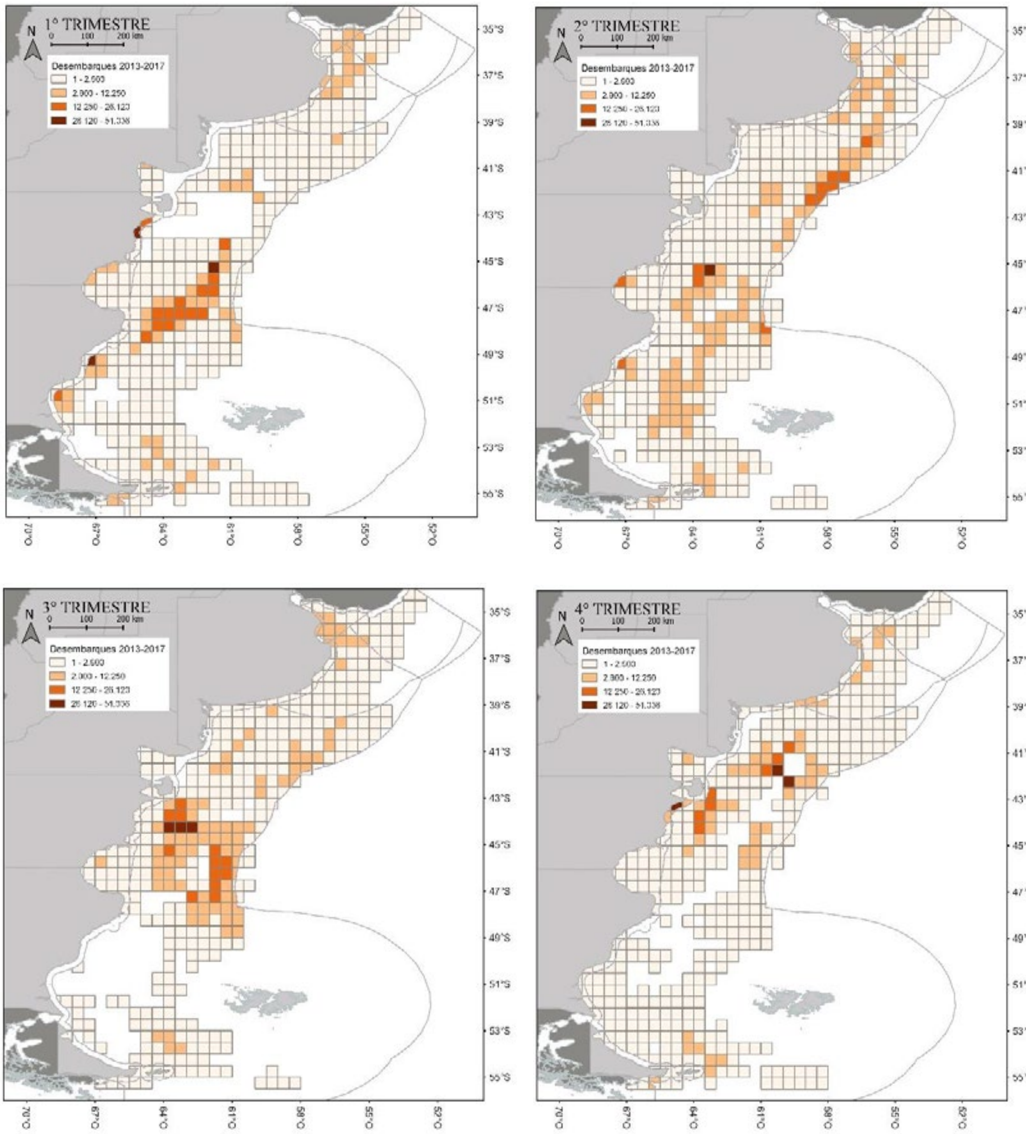

Figure 8. Distribution of cumulative quarterly landings in the Exclusive Economic Zone during the period 2013-2017. Source:https://docplayer.es/200895577-Informe-dpygp-n-09-2019-operatoria-y-desembarques-de-la-flota-pesquera-argentina-cuenca-norte-y-austral.html

[219] https://docplayer.es/200895577-Informe-dpygp-n-09-2019-operatoria-y-desembarques-de-la-flota-pesquera-argentina-cuenca-norte-y-austral.html

Argentinean fisheries exploitation is characterised by a low level of diversification. Although 70 to 75 species of fish, 5 to 7 crustaceans and 6 to 10 molluscs are reported annually, a high proportion of landings correspond to a small number of resources. For example, during 2018[220], **80% of the catches corresponded to 3 species: Argentine hake (*Merluccius hubbsi*) (33.9%), shrimp (*Pleoticus muelleri*) (32.3%) and Argentine squid (*Illex argentinus*)** (13.8%) (Figure 9).

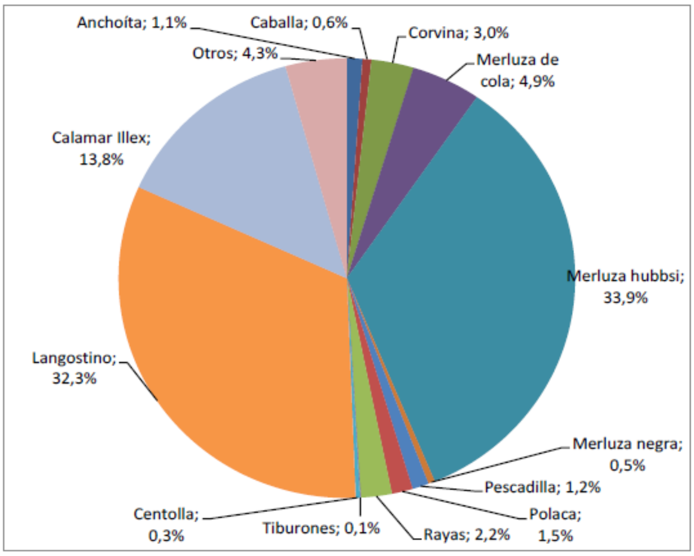

Figure 9. Percentage of main species landed in 2018.

The main fishery resources of the Argentinean Sea include bony fish, cartilaginous fish, molluscs and crustaceans. Fishery resources do not have a homogeneous distribution, so different ecological groups are recognised[221].

- The **coastal-Bonaerense fishing group** includes as main species "corvina", "gatuzo" and "pescadilla" and as secondary species "corvina negra", corvina negra, "pescadilla", "pargo", "testolin" (*Prionotus nudigula*), "bagre de mar" (*Genypterus blacodes*), "besugo", "brótola", "trilla" (*Mullus argentinae*), "lenguados" (*Mancopsetta maculata*, *Paralichthys orbygnianus*, *P. patagonicus*) and "chucho". (*Myliobatis goodei*).
- The "merluza argentina" is the dominant species on **the inner and outer shelves of the Bonaerense and Patagonian sectors**, followed in importance by the "abadejo", "tiburón espinoso" (*Squalus acanthias*), "castañeta" (*Cheilodactylus bergi*) and "nototenia" (*Patagonotothen ramsayi*).
- The **North Patagonian gulfs (San Matias, San Jose and Nuevo)** include "merluza argentina", "merluza de cola", "palometa pintada" (*Parona signata*), "savorín" (*Seriolella porosa*), "abadejo", "mero", "salmón de mar" (*Pseudopercis semifasciatus*), "cherna" (*Polyprion americanus*), "castañeta", "bacalao austral", "nototenia", "cazón", "gatuzo", "tiburón espinoso", "pez gallo" (*Callorhynchus callorhynchus*) and various rays.
- The **Southern Patagonian-Fuegian and Malvinas shelf complex** comprises "polaca" (*Micromesistius australis*), "merluza de cola", "merluza común", "merluza austral", "merluza negra", "abadejo" and "bacalao austral" (*Salilota australis*).
- The **deep-water assemblage of the continental slope area** consists of "granadero" (*Coelorhynchus fasciatus*), "polaca", "merluza austral" and "merluza de cola".

[220]https://cepapesquera.org/wp-content/uploads/2020/05/La-Industria-Pesquera-y-las-Areas-Marinas-Protegidas-CEPA.pdf
[221]Cousseau, M. B. y R. G. Perrotta (2004). Peces marinos de Argentina. Biología, distribución, pesca. INIDEP, Mar del Plata.

From the point of view of exploitation, the species of the "coastal variety" are identified, which inhabit the littoral zones down to a depth of 50 metres along the coast of Buenos Aires. They sustain small-scale fisheries of regional scope, with relatively small biomasses and which support a great fishing effort and in some cases signs of overfishing. This group is made up of "corvina rubia", "pescadilla de red", "pescadilla real" (*Macrodon anclyodon*), "pargo" (*Umbrina canosai*), "corvina negra", "lenguados", "rayas", "gatuzo", "besugo", "palometa", "pez palo" (*Percophis brasiliensis*), "pez ángel" (*Squattina guggenheim*), "brótola", "mero", "salmón", "congrio" (*Conger orbygnianus*), "lisa", "saraca" y "pejerrey". On the other hand, there are those species that sustain industrial fishing, such as "merluza común", "polaca", "merluza de cola", "corvina" and "abadejo".

According to the degree of exploitation, a distinction is made between: i) resources that are **intensely exploited** and/or **have been overfished**: "merluza común", "besugo", "corvina rubia", "pescadilla", "merluza austral", "polaca", "merluza negra", and some coastal chondrichthyans ii) resources with conditions close to overexploitation: "abadejo", "gatuzo", "mero", "salmón", centollón (*Paralomis granulosa*) iii) resources with **high temporal variation**: the Argentine shrimp and squid; iv) **underexploited** resources: anchovy and Patagonian toothfish mainly but also "caballa", "castañeta" and "rubio" (*Helicolenus dactylopterus*), "sardina fueguina" (*Sprattus fuegensis*), "savorín", "granadero" and "congrio" (*Conger orbygnianus*).

The vessels that make up the **Argentinean fishing fleet**[222] can be divided, from the point of view of their mode of operation, into **trawlers** (the majority of the fleet) and **vessels equipped with specific and selective gear and equipment** (beam trawlers, longliners, jiggers and trappers). On the other hand, according to the type of methods of preservation and processing of fish on board, the fleet can be divided into fresh fishing vessels, freezer vessels and factory vessels.

Fresh fishing vessels (also known as "hieleros" or "cajoneros") are vessels that transport the catch in refrigerated form, irrespective of the fishing gear used and their loading and navigation capacity. The fresh fishing fleet comprises "**rada o ría**" vessels, "**coastal**" vessels and part of the "**deep-sea fleet**". Inland vessels are units with or without cold (ice) capacity and with or without hold, with a reduced sailing time. The coastal and deep-sea fresh fleet is made up of vessels with cold storage capacity (mechanical equipment or ice), whose dimensions, load capacity and autonomy, in some cases allow them to sail for up to thirty days. Depending on the resources targeted by their activity, fresh trawlers mainly use bottom trawls (targeting "corvina", "pescadilla", "coastal mixted", "merluza"), mid-water trawls (targeting pelagic species such as anchovy, mackerel) and beam trawlers (targeting shrimps).

The **freezer fleet** is made up of deep-sea fishing vessels equipped with mechanical **freezing systems** (plates/tunnels or other). Depending on the type of fishing gear used, freezer vessels can be "**ramperos**" bottom trawlers (Argentine hake and accompanying fauna, southern demersal species and scallops), "**beam trawlers**" (prawns), "**jiggers**" (Argentine squid), "**trappers**" (spider crab) and "**longliners**" ("merluza negra", "abadejo", "rayas" and other southern species), and can process the products in different ways, regardless of the fishing gear used, given their status as floating processing plants. Table 3 shows the landings of the Argentinean fleet from 2010 to 2020 by vessel type [223,224].

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[222]https://www.magyp.gob.ar/sitio/areas/pesca_maritima/informes/pesquerias/_archivos//000001_Generales/220209_Distribuci%C3%B3n%20espacial%20de%20los%20Desembarques%20de%20la%20flota%20argentina%202006-2019.pdf

[223]INF DPP Nº 02/2022. Actividad de la flota comercial argentina, Cuenca Norte y Austral. Res. MEyM 197/2018.

[224]https://docplayer.es/227250037-Informe-dpp-n-02-2022-actividad-de-la-flota-comercial-argentina-cuenca-norte-y-austral-res-meym-197-2018-periodo.html

Table 3. Evolution of landings by type of vessel (period 2010-2020) in tons.

Year	Fresh fleet "Fresqueros"			Freezer fleet "Congeladores"					TOTAL
				Trawlers "Arrastreros"		Longliners "Palangreros"	Jiggers "Poteros"	Trappers "Tramperos"	
	Rada o ría	Coastal "Costeros"	Offshore "Altura"	Ramperos	Beam trawlers "Tangoneros"				
2010	31.289	96.727	273.697	233.397	54.117	1.384	72.351	1.694	764.655
2011	29.917	113.652	255.896	210.011	60.038	2.029	58.990	3.333	733.867
2012	38.033	105.459	201.192	195.654	63.711	2.117	81.529	4.567	692.263
2013	41.353	112.591	227.791	202.318	72.234	1.944	162.186	3.728	824.145
2014	35.490	118.329	207.166	199.332	78.239	557	148.857	3.174	791.142
2015	27.509	121.612	208.366	198.551	89.485	965	117.039	4.132	767.657
2016	26.988	126.384	198.461	196.001	100.826	402	54.186	2.477	705.725
2017	30.706	149.028	208.992	191.399	109.708	300	86.695	2.174	779.001
2018	43.222	134.598	209.913	185.181	119.943	122	96.564	2.093	791.636
2019	40.666	142.897	212.106	196.295	100.492	74	86.790	1.984	781.304
2020	44.249	139.409	210.327	189.508	55.492	14	148.826	1.922	789.746

The **Argentinean fleet consists between 800 to 1000 multipurpose vessels**, whose activities vary depending on the season and year. In 2011, of the 896 vessels operating in Argentina, 420 of them were artisanal craft limited to bays and estuaries (**i.e. *"rada o ría" and "artisanal"***), including 293 vessels that have only provincial license and operate within the 12 mile territorial sea; 121 were the far and near coastal fleet (***"costeros cercanos" and "lejanos"***); 139 belonged to the offshore fleet (***"fresqueros de altura"***), and 216 were freezer trawlers (***"congeladores"***). The freezer trawlers can in turn be broken down into demersal and pelagic trawlers (44), beam trawlers (*"ramperos"* 79), longline (6), jiggers (84), and factory trawlers (3)[225,226]. Table 4 shows the characteristics of the Argentinean fishing fleet with an indication of the type of gear used and the target species.

Table 4. Characteristics of Argentina's fishing fleet.

Type	Length (m)	Beam (m)	Engine (HP)	Load (ton)	Crew	Navigation Distance (mn)	Gears	Species
"Rada o ría"	9	4	100-200	5-8	2-6	15	1,2,4,5,6,7	1,2,3,4,5,6,7,8,9,10
Near coastal fleet	9-15	3.5-4	250-300	10-12			1,2,4,5,6,7	1,2,3,4,5,6,7,8,9,10,11
Far coastal fleet	15-25	4.5-6	250-400	10-20	4-10	180	1,4,5,8,9, 10,11	1,2,5,6,7,8,9,10,11
Offshore fleet	25-50	6-9	400-1700	50-200	6-21	ZEE	3,4,6,8,10	1,2,8,11,1,15,16,17
Jiggers	45-70	9-12	1220-2200	400-500	22-30	ZEE	12	19
Freezers	40-144	10-20	1800-7000	400-2000	25-80	ZEE	3	1,15,16,17
Longliners	28-60	7-11	700-2400	90-400	20-35	ZEE	13	16,20,21,22
Beam trawlers	28-50	7-10	800-200	90-400	18-25	ZEE	14	8

EEZ: Economic Exlusive Zone.
Species caught: 1: "anchoíta" (*Engraulis anchoita*), 2: "caballa" (*Scomber japonicus*), 3: "pejerrey", 4: "lisa" (*Mugil lisa*), 5: "corvina rubia", 6: "pescadilla", 7: "anchoa de banco" (*Pomatomus saltatrix*), 8: "langostino", 9: "camarón", 10: "saraca" (*Brevoortia aurea*), 11: "bonito" (*Sarda sarda*), 12: "besugo" (*Pagrus pagrus*), 13: "anchoa de banco", 14: "saraca", 15: "merluza argentina", 16: "abadejo" (*Genypterus blacodes*), 17: "merluza de cola" (*Macruronicus magellanicus*), 18: "caballa", 19: "calamar argentino", 20: "merluza negra" (*Dissostichus eleginoides*), 21: "merluza austral" (*Merluccius australis*) y 22: "brótola". Gears. 1: "red de cerco lampara", 2: "línea de mano", 3: "red de arrastre de fondo", 4: "red de media agua", 5: "a la pareja a media agua", 6: "a la pareja a fondo", 7: "ranio o rastra", 8: "red de cerco con jareta", 9: "rastra de mejillones", 10: "nasas de besugo", 11: "redes de enmalle", 12: "poteras", 13: "palangres de fondo", 14: "redes marisqueras".

[225] Sebastian Villasante, Gonzalo Macho, Josu Isusu de Rivero, Esther Divovich, Kyrstn Zylich, Sarah Harper, Dirk Zeller and Daniel Pauly. 2015. Reconstruction of marine fisheries catches in Argentina (1950-2010).Working Paper Series Nº 50. Fisheries Centre, University of British Columbia, Vancouver, Canada.
[226]2018. FAO Fisheries and Aquaculture Department. Perfiles sobre la pesca y la acuicultura por países. La República Argentina (https://www.fao.org/fishery/es/facp/arg?lang=es)

In 2018, **exports of Argentine fishery products**[227] reported a value of USD 2,148 million, experiencing a significant increase in value compared to previous years (Figure 10). This increase was especially driven by the growing export of **shrimp** (USD 1.3 billion), followed by **Argentine hake** (USD 252 million) and **Argentine squid** (USD 238 million). Of the remaining species, the following stand out for their value: "**merluza negra**" (*Dissostichus eleginoides*) (65.6 million USD), **scallops** (*Zygochlamys patagonica*) (50.4 million USD), **rays** as a whole (various species) (32.7 million USD), "**corvina**" (*Micropogonias furnieri*) (27.4 million USD) and **spider crab** (*Lithodes santolla, Lithodes confundens*) (24.7 million USD).

The highest value products recorded in exports in 2018 were "**merluza negra**" (U$D 24,700/t), **scallop** (U$D 12,600/t) and **prawn** (U$D 7,000/t).

The main destinations for Argentine fishery products are the **European and Asian markets**, which accounted for around 75% of the total value of exports in 2018, with the Brazilian and North American markets also standing out. **Spain and China** led imports with 483.5 M and 475.6 Million U$D, respectively. Italy (181.1 million USD), USA (150.6 million USD), Japan (104.4 million USD) and Brazil (92.8 million USD) were also important trade destinations. Other countries such as Thailand, Peru, Russia, Vietnam, Korea and France imported Argentine fishery products for more than 50 million USD during 2018.

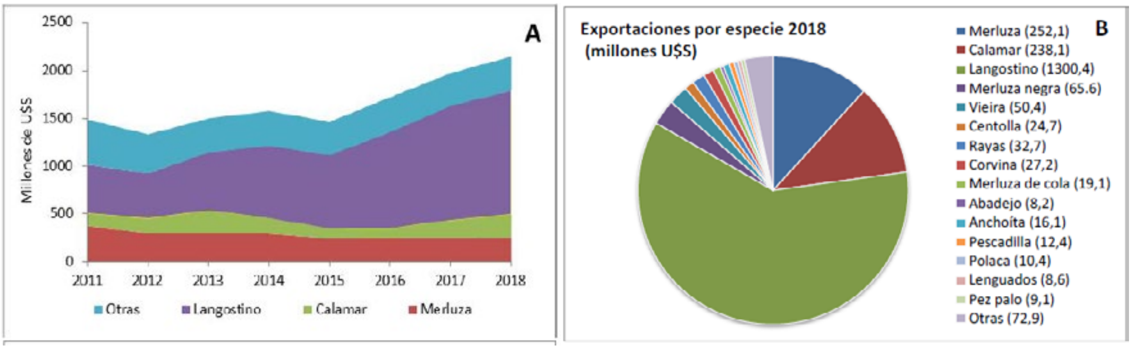


Figure 10. A: Evolution of exports (in million US$) of the main Argentine marine fishery species in the period 2011-2018. B: Specific composition of the main exports of Argentine fishery products during 2018.

Argentina's fisheries regulations related to the protection of resources and ecosystems are summarised below.

1.- <u>Federal Fisheries Act</u> – "<u>Ley Federal de Pesca (LFP)</u>"

The **Federal Fishing Regime** established by **Law Nº 24.922 (1997)**, has determined the institutions which are in charge of generating policies, establishing regulations and ensuring compliance, as well as authorising access to fishing grounds and distributing resources, making the maximum development of fishing activity compatible with the rational use of its living resources.

The emphasis on the federal character of the law comes from the extension of the jurisdiction of the Provinces with a maritime coastline over the territorial sea adjacent to their coasts, in line with the **jurisdiction of the Nation beyond the first twelve nautical miles**, within the framework established by the law, as well as the legal design of the **Federal Fisheries Council (CFP)**, the governing body of the national fisheries policy and the main regulator of the activity. In particular, due to its collegiate composition of five provincial representatives and five from the national government. The law covers the various aspects relevant to maritime fisheries: research, conservation and management of the sea's living resources. Since its creation, it has been the legal basis on which the Federal Fisheries Council has

[227] https://cepapesquera.org/wp-content/uploads/2020/05/La-Industria-Pesquera-y-las-Areas-Marinas-Protegidas-CEPA.pdf

designed the national fisheries policy. The **instruments for fisheries management** from the biological point of view are currently used by the CFP to ensure the **sustainability of the resources and their fisheries**, as well as to **preserve the marine environment** in accordance with the international guidelines established by the FAO: (i) establishment of a total allowable catch or control of fishing effort, (ii) regulation of minimum catch size or implementation of selective fishing gear and methods, (iii) creation of closed or restricted effort areas and seasons, and (iv) establishment of measures that do not allow illegal or unreported fishing.

2.- <u>Regulation of catches</u>

Article 18 of the **LFP** establishes that the **CFP** will establish annually the **Maximum Allowable Catch (MAC)** per species, based on the recommendations of **INIDEP**. It also establishes the **annual catch quotas** per vessel, per species, per fishing zone and per fleet type. At present these species are: "abadejo", "merluza austral", "merluza de cola", "anchoíta", "caballa", "merluza común", "merluza negra", "polaca" and "vieira".

In the case of the species under the **Individual Transferable Catch Quotas (ITCQ)** management system ("merluza común sur" 41°S, "merluza de cola", "polaca", "merluza negra" and "vieira"), the corresponding tonnes are calculated for each vessel according to its own quota.

On the other hand, in the framework of the **CTMFM**, a binational body that administers the resources of the Common Fishing Zone shared by Argentina and Uruguay, management measures are established, among which are the **Total Allowable Catches** ("merluza", "anchoíta", "corvina rubia", "pescadilla", "lenguados", "rayas costeras" and "de altura", "gatuzo", "pez ángel", "besugo" and "pez palo"), **closed areas** ("merluza" and chondrichthyans) and **restricted effort** ("corvina"), among others.

3.- <u>Closed areas or seasons</u>

The establishment of **closed areas or seasons** corresponds to the **CFP**[228] under the advice and recommendations of **INIDEP**, since it is the body whose purpose is the formulation and execution of pure and applied research programmes relating to fishing resources and their rational exploitation throughout the national territory in accordance with the fishing research policies to be formulated by the CFP itself. Therefore, the **CFP** has not only established catch limits according to scientific advice, but has also set restrictions on access to fishing grounds through the establishment of temporary and spatial closures. Such closures and restricted fishing effort zones affect the accessibility of fishing fleets to the resources they are intended to protect. In addition, closures act by limiting the vulnerability of these resources to the fishing gear used. Figure 11 shows the closed and/or restricted effort areas currently in force within Argentina's EEZ.[229].

[228]Article 19 of LFP.
[229] https://www.argentina.gob.ar/inidep/areas-de-veda

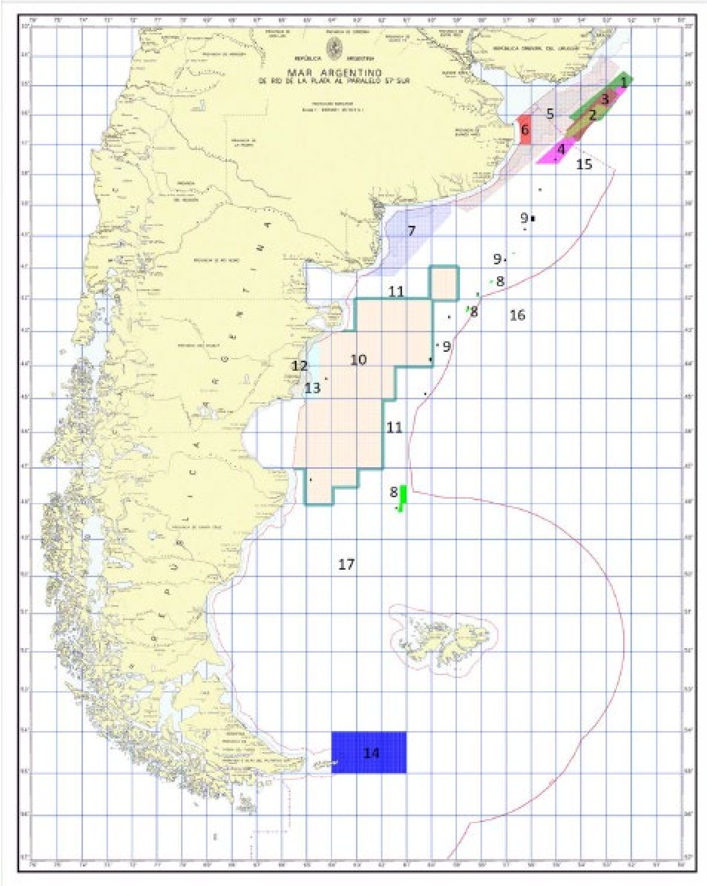


Figure 11. Closed and/or restricted effort areas established by the Consejo Federal Pesquero and the Comisión Técnica Mixta del Frente Marítimo Argentino Uruguayo.

1) Summer precautionary closure area for hake (CTMFM). (2) Autumn precautionary closure area (CTMFM). (3) Winter precautionary closure area (CTMFM). (4) Spring precautionary closure area (CTMFM). (5) Restricted effort area (CARP-CTMFM). (6) Closed area for chondrichthyans (CTMFM). (7) El Rincón spawning and fishing effort restricted area (CFP). (8) Closed areas for pollock catch (CFP). (9) Spawning reserve areas - scallop (CFP). (10) Patagonian Hake Closed Area (CFP). (11) 5-mile area adjacent to the Patagonian Closed Area (CFP). (12) Inter-jurisdictional Area of restricted fishing effort in Chubut waters (CFP - Province of Chubut). (13) Restricted fishing effort area in waters under national jurisdiction (CFP). (14) Patagonian toothfish juvenile protection area (CFP - Tierra del Fuego Province). (15) ZCP squid fishing area (CTMFM). (16) Squid fishing area north 44°S (CFP). (17) Squid fishing area south 44°S (CFP).

Details of the regulations in force establishing closed areas, restricted access or special fishing regimes in waters under national jurisdiction are given below:

1. **Resolution N° 16/2018 CTMFM**. Prohibits from 1 January to 30 March 2019 inclusive, the fishing of the Argentine hake species (*Merluccius hubbsi*), as well as the use of all types of bottom fishing gear in the sector demarcated and identified with the number 3 within the Common Fishing Zone. It applies to both the Argentine and Uruguayan fleets. The main purpose of this closure is to protect juvenile hake. It has been established every year since 1995 and its limits are determined annually on the basis of the latest scientific information available. Average annual area involved: approximately 14,000 km^2.

2. **Resolution N° 1/2019 CTMFM.** Prohibits from 1 April to 30 June 2019 inclusive, the fishing of the Argentine hake species (*Merluccius hubbsi*), as well as the use of all types of bottom fishing gear in the sector delimited and indicated as number 4 within the Common Fishing Zone. It applies to both the Argentinean and Uruguayan fleets. The main purpose of this closure is to protect juvenile hake. It has been established every year since 1993 and its limits are determined annually on the basis of the latest scientific information available. Average annual area involved: approximately 14,000 km^2.
3. **Resolution N° 6/2019 CTMFM.** Prohibits from 1 July to 30 September 2019 inclusive, the fishing of the Argentine hake species (Merluccius hubbsi), as well as the use of all types of bottom fishing gear in the sector delimited and indicated as number 5 within the Common Fishing Zone. It applies to both the Argentinean and Uruguayan fleets. The main purpose of this closure is to protect juvenile and adult hake spawners. It has been established every year since 2011 and its limits are determined annually according to the updated scientific information available. Average annual area involved: approximately 14,000 km^2.
4. **Resolution N° 11/2019 CTMFM.** Prohibits from 1 October to 31 December 2018 inclusive, the fishing of the Argentine hake species (Merluccius hubbsi), as well as the use of all types of bottom fishing gear in the sector delimited and indicated as number 6 within the Common Fishing Zone. It applies to both the Argentinean and Uruguayan fleets. The main purpose of this closure is to protect juvenile hake. It has been established every year since 1993 and its limits are determined annually on the basis of the latest scientific information available. Average annual area involved: approximately 14,000 km^2.
5. **Resolution CARP - CTMFM N° 10/2000** establishing a limit of 28 m for the maximum/total length of vessels authorised to operate in the area delimited and identified as number 5 on the reference map. This rule limits the fishing effort on species such as "corvina", whiting and other inshore resources. It applies to both the Argentinean and Uruguayan fleets. Area involved: approximately 69,000 km^2.
6. **Resolution N° 11/2018 CTMFM** (complemented with Province of Buenos Aires in jurisdictional waters). Prohibits from 1 November 2018 to 31 March 2019 inclusive, bottom trawling in the sector delimited and indicated as number 6 within the Common Fishing Zone. It applies to both the Argentine and Uruguayan fleets. The main purpose of this closure is to protect juveniles and spawning fish of various species of chondrichthyans and coastal bony fish. Total area involved: approximately 5,600 km^2.
7. **Resolution 02/2010 CFP.** Establishes a closed and restricted effort zone in the area known as El Rincón. Trawling is prohibited in the sector identified as No. 10 from 1 October to 31 March each year. In this restricted effort zone, vessels of less than 25 metres in length or up to 29 metres with a history of fishing in the area are allowed to operate in the non-closed season. Area involved: approximately 46,100 km^2.
8. **Resolution 10/2017 CFP.** Establishes the prohibition of bottom trawling in order to protect concentrations of pollock (*Genypterus blacodes*) located in 6 areas along the shelf edge between 40°30'S and 48°15'S. Total area involved: approximately 1800 km^2.
9. **Resolution 15/2012 CFP.** Establishes 14 fishing exclusion areas for reproductive reserve purposes in the respective scallop (*Zygochlamys patagónica*) management units, prohibiting bottom trawling permanently in these areas. Total area involved: approximately 750 km^2.

10. **Resolution 26/2009 (art. 8) CFP.** Creation of the Patagonian Closed Area for the protection of juvenile Argentine hake (*Merluccius hubbsi*). Its limits have been modified over the years until reaching the current extended delimitation, identified with the number 13 in the graph. Bottom trawling operations are permanently prohibited. Area concerned: approximately 180,000 km^2.
11. **Resolution 26/2009 (art. 11) CFP**. Creates a 5-mile area adjacent to the Patagonian closed area, at its northern, eastern and southern limits, in which fishing activities by freezer vessels are prohibited. Area concerned: approximately 18,500 km^2.
12. **Resolution 484/2004 (art. 20) Ex SAGPyA.** Establishes an interjurisdictional area of restricted effort in the territorial waters of the province of Chubut, in which only the fleet of vessels authorised to fish for Argentine hake (*Merluccius hubbsi*) by a resolution can operate. Article 9 of Resolution CFP 26/2009 ratifies the prohibition of bottom trawling for hake in this area. Area concerned: approximately 7,300 km^2.
13. **Resolution 484/2004 (art. 20) Ex SAGPyA.** Establishes an interjurisdictional area of restricted effort in national waters in which only the fleet of vessels authorised to fish Argentine hake (*Merluccius hubbsi*) can operate. Article 9 of Resolution CFP 26/2009 ratifies the prohibition of bottom trawling for hake in this area. Area concerned: approximately 6,800 km^2.
14. **Resolutions 17/2002 and 03/2004 CFP (complemented by Resolution MP 98/2004 -** Province of Tierra del Fuego in jurisdictional waters). Establishes the protection area for juvenile Patagonian toothfish (*Dissostichus eleginoides*), prohibiting trawling at depths of less than 800 metres. It requires the presence of inspectors and observers on board when operating in this area. Total area concerned: approximately 23,100 km^2.
15. **Resolution 2/2019 CTMFM.** Establishes the opening of fishing for Argentine squid (*Illex argentinus*) in the Argentine-Uruguayan Common Fishing Zone as from 10 April 2019.
16. **Resolution 973/1997 Ex SAGPyA.** Establishes the opening of fishing for Argentine squid (*Illex argentinus*) north of the 44° parallel from 1 May to 31 August each year, unless for conservation reasons the fishing season is closed earlier, with directed fishing for the species remaining prohibited in that sector for the rest of the year.
17. **Resolution 973/1997 Ex SAGPyA.** Establishes the opening of fishing for Argentine squid (*Illex argentinus*) south of the 44° parallel on 1 February to 31 April each year, unless for conservation reasons the fishing season is closed earlier, with directed fishing for the species remaining prohibited in that sector for the rest of the year.

The surface area of the **closed areas represents a total of 289,000 km^2** and those of **restricted effort an additional 88,000 km^2**, in the latter case with partial protection. Considering the entire EEZ in which the Argentinean fleet can operate, the area protected by spatial closures represents a percentage of around 23%, and adding the restricted effort areas, 30%. This means that even without considering the existence of the three Marine Protected Areas (MPAs) established by law (Namuncurá/Banco Burdwood, Burdwood II and Yaganes), and all the coastal protected areas with marine projection (26), a **large part of the Argentinean Sea** that the flag fleet can access **is protected** by different resolutions/provisions established by the specific regulatory bodies related to fishing.

If additionally, it **is considered the three MPAs** mentioned above and the regions of the territorial sea protected by the coastal-marine MPAs, whose total surface area together amounts to some 148,000 km^2, this proportion **rises to a total of 42%** of the areas under the control of the Argentine state.

The **closed areas**, although they are generally established by Resolutions and not by law, are conceptually assimilable to MPAs, and should therefore be **considered within the framework of Argentina's Marine Protected Areas System**. Although their limits can be modified according to the protection needs and the distribution of the resources that inhabit them, they have regulatory measures for the management of permitted and prohibited activities within them. Although they do not have a specific management plan for each area, the protective effect on the ecosystems and/or resources included in these zones is similar to that of the MPAs established by law.

4.- <u>Other measures adopted</u>.

Since 2008, Argentina has had a "**National Action Plan to prevent, deter and eliminate illegal, unreported and unregulated fishing**". This plan was drawn up following the guidelines of the FAO's International Plan of Action, developing an integrated control system, which includes the granting of **fishing permits**, their registration, the **generation of databases of fishing declarations**, **satellite monitoring of the industrial and commercial fleet, on-board and landing controls, control of compliance with quotas**, etc.

Recently it has included: (i) **Legal Catch Certification System**: for the main fisheries and for all destinations, a customs control system has been established that requires the presentation of a certificate issued by the Fisheries Enforcement Authority indicating the legal origin of the exported catches, and (ii) **On-board camera system**: implementation of a control system using cameras installed on fishing vessels, and the development of the system's management software. It is currently operational on only a few test vessels, but planning includes the significant expansion of the number of units to be fitted with the devices.

5.- <u>Non-target species measures</u>

Regarding **non-target species**, following the principles of the FAO Code of Conduct for Responsible Fisheries, the CFP has approved four **National Plans of Action** (“**Planes de Acción Nacional”- PAN**) to reduce interactions with **Sharks, Birds, Mammals and Marine Turtles** (CFP Res. 6/2009, CFP Res. 3/2010, CFP Res. 11/2015 and Act 37/2016) where the main objective is to contribute to the ecosystem-based management of fisheries. FAO's **International Plans of Action (IPOAs)** are tools of diagnostic value and voluntary application by States that highlight conservation as a central objective of fisheries management.

All IPOAs were developed in a participatory manner in conjunction with the scientific sector and civil society organisations and have a permanent **Technical Advisory Group (TAG)** and three-year operational plans.

The CFP adopted concrete measures to mitigate seabird bycatch in fishing operations (Res. 03 /2017 and 08/2008) following the guidelines of the **PAN-Birds** as well as the recommendations of the **Agreement for the Conservation of Albatrosses and Petrels (ACAP)**, which was approved by Congress through Law No. 26,107, for which specific projects were carried out to adapt technology and operations to the characteristics of Argentina's longline and trawl fleet.

In 2009, the CFP approved the "**National Action Plan for the Conservation and Management of Chondrichthyans (sharks, rays and chimaeras) in Argentina**". The main objective is to guarantee the conservation and sustainable exploitation of chondrichthyans within the national jurisdiction. It establishes a protection framework for rays, sharks and chimaeras, which are top predators of the marine ecosystem and at the same time sensitive species vulnerable to sustained fishing exploitation due to their longevity and late maturity. It is part of the International **Plan of Action for the Conservation and Management of**

Chondrichthyans (IPOA-Sharks) established by FAO in 1999, in response to growing international concern about the vulnerability of chondrichthyan (sharks, rays and chimaeras) populations, the collapse of some historic shark fisheries around the world and the rapid increase in chondrichthyan landings in recent years. It is complemented by the **Regional Plan of Action for the conservation and sustainable fishing of chondrichthyans of the Rio de la Plata Treaty Area and its Sea Front**, established in 2018.

3.4 – Mapping of sensitive species and habitats

Deep-sea environments are under increasing anthropogenic pressure. Marine spatial planning is central to applying ecosystem-based management and area-based conservation strategies, which have been called for by the UN 2030 sustainable development agenda goal 14. Marine spatial planning relies on accurate mapping of biodiversity and habitats in relation to anthropogenic activities. However, deep-sea environments remain poorly mapped, especially in the South-West Atlantic due in part to remoteness and being a funding limited location

According to Pearman *et al*., (2022)[230] the Southwest Atlantic deep sea is an undersampled region that hosts unique and globally important faunal assemblages. To date, our knowledge of these assemblages has been predominantly based on ex situ analysis of scientific trawl and fisheries bycatch specimens, limiting our ability to characterise faunal assemblages. Incidental sampling and fisheries bycatch data indicate that the Falkland Islands deep sea hosts a diversity of fauna, including vulnerable marine ecosystem (VME) indicator taxa. To increase our knowledge of Southwest Atlantic deep-sea epibenthic megafauna assemblages, benthic imagery, comprising 696 images collected along the upper slope (1070–1880 m) of the Falkland Islands conservation zones (FCZs) in 2014, was annotated, with epibenthic megafauna and substrata recorded. A suite of terrain derivatives were also calculated from GEBCO bathymetry and oceanographic variables extracted from global models. The environmental conditions coincident with annotated image locations were calculated, and multivariate analysis was undertaken using 288 'sample' images to characterize faunal assemblages and discern their environmental drivers. Three main faunal assemblages representing two different sea pen and cup coral assemblages, and an assemblage characterised by sponges and Stylasteridae, were identified. Subvariants driven by varying dominance of sponges, Stylasteridae, and the stony coral, *Bathelia candida*, were also observed. The fauna observed are consistent with that recorded for the wider southern Patagonian Slope. Several faunal assemblages had attributes of VMEs. Faunal assemblages appear to be influenced by the interaction between topography and the Falkland Current, which, in turn, likely influences substrata and food availability. Quantitative analyses provide a baseline for the southern Patagonian shelf/slope environment of the FCZs, against which to compare other assemblages and assess environmental drivers and anthropogenic impacts.

The map of corals recorded on the Argentine continental shelf (Figure 12) indicating the regions where high densities have been recorded (corresponding to VMEs) is available in Allega *et al.* (2020)[231].

Furthermore, Spain carried out a series of surveys within the Argentine continental slope up to 1500 m depth to identify VMEs and possible interactions with fisheries in international waters in the Southwest Atlantic, following the recommendations of the

[230] Pearman, T.R.R.; Brewin, P.E.; Baylis, A.M.M.; Brickle, P. (2022). Deep-Sea Epibenthic Megafaunal Assemblages of the Falkland Islands, Southwest Atlantic. Diversity, 14, 637. https://doi.org/10.3390/d14080637

[231] Allega, L., Braverman, M.S., Cabreira, A.G., Campodónico, S., Colonello, J.H. et al. (2020) Estado del conocimiento biológico pesquero de los principales recursos vivos y su ambiente, con relación a la exploración hidrocarburífera en la Zona Económica Exclusiva Argentina y adyacencias. Mar del Plata Instituto Nacional de Investigación y Desarrollo INIDEP. 119p.

United Nations (UNGA Resolutions 59/25[232] and 61/105[233]) and the International Guidelines for the Management of Deep-Sea Fisheries in the High Seas (FAO, 2008) [234], cold-water coral reefs were detected in this region, mainly composed of the species *Bathelia candida*, gardens of soft corals that present to their times a large amount of associated fauna, located at depths of between 400 and 1,000 m and fields or aggregates of sponges in deep waters that are formed mainly by porifera of two classes: Cl. Hexactinellida and Cl. Demospongiae, located between 250 and 1,300 m deep. depth (Figure 13). In deep areas dominated by soft substrate, sea pens (Order Pennatulacea) were recorded, with *Anthoptilum grandiflorum* being the most frequent, according to Portela *et al*., (2012)[235].

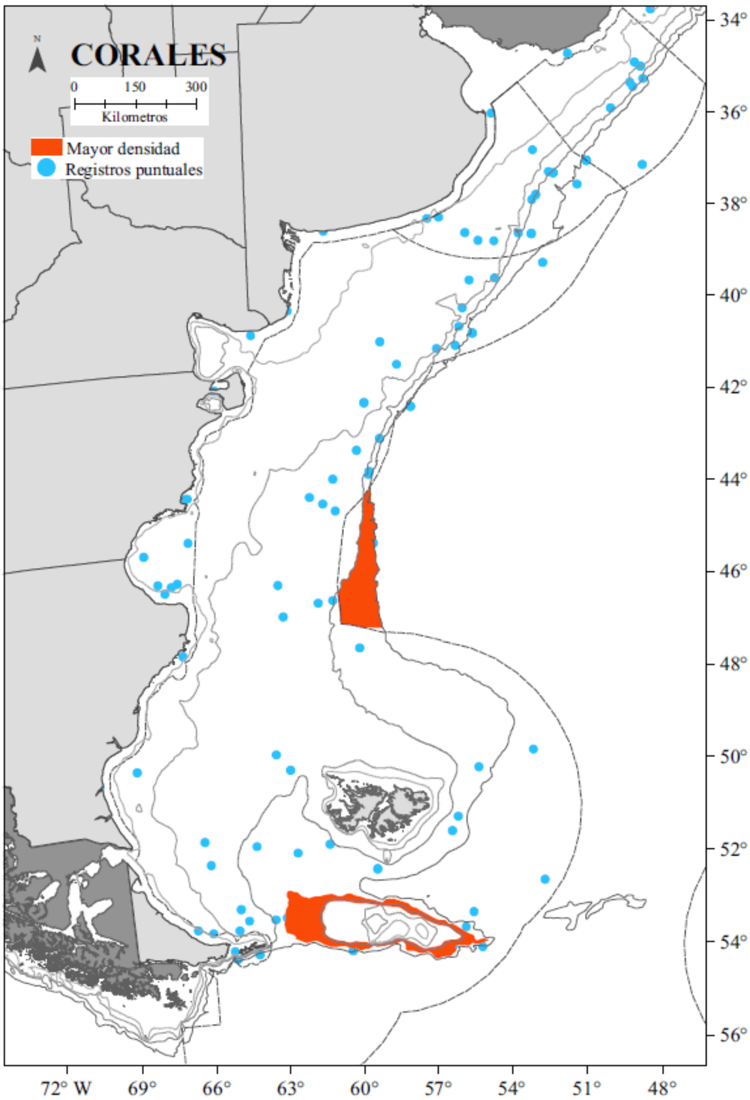


Figure 12.- Corals recorded on the Argentine continental shelf. Areas shaded in orange indicate the regions where high densities have been recorded, corresponding to VMEs. The blue dots correspond to point records of corals (Source: Allega *et al.*, 2020)

232 Resolución AGNU 59/25 de 17 de noviembre de 2004.
233 Resolución AGNU 61/105 de 8 de diciembre de 2006.
234 FAO, 2008. Consulta técnica sobre las directrices Internacionales para la ordenación de las Pesquerías de aguas profundas en alta mar. Roma (Italia), 4-8 de febrero de 2008. TC: DSF/2008/Inf.3. 33pp.
235 Portela, J., Acosta, J., Cristobo, J., Muñoz, A., Parra, S., Ibarrola, T., Del Río, J.L., Vilela, R., Ríos, P., Blanco, R., Almón, B., Tel, E., Besada, V., Viñas, L., Polonio, V., Barba, M. & Marín, P. 2012. Management Strategies to Limit the Impact of Bottom Trawling on VMEs in the High Seas of the SW Atlantic. En: Cruzado, A. (Ed.). Marine Ecosystem. InTech: 199-228.

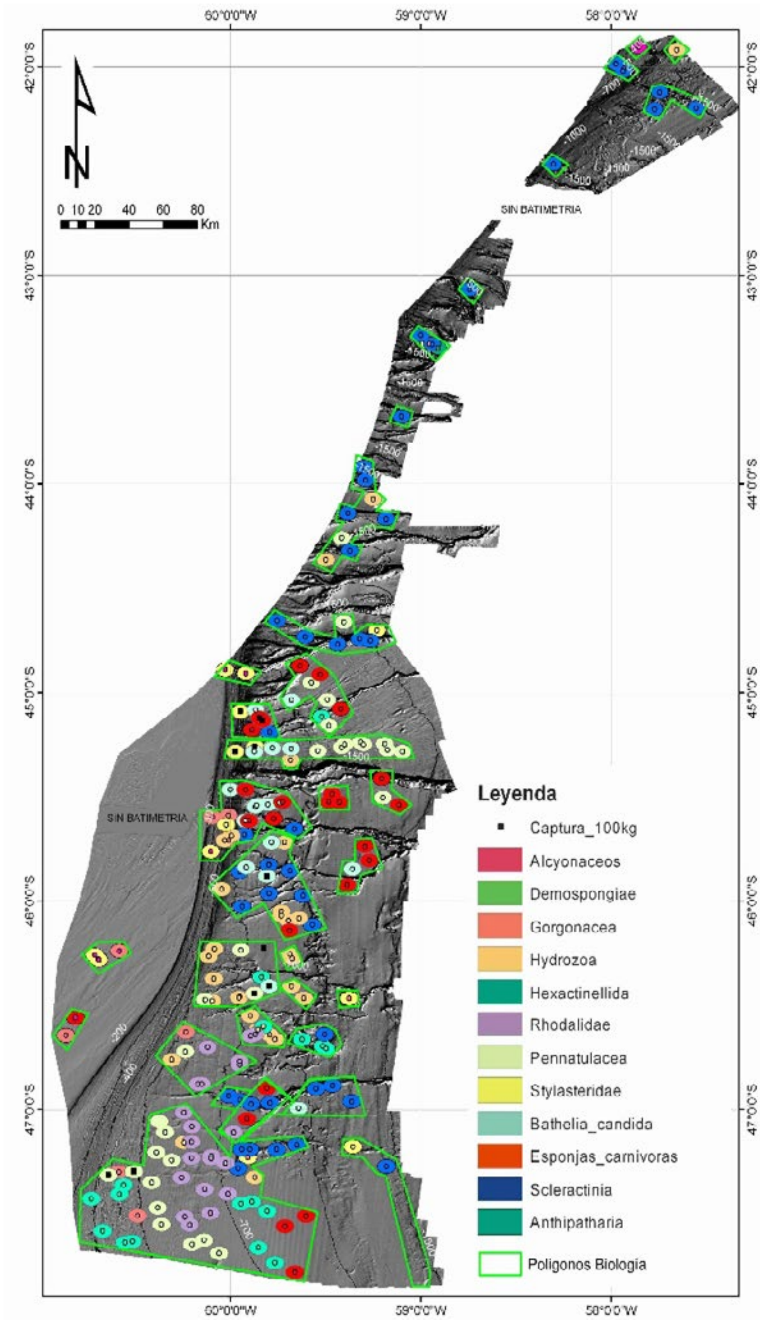


Figure 13.- Positions of all organisms considered vulnerable in international waters of the Southwest Atlantic according to UN and OSPAR criteria. The conservation polygons that circumscribe them are also shown.
Source:http://www.ieo.es/documents/10640/31690/Temas+de+Oceanograf%C3%ADa+06+-.pdf/9f7d8404-4682-498d-b0a7-1ab4c2357aa0

3.5 – Impact mitigation and protection measures

Argentina, through the **National Biodiversity Strategy and Action Plan 2015-2020**[236], set a target of 10% protection coverage of marine and coastal areas within its maritime spaces by 2020, in accordance with Target 11 of the Strategic Plan for Biodiversity 2011-2020[237], adopted in 2010 by the 10th meeting of the Conference of the Parties to the Convention on Biological Diversity[238].

[236] https://www.argentina.gob.ar/ambiente/biodiversidad/estrategia-nacional
[237] https://www.cbd.int/doc/meetings/ecr/cbwecr-sa-01/other/cbwecr-sa-01-cbd-02-es.pdf
[238] https://www.cbd.int/undb/media/factsheets/undb-factsheets-es-web.pdf

To achieve this goal, the **National Secretariat of Environment and Sustainable Development (SGAyDS)** promoted the creation of three **MPAs**, which are currently established, and has identified and plans to transform into **MPAs** different areas considered of interest to be incorporated into the **National System of Marine Protected Areas (SNAMP).**

Law 27.037[239] of 2014, which creates the **SNAMP** with the aim of **protecting and conserving marine areas representative of different habitats and ecosystems**, distinguishes five categories for protection within MPAs and in each of them different activities are prohibited and permitted, as described below:

a) Strict National Marine Reserve: Area of maximum protection. Reserved as reference areas for scientific research, monitoring, control and surveillance activities.
b) National Marine Park: Area of conservation of marine biodiversity, landscape quality and large-scale ecological processes. Scientific, educational, and recreational uses. Tourism is the only economic activity allowed.
c) Marine National Monument: Area limited to the conservation of an attribute of special or unique interest of marine biodiversity or landscape quality. Scientific, educational, and recreational uses. Tourism is the only economic activity allowed.
d) National Marine Reserve for Habitat or Species Management: An area intended to protect the identified needs of particular species or the maintenance of habitats. It is characterised by its location limited to its special interest, which may be permanent or temporary.
e) National Marine Reserve: Admits scientific, educational, recreational uses and the sustainable use of one or more of its resources.

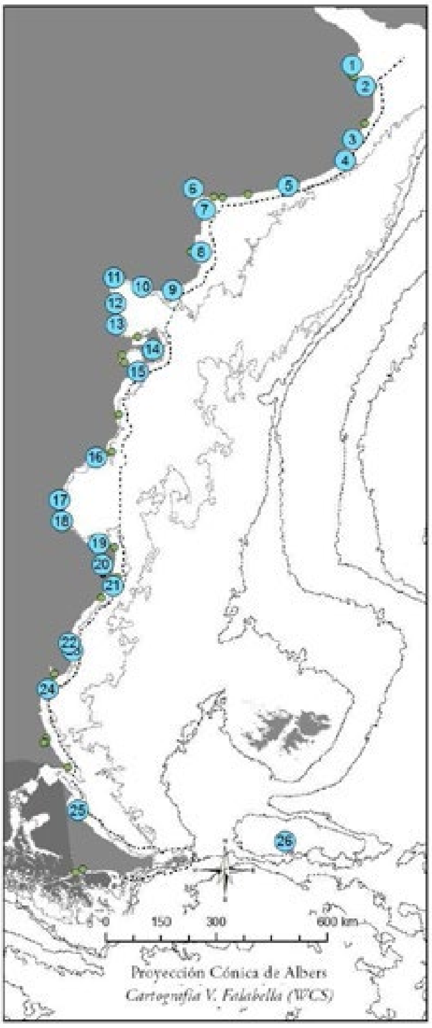
The **oceanographic characteristics of the Argentinean Sea** are strongly influenced by the cold Malvinas Current, which circulates northwards, providing nutrient-rich waters, and the Brazil Current, with warmer and saltier waters, which circulates southwards. The existence of **fronts or areas where different water masses meet** in certain sectors of the Argentinean Sea generate conditions of high biological productivity. These include the **Brazil-Malvinas convergence, the tidal fronts, the mid-shelf front, the southern front and the slope front**. This complex oceanographic system makes the Argentinean Sea a diverse ecosystem rich in environments and biological diversity.

The coast presents a **high geomorphological and climatic variety** that maintains a biodiversity of coastal marine species of global significance. It is home to important **colonies of seabirds and marine mammals**, **cetacean breeding areas (whales and dolphins)**, sites of international importance for the resting and feeding of migratory birds, areas of fish and crustacean reproductive concentration, algae meadows, subtidal mollusc banks, among other aspects of ecological importance.

The fauna of the Argentinean Sea is made up **of invertebrates, bony and cartilaginous fish, birds, turtles and marine mammals**. Many of the species, whether turtles, birds, mammals or even fish (mainly cartilaginous), are subject to different conservation problems. For example, the grey-headed albatross is in danger of extinction and the black-browed albatross and the southern giant petrel are in the vulnerable category. Two turtle species (green and loggerhead) are threatened, while the leatherback turtle is endangered. Most marine mammals are in the vulnerable category according to **SGAyDS Resolution N° 1030/2004**. Of all of them, the Franciscana dolphin is one of the most endangered marine mammals of the Argentinean coasts.

[239] https://www.argentina.gob.ar/parquesnacionales/normativas/ley27037#:~:text=La%20Ley%20N%C2%BA%2027.037%20instituye,y%20ecosistemas%20de%20importancia%20nacional.

There are currently **61 Coastal Marine Protected Areas (APCM)** in Argentina, 26 of them include in their boundaries marine protected areas[240]. Most of them are very small (median 89 km^2) and were created as isolated and independent units, according to particular characteristics of the coast and biota that were considered unique and therefore worthy of protection. Of these, there are **21 provincial areas** that protect approximately 11,500 km^2 of marine spaces within 12 miles of the Territorial Sea. Likewise, three **Interjurisdictional Parks** (Southern Patagonia, Isla Pingüino and Makenke) add up to approximately 3,000 km^2 of marine spaces also within the 12 nautical miles. The last of these to be incorporated is the **Patagonia Azul Biosphere Reserve**[241], which is a large area (totalling some 27,000 km^2) including 15,000 km^2 of marine area off the coast of the Province of Chubut (Figure 14).



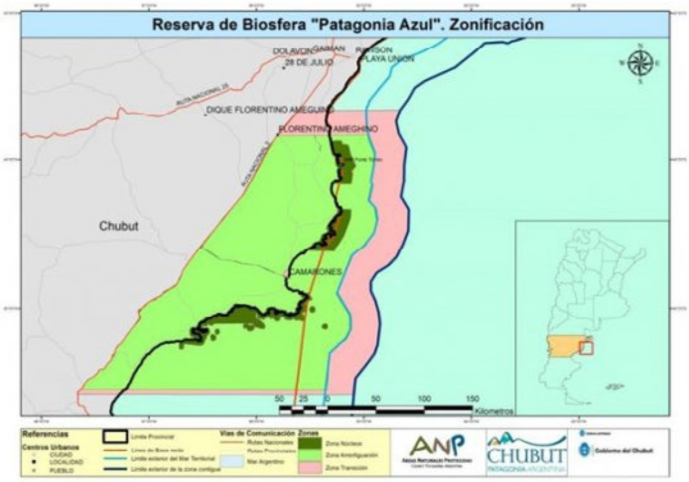


Figure 14. Coastal Marine Protected Areas in Argentina (left) and detail of the Patagonia Azul Biosphere Reserve (right).
Sources:https://www.argentina.gob.ar/sites/default/files/ambiente-sistema-nacional-areas-marinas-protegidas.pdf; https://lu17.com/destacado/patagonia-azul-la-reserva-de-biosfera-mas-grande-del-pais

[240]https://www.argentina.gob.ar/sites/default/files/ambiente-sistema-nacional-areas-marinas-protegidas.pdf
[241]https://lu17.com/destacado/patagonia-azul-la-reserva-de-biosfera-mas-grande-del-pais

There are currently three exclusively oceanic **Marine Protected Areas** in the Argentinean Sea. The first of these, called **Namuncurá-Banco Burdwood**[242], was created in 2013 by Law 26.875 (3 July 2013). It contributes some **28,000 km^2** to the SNAMP and comprises the water column and benthic space of the underwater plateau known as Burdwood Bank, delimited by the 200-metre isobath. The **CFP** had already established a closed area for fishing activities in the area in 2008 (ACTA CFP 18/2008, which led to SSPyA Provision 250/2008). Burdwood Bank is a submerged plateau located south of the Falkland Islands and one hundred and fifty kilometres east of Staten Island. It is at least fifty metres deep and is surrounded by much deeper water. The Bank interrupts the flow of water of the Falkland Current as it moves northwards. At its encounter with Burdwood Bank, this current produces vertical water movements or "upwellings" that bring nutrients from the seabed to the surface, and together with the contribution of sunlight, generate an increase in productivity relative to adjacent marine regions. As a result, it is an **important feeding and distribution area for different types of birds** such as penguins, albatrosses and petrels, and **mammals** such as the southern dolphin, the southern elephant seal and the South American sea lion. In addition, the surrounding waters are breeding and **spawning grounds** for "polaca", "merluza negra" and "sardina fueguina". Among the species that make up the benthic ecosystem in Burdwood Bank and its slope, organisms considered **"vulnerable"** stand out, such as **corals, sponges, ascidians and bryozoans**, with the presence of **fourteen endemic species of cold water corals being of particular interest.**

In order to regulate extractive and scientific activities in **Namuncurá Bank**, Law 26.875 established a zoning in concentric areas that differentiates the activities permitted in the **Core Zone, the Buffer Zone and the Transition Zone** (Figure 15).

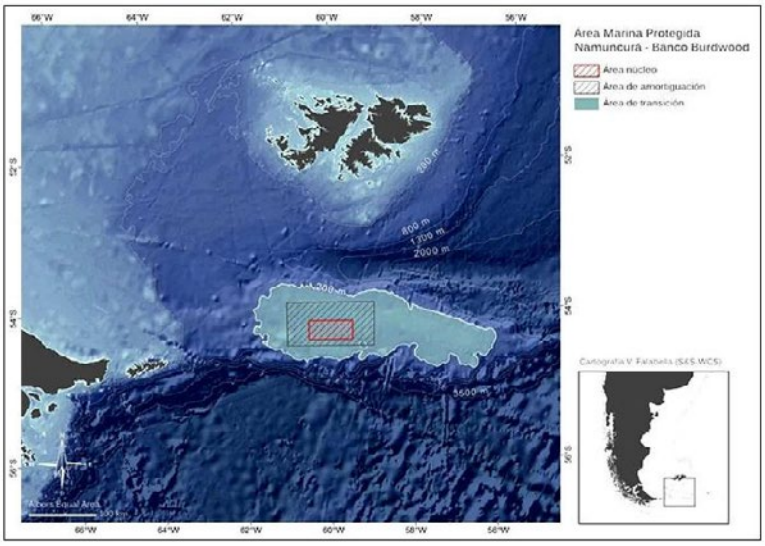


Figure 15. Namuncurá-Bank Burdwood Marine Protected Area. The Core Zone, Buffer Zone and Transition Zone are indicated. Source: Ezquiroz, M. y Uena, L. (2014). Área Marina Protegida Namuncurá-Banco Burdwood: primera área protegida oceánica, avances y desafíos. Revista Digital del Instituto Universitario Naval (INUN) N° 4. Buenos Aires: 11pp

In the core zone, activities are only for control and monitoring. In the buffer zone, scientific research and resource exploration activities are allowed for the sole purpose of increasing knowledge of marine biodiversity, sustainable management of natural resources, restoration of degraded areas and monitoring the effects of global change on the marine environment. In the transition zone, productive and extractive

[242] https://www.argentina.gob.ar/parquesnacionales/areasmarinas/namuncura-burdwood

activities contemplated in the Management Plan[243] and authorised by the Authority of Application are authorised.

In parallel with the creation of the Namuncurá-Banco Burdwood MPA in 2013, the "**Faros del Mar Patagónico**"[244] (FMP) initiative was developed, consisting of an international network of NGOs created to coordinate the joint work of civil society organisations. In the FMP initiative, a series of marine areas were identified as relevant for biodiversity conservation, particularly for endemic or threatened species. With the precedent of the "FORO FMP"[245] held in 2013, the SGAyDS held a workshop in 2014 to identify key ecological areas in Argentina's EEZ as candidate sites for the creation of MPAs. Eight large marine areas outside the territorial sea (12 nautical miles) were identified, based on the Convention on Biological Diversity criteria for the identification of Areas of Biological and Ecological Importance (Figure 16).

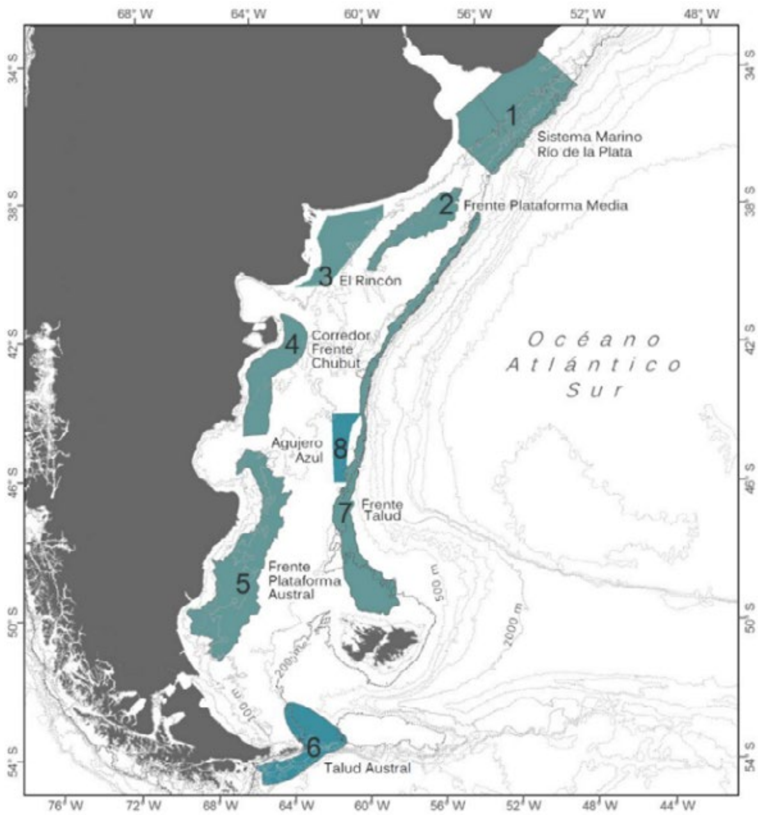


Figure 16. Candidate areas for the creation of Marine Protected Areas resulting from the national expert consultation held in 2014. Source: https://www.argentina.gob.ar/sites/default/files/2018/10/identificacion_de_areas_de_alto_valor_de_conservacion_2014.pdf

According to the criteria used, all proposed marine areas met at least 5 of the 7 CBD criteria: i) Exclusivity or rarity, ii) Special importance for the life cycle of species, iii) Special importance for threatened species or habitats, iv) Vulnerability, fragility, sensitivity or slow recovery, v) Biological productivity, vi) Biological diversity and vii) Naturalness.

As a result of the debate in various workshops attended by representatives of different ministries with interests in the Argentine Sea, six areas of interest were finally selected to integrate the SNAMP, which were presented at a meeting convened by the Chief of Cabinet of Ministers on 19 June 2017. They were:

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[243] http://argentinambiental.com/wp-content/uploads/pdf/1023-PlanManejoAreaNamuncura.PDF
[244] https://marpatagonico.org/proyectos/faros-del-mar-patagonico/
[245] Foro (2013). Faros del Mar Patagónico. Áreas relevantes para la conservación de la biodiversidad marina. V. Falabella, C Campagna, S. Krapovickas (Eds). Resumen Ejecutivo. Buenos Aires, Argentina. WCS y FVSA.

1. El Rincón National Marine Park and National Marine Reserve.
2. Frente Valdés National Marine Park.
3. Patagonia Azul Marine Nature Reserve.
4. Agujero Azul Marine National Reserve and Marine National Monument.
5. Burdwood Bank II National Marine Reserve and Strict Marine National Reserve.
6. National Marine Reserve, National Marine Park and Yaganes Strict Marine National Reserve.

Of the 6 new MPAs proposed, the last two mentioned were established by Law No. 27.490 in December 2018. Therefore, two more fully marine MPAs were created: the **Yaganes MPA**[246] and the **Namuncurá-Banco Burdwood II MPA**[247].

The incorporation of these areas adds more than 100,000 km² to the marine area protected by MPAs, constituting, according to the criteria of the **SAyDS**, an important step towards achieving the protection of 10% of Argentina's maritime spaces, as foreseen in the **Strategic Plan for Biological Diversity 2011-2020** assumed by the parties to the Convention on Biological Diversity.

Yaganes adds nearly 69,000 km² to marine protection, while **Namuncurá-Banco Burdwood II** covers more than 32,000 km². They are located at the southern tip of the continent, with Yaganes located further west, to the Chilean border, and Namuncurá-Banco Burdwood II to the southwest of this geographical feature, bordering the northern part of the Namuncurá-Banco Burdwood MPA.

The **Yaganes MPA** involves important sectors of two productive fronts of high biodiversity, corresponding to the Cold (Beagle Channel) and Subantarctic Estuarial Fronts (Figure 17). It also includes a portion of the **slope, canyons and seamounts containing high biodiversity and high vulnerability**, with the presence of corals (Hexacorallia; Octocorallia) that generate structures that increase the biodiversity of the communities over time and are identified as VMEs. It is the area of physical and biological connection between the Pacific and Atlantic Oceans, influenced by the Antarctic Circumpolar Current and constitutes a representative sample of the Southern Slope and Drake Passage region.

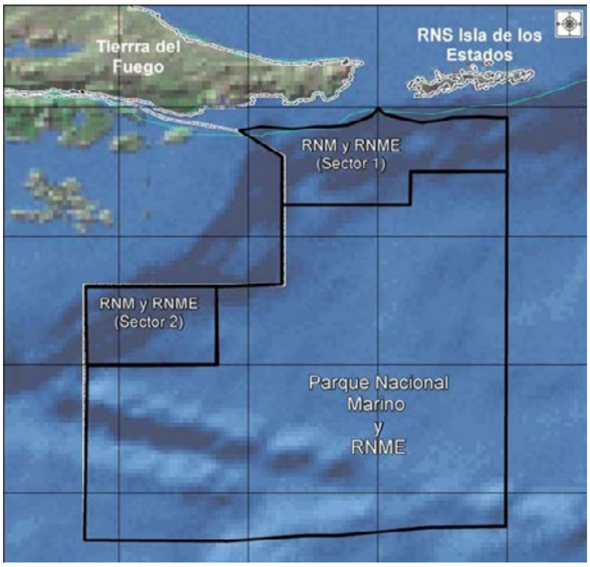

Figure 17. Yaganes MPA. The location of the National Marine Reserves and Strict National Marine Reserves, as well as the National Marine Park, are indicated.
Source: https://www.argentina.gob.ar/parquesnacionales/areas-marinas-protegidas

[246] https://www.argentina.gob.ar/parquesnacionales/areasmarinas/yaganes
[247] https://www.argentina.gob.ar/parquesnacionales/areasmarinas/namuncura-burdwood

The **Namuncurá-Banco Burdwood II National Marine Reserve and Strict Marine National Reserve** (Figure 18) constitutes an MPA that is integrated to the existing Namuncurá-Banco Burdwood, extending protection to the slope and southern slope of the Bank. The southern slope includes a deep seabed (4,000 m) with the presence of submarine canyons important for benthic biodiversity, constituting an **area of high biodiversity for vulnerable and endemic benthic species considered VME indicator taxa**. It constitutes a representative sample of the Southern Slope region that complements deep-sea environments with the Namuncurá-Banco Burdwood Marine Protected Area.

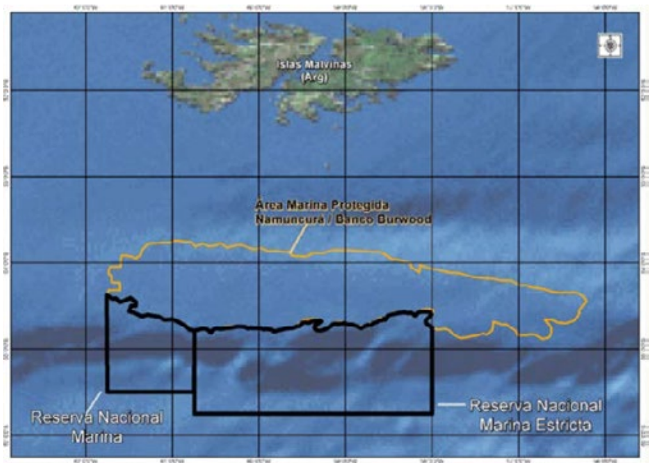

Figure 18. Namuncurá-Banco Burdwood II MPA. The areas corresponding to the National Marine Reserve and the Strict National Marine Reserve are indicated.
Source: https://www.argentina.gob.ar/parquesnacionales/areas-marinas-protegidas

In the proposals for the creation of the three MPAs, the conservation value of the area was described on the basis of three main aspects: **benthic communities of conservation importance**, the existence of feeding and migration areas for top predators, and areas of importance for the conservation of fish of commercial interest.

Regarding **benthic communities**, there are recent records of the presence of organisms mentioned as "**Indicator Taxa**" for the detection of so-called **Vulnerable Marine Ecosystems (VMEs)**. These communities are also known as "animal forests" and are represented by "**true corals" (Hexacorallia)**, **such as "soft corals" (Octocorallia) and "false corals"**, distributed from 120 m depth and more abundant on the slope. Although there is no doubt about the importance of protecting VMEs, **there are no studies carried out in the Argentinean EEZ** that report on their geographic distribution that would allow us to quantify in any way the positive conservation impact that a protected area would generate.

Recently, a polemic Bill[248] was sanctioned by the Chamber of Deputies of the National Congress that contemplates the creation of a new **"Agujero Azul" Strict Benthic National Marine Reserve** (Figure 19), which if approved[249] would be the largest MPA in the country and one of the pioneering cases in the world of the creation of this type of tool for the protection of the benthic environment. As established in the

[248] At the date of preparation of this report, the Bill was under review: Parliamentary processing had stalled in 2021, but the bill was subsequently debated in the Extraordinary Sessions of Congress. On July 6, 2022, the bill was finally approved by the Chamber of Deputies (https://www.hcdn.gob.ar/proyectos/proyecto.jsp?exp=5893-D-2020) and sent to the Senate for discussion (https://www.senado.gob.ar/parlamentario/Agenda/AgendaWeb/27,10,2022).

[249] After approval (July 2022) by the Chamber of Deputies, the Senate session in which the bill was scheduled to be debated (October 2022), was suspended. According to the Argentine legislative system, in order to become a law of the Nation, the bill must be discussed and approved by the Senate during 2023, otherwise, it would lose parliamentary status. In this regard, in April 2023, some civil society organizations urged the Senate to approve the Agujero Azul benthic MPA. https://drive.google.com/file/d/1T4V9Chr_yUa4joKoDQTCEYXS9lgAJbvd/view

Bill, it promotes the creation of a Benthic Marine Protected Area "Agujero Azul"[250] with a surface area of 164,000 km^2, covering an area of the Argentine Continental Shelf, in international waters outside the EEZ, with limits defined to the north by the parallel of 42°32'S, to the south by the parallel of 47°30'S, to the east by the limit of the Argentine EEZ and to the west by the 5,000 metre isobath defined in the official cartography of Argentina. Being of a "benthic" nature, the protection involves only the seabed, excluding the upper water column. According to the Bill, the benthic protection promoted by the proposed area would allow: i) the **conservation of a system of submarine canyons** in the slope area; ii) the care of **vulnerable benthic species**, builders of complex three-dimensional structures that generate refuge spaces and conditions for the reproduction and breeding of other species; and iii) the **protection of the only sector of shelf in international waters**, currently the scene of intense fishing activity.

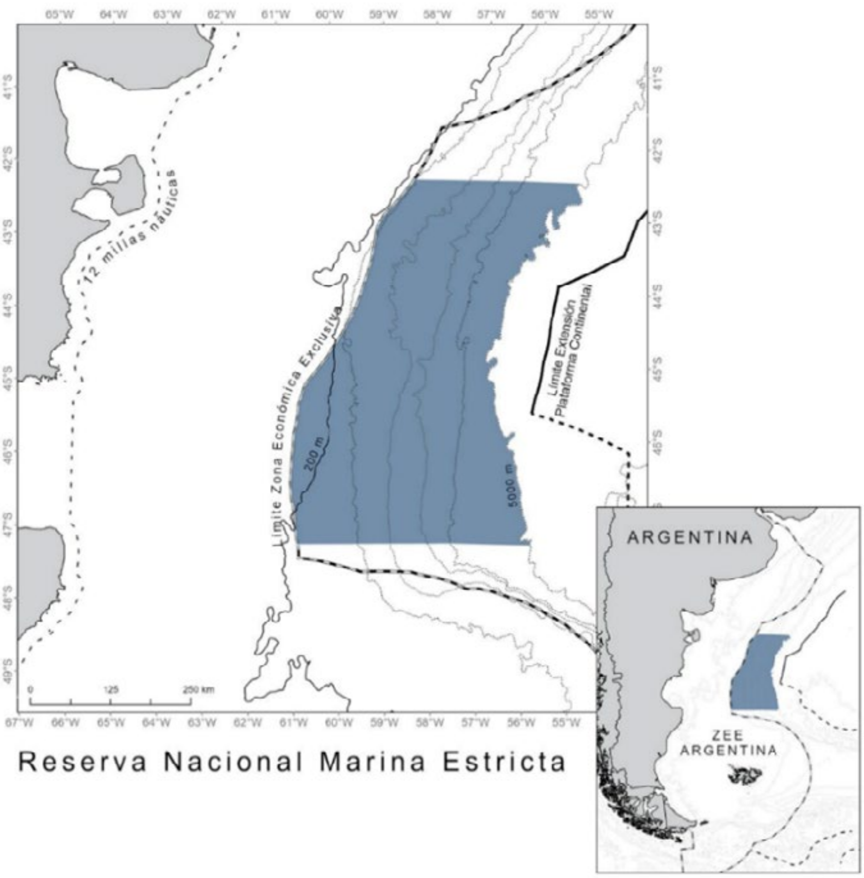

Figure 19. Location of the proposed "Agujero Azul" Strict Benthic National Marine Reserve. Source: https://www.hcdn.gob.ar/proyectos/proyecto.jsp?exp=5893-D-2020

Finally, regarding oil and gas exploration in the Argentinean sea, according to the information available from website of the **Ministry of Economy**[251], from 1979 to date, more than 400 thousand km of seismic lines have been carried out on the seabed and hundreds of wells have been drilled, of which 36 are productive. In 50 years of oil and gas activity there has been no proven report of damage to marine fauna, nor any spill that has generated irreparable damage to the coasts. From 2015 to 2019 seismic surveys were carried out in the area of the North Argentina Basin. During that period, there were no reports of fishing being affected by seismic prospecting. However, as mentioned above, specific data and information on the

[250] https://www.pampazul.gob.ar/investigacion-y-desarrollo/areas-prioritarias/agujero-azulfrente-del-talud/

[251] https://www.argentina.gob.ar/economia/energia/exploracion-costa-afuera/turismo-ambiente-y-pesca

assessment of the potential impacts of such activities on fisheries and ecosystems as well as mitigation measures are scarce or difficult to obtain from public websites.

3.6 – Monitoring of VME impacts

No information was found on current scientific monitoring surveys to help minimize impacts on VMEs. Data on benthic species was obtained from commercial fishing activity (e.g. scallop and prawn fisheries) collected by onboard scientific observers, as well as from research surveys (e.g. scallop assessments surveys). Even if by-catch information did not allow for a detailed habitat mapping of VMEs, it provided a valuable indication of VME presence/absence that was used to propose conservation measures, such as closed areas or MPAs.

The **"Pampa Azul Initiative"** (see section 3.1) has several objectives related to long-term monitoring of ecosystems and habitats[252]:

(i) Characterize and evaluate the conservation status of biodiversity and ecosystems in priority geographic areas;

(ii) Identify and characterize the distribution of VMEs in the Argentinean Sea;

(iii) Identify those habitats essential for the life cycles of species of priority conservation interest; and

(iv) Design a national system of indicators for monitoring biodiversity and socio-ecological systems.

[252] https://www.pampazul.gob.ar/redes-de-observacion/

List of Acronyms

ACAP	Agreement for the Conservation of Albatrosses and Petrels
ACS	Argentine Continental Shelf
MPAs	Marine Protected Areas
APCM	Coastal Marine Protected Areas/ Áreas Protegidas Costero Marinas
BAC	Biologically Acceptable Catch
BIP	
CADIC	Centro Austral de Investigaciones Científicas
CARP	Comisión Administradora del Río De La Plata
CBD	Convention on Biological Diversity
CCAMLR	The Convention on the Conservation of Antarctic Marine Living
CCRVMA	Convención sobre la Conservación de los Recursos Vivos Marinos Antárticos.
CFP	Federal Fisheries Council/ Consejo Federal Pesquero
CLCS	Commission on the Limits of the Continental Shelf
CONICET	National Council for Scientific and Technical Research/ Consejo Nacional de Investigaciones Científicas y Técnicas
CONVEMAR	United Nations Convention on the Law of the Sea/Convención de las Naciones Unidas sobre el Derecho del Mar
COPLA	National Commisssion on the Outer Limit of the Continental Shelf/ Comisión Nacional del Límite Exterior de la Plataforma Continental
CTMFM	Comisión Técnica Mixta del Frente Marítimo
FAO	Food and Agriculture Organisation of the United Nations
FCZs	Falkland Islands Conservation Zones
FMP	Faros del Mar Patagónico
EEZ	Exclusive Economic Zone
GEBCO	
INIDEP	National Institute for Fisheries Research and Development/ Instituto Nacional de Investigación y Desarrollo Pesquero
IPOAs	International Plans of Action
IT	Indicator Taxa
ITCQs	Individual Transferable Catch Quotas
LFP	Federal Fisheries Law/ Ley Federal Pesquera
MAC	Maximum Allowable Catch
NGOs	Non-Governmantal Organisations
OAB	National Programme of Observers on Board the Commercial Fleet/ Programa de observadores a bordo
PAN	National Plans of Action/ Planes de Acción Nacional
PCA	Argentine Continental Shelf/ Plataforma Continental Argentina
PROMAR	National Programme for Research and Productive Innovation in Argentine Maritime Areas/ Programa Nacional de Investigación e Innovación Productiva en Espacios Marítimos Argentinos
SIIP	Integrated Fisheries Information System/ Sistema Integrado de Información Pesquera
SAyDS	Secretaría de Ambiente y Desarrollo Sostenible
SAGPyA	Secretaría de Agricultura, Ganadería, Pesca y Alimentación

SGAyDS	National Secretariat of Environment and Sustainable Development/ Secretaría de Gobierno de Ambiente y Desarrollo Sostenible de la Nación
SNAMP	National System of Marine Protected Areas/ Sistema Nacional de Áreas Marinas Protegidas
SSPyA	Undersecretariat of Fisheries and Aquaculture/ Subsecretaria de Pesca y Acuicultura.
TAC	Total Allowable Catch
TAG	Technical Advisory Group
UNGA	United National General Assembly
VMEs	Vulnerable Marine Ecosystems
VMS	Satellite Monitoring System

CASE STUDY 4 - AUSTRALIA

4.1 – Data availability and governance frameworks

-Australian Fisheries Management Authority (AFMA)-

The Australian Fisheries Management Authority (AFMA)[253] is the Australian Government agency responsible for the efficient and sustainable management of Commonwealth fish resources on behalf of the Australian community. AFMA (www.afma.gov.au) was established as a statutory authority in 1992 and is governed by the *Fisheries Administration Act 1991*[254] to manage Australia's Commonwealth fisheries and apply the provisions of the *Fisheries Management Act 1991*[255] (Fisheries Management Act).

AFMA comprises the AFMA Commission (the Commission), the Chief Executive Officer (CEO), and 152 staff (see Table 1).

Table 1. AFMA's organisational structure as at 30 June 2020 (Source: AFMA Annual Report 2019–20)

Chief Executive Officer		
Fisheries Management Branch	Corporate Services Branch	Fisheries Operations Branch
Executive Manager	Chief Operating Officer	General Manager
Senior Manager Demersal & Midwater	Senior Manager People, Capability & Engagement	Senior Manager Compliance Operations
Senior Manager Policy, Environment, Economics, Research	Chief Finance Officer	Senior Manager National Compliance Strategy
Senior Manager Tuna & International Fisheries	Senior Manager Legal & Parliamentary Services	Senior Manager Foreign Compliance
Senior Manager Northern Fisheries	Senior Manager Business Operational Support	
Senior Manager Fisheries Services		
Manager Torres Strait Fisheries		

The Commission is established under section 10B of the Fisheries Administration Act. It is responsible for performing and exercising the domestic fisheries management functions and powers of AFMA[256].

The Chief Executive Officer (CEO) is AFMA's accountable authority[257]. The CEO is responsible for performing and exercising the foreign compliance functions and powers of AFMA, assisting the Commission and giving effect to its decisions[258].

Committees: Under section 54 of the Fisheries Administration Act, AFMA may establish committees to assist it in the performance of its functions and the exercise of its powers. AFMA's primary advisory bodies are the Management Advisory

[253] https://www.afma.gov.au
[254] https://www.legislation.gov.au/Series/C2004A04237
[255] https://www.legislation.gov.au/Series/C2004A04237
[256] Domestic fisheries management functions and powers means the functions and powers of AFMA, other tan the foreign compliance functions and powers, which are the responsibility of the CEO.
[257] Subsection 5A(b) of the Fisheries Administration Act specifies that the CEO is the accountable authority.
[258] Foreign compliance functions and powers relate to foreign boats in the Australian Fishing Zone and boats operating outside the Australian Fishing Zone with an authorised fishing concession.

Committees (MACs), the Resource Assessment Groups (RAGs) and the AFMA Research Committee (ARC).

Management Advisory Committees (MACs) are statutory committees established under section 56 of the Fisheries Administration Act, with functions determined by AFMA. There are seven MACs covering 10 of the 13 operational. MACs provide advice to AFMA on fisheries management and operations, and report on the status of fish stocks and the impact of fishing on the marine environment. Members are appointed by the Commission and come from industry, policy, conservation, state and territory governments, recreational and research fields.

Resource Assessment Groups (RAGs) are non-statutory bodies established to provide scientific advice to the Commission, AFMA management and the relevant MACs, on the biological, economic and wider ecological factors relevant to a fishery or a particular species. There are 10 RAGs covering 10 of the 13 operational fisheries. Members are appointed by the CEO following a public. expression of interest process and include fishery scientists, industry members, fishery economists, AFMA management and other interest groups.

The AFMA Research Committee, in conjunction with the MACs and RAGs, develops research priorities and the five-year strategic research plan. It also reviews fishery research plans and assesses research project outcomes. The research committee comprises five members drawn from AFMA's Commission and executive management.

AFMA has offices in Canberra, Darwin, Thursday Island and Lakes Entrance and look after commercial fisheries from three nautical miles out to the extent of the Australian Fishing Zone. The states and the Northern Territory look after recreational, commercial coastal and inland fishing and aquaculture. AFMA provides fisheries management services to Joint Authorities of the Commonwealth and state governments, including the Torres Strait Protected Zone Joint Authority (PZJA). Through foreign compliance functions, AFMA works together with other Australian Government agencies and international counterparts to deter illegal fishing in the Australian Fishing Zone.

-AFMA objectives-

AFMA objectives are listed in the Fisheries Administration Act 1991 and the Fisheries Management Act 1991 which cover all AFMA's operations. Legislative objectives govern all of AFMA's activities. The following objectives must be pursued by the Minister in the administration of the Fisheries Management Act 1991 and by AFMA in the performance of its functions:

i) Implementing efficient and cost-effective fisheries management on behalf of the Commonwealth;
ii) Ensuring that the exploitation of fisheries resources and the carrying on of any related activities are conducted in a manner consistent with the principles of ecologically sustainable development (which include the exercise of the precautionary principle), in particular the need to have regard to the impact of fishing activities on non-target species and the long-term sustainability of the marine environment;
iii) Maximising net economic returns to the Australian community from the management of Australian fisheries;
iv) Ensuring accountability to the fishing industry and to the Australian community in AFMA's management of fisheries resources and
v) Achieving government targets in relation to the recovery of AFMA's costs.

In addition to those objectives of the Fisheries Management Act 1991, the Minister, AFMA (and Joint Authorities) are to have regard to the objectives of:

i) Ensuring, through proper conservation and management measures, that the living resources of the Australian Fishing Zone (AFZ) are not endangered by over-exploitation;
ii) Achieving the optimum utilisation of the living resources of the AFZ;
iii) Ensuring that conservation and management measures in the AFZ and the high seas implement Australia's obligations under international agreements that deal with fish stocks and
iv) To the extent that Australia has obligations:
    i) under international law; or
    ii) under the Compliance Agreement or any other international agreement; in relation to fishing activities by Australian-flagged boats on the high seas that are additional to the obligations referred to in paragraph (c) – ensuring that Australia implements those first-mentioned obligations.

but must ensure, as far as practicable, that measures adopted in pursuit of those objectives must not be inconsistent with the preservation, conservation and protection of all species of whales.

The Fisheries Administration Act 1991 also requires AFMA to pursue the objective of ensuring that:

i) The exploitation in the Australian Fishing Zone (as defined in the Fisheries Management Act) and the high seas of fish stocks in relation to which Australia has obligations under international agreements;
ii) Related activities; are carried on consistently with those obligations.

In relation to fishing activities by Australian-flagged boats on the high seas ensuring that those activities are carried on consistently with those obligations, and ensuring that the exploitation in the Australian fishing zone (as defined in the Fisheries Management Act 1991) and the high seas of fish stocks in relation to which Australia has obligations under international agreements and related activities are carried on consistently with those obligations.

In pursuing all of these objectives under both the Fisheries Management Act and the Fisheries Administration Act, AFMA must place equal emphasis on all of the objectives and not pursue some at the expense of others. However, varying degrees of weight and emphasis may be given to a particular objective depending on the circumstances. This position has been confirmed where AFMA's approach to pursuing these objectives has been tested before the courts.

AFMA is the Commonwealth agency which, jointly with Queensland, co-ordinates and delivers fisheries management and surveillance/enforcement programs in the Torres Strait Protected Zone on behalf of the Torres Strait Protected Zone Joint Authority (PZJA).

The PZJA comprises the Commonwealth and Queensland Ministers responsible for fisheries and was established under the *Torres Strait Fisheries Act 1984*[259]. The PZJA is responsible for the management of fisheries in the Australian section of the Zone, with a primary obligation to manage the fisheries in a manner that protects the way of life and livelihood of the traditional inhabitants. A significant emphasis is also placed on environmental monitoring and conservation of Torres Strait fisheries.

Table 2 shows a summary of the 11 AFMA´s legislated obligations.

[259] https://www.legislation.gov.au/Series/C2004A02887

Table 2. AFMA's legislated obligations (Source: The FishAFeries Administration Act and the Fisheries Management Act.)

Act and section	Summary of objective[a]
Fisheries Administration Act, section 6 Fisheries Management Act, section 3	Implement efficient and cost-effective fisheries management.
	Ensure the exploitation of fisheries and related activities is consistent with the principles of ecologically sustainable development.[b]
	Where Australia has obligations under international agreements, ensure the exploitation of fish stocks and related activities in the Australian fishing zone and the high seas are carried on consistently with those obligations.
	To the extent that Australia has obligations under international law or agreements, ensure that fishing activities by Australian flagged vessels on the high seas are conducted consistently with those obligations.[c]
	Maximise net economic returns to the Australian community from the management of Australian fisheries.
	Ensure accountability to the fishing industry and the Australian community in the management of fisheries resources.
	Achieve government targets in relation to the recovery of AFMA's costs.
	Ensure that the interests of commercial, recreational and Indigenous fishers are taken into account.
Fisheries Management Act, section 3	Ensure, through proper conservation and management measures, that the living resources of the Australian fishing zone are not endangered by over-exploitation.
	Achieve optimum utilisation of the living resources of the Australian fishing zone.
	Ensure, as far as practicable, that measures adopted in pursuit of legislated objectives must not be inconsistent with the preservation, conservation and protection of whales.

Note a: Objectives that AFMA must pursue are shaded blue. Objectives that AFMA must have regard to are unshaded.
Note b: The principles of ecologically sustainable development as defined in the Fisheries Management Act are:
(a) decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equity considerations;
(b) if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;
(c) the principle of inter-generational equity—that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;
(d) the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making; and
(e) improved valuation, pricing and incentive mechanisms should be promoted.

Note c: This objective is listed as one that AFMA must pursue in the Fisheries Administration Act and as one that AFMA is to have regard to in the Fisheries Management Act.

-Fisheries under their Australian national jurisdiction-

AFMA currently administer to 18 different fisheries under their area of national jurisdiction[260]:

- Bass Strait central zone scallop fishery;
- Christmas Island and Cocos Islands;
- Coral Sea fishery;
- Eastern tuna and billfish fishery;
- Heard and McDonald Island fishery;
- Macquarie Island toothfish fishery;
- Norfolk Island fishery;
- Small pelagic fishery;

[260] https://www.afma.gov.au/fisheries

- South Tasman rise;
- Southern and eastern scalefish and shark fishery;
- Southern bluefin tuna fishery;
- Southern squid jig fishery;
- Torres Strait fisheries;
- Western deepwater trawl fishery;
- Western tuna and billfish fishery.

Management advice is guided through scientific research whose priorities are decided on an annual basis through Resource Assessment Groups (RAGs) and Management Advisory Committees (MACs). They assess research proposals as well as outcomes of previous research for both stock assessments and other relevant management related projects. The annual research budget is managed through AFMA, although the majority of this is put aside for stock assessments for the different domestic fisheries.

The AFMA Research Committee (ARC) provides more strategic advice to the AFMA Commission including cross cutting research across fisheries and long-term goals.

There are currently five-year research plans in place for nine different fisheries (Antarctic fisheries, small pelagic fishery, southern bluefin tuna fishery, southern and eastern scalefish and shark fishery, southern squid jigging fishery, northern prawn fishery, Bass Strait central zone scallop fishery, eastern and western tuna and billfish fisheries and the great Australian Bight trawl fishery).

With the exception of the Antarctic fisheries there are no specific regulations, research or management plans in place specifically for VMEs. The Environmental Protection and Biodiversity Act (EPBC) 1999 requires Australian Commonwealth fisheries to assess the risks posed to the marine environment by their activities. The Australian Antarctic Division (AAD) leads the Australian Government's scientific programs in Antarctica and is guided by the Australian Antarctic Strategic Plan. Regulations and management of VMEs for areas under Australia's jurisdiction in this region follow the guidelines set out by CCAMLR, as outlined below. With the exception of the AAD, there are no scientific bodies responsible for monitoring or managing VMEs within fisheries under national jurisdiction.

The Australian petroleum's offshore activities include seismic surveys, exploration, drilling, pipeline construction, and oil and gas production. Many of these activities overlap fishing grounds and AFMA ensure that the impacts on fisheries of any of these activities is assessed. They must submit both an environment plan and an oil spill contingency plan.

In addition to fisheries under national jurisdiction, Australia are also members of a number of RFMOs which include demersal fisheries and for which they provide scientific advice for VME management through the scientific Working Groups. These are summarised below.

-Demersal fishing on the high seas-

Demersal fishing on the high seas by Australian vessels occurs under permits issued by the Australian Fisheries Management Authority (AFMA). High-seas permits allow Australian vessels to fish in high-seas areas outside the Australian Fishing Zone (AFZ), outside the Exclusive Economic Zones (EEZs) of other countries, and within the area of competence of either the SPRFMO or the SIOFA.

United Nations General Assembly (UNGA)

In 2007, the United Nations General Assembly (UNGA) adopted Resolution 61/105[261], later affirmed by 64/72[262] in 2009, to protect VMEs from destructive fishing practices,

[261] https://undocs.org/A/RES/61/105
[262] https://undocs.org/A/RES/64/72

including bottom fishing, in areas beyond national jurisdiction. Under these Resolutions, fishing nations and RFMOs are obliged to take precautionary action which complies with the following requirements:

1. Conduct impact assessments before vessels engage in bottom fishing;
2. Implement closed areas or other measures to prevent SAIs on VMEs;
3. Implement protocols to cease fishing where evidence of VMEs is encountered (known as 'move-on rules' typically based on a pre-determined minimum weight or volume thresholds for bycatch of specified vulnerable taxa) and report it; and
4. Adopt measures to ensure:
    i. Long-term sustainability of deep-sea fish; target & non-target species;
    ii. Rebuild depleted stocks; and,
    iii. Consistent with precautionary approach

Southern Indian Ocean Fisheries Agreement (SIOFA)

Australia is a contracting party to the Southern Indian Ocean Fisheries Agreement (SIOFA), a FAO Regional Fisheries Management Body, which regulates and manages some aspects of DSF in its jurisdiction. Since its establishment in 2012, SIOFA has implemented 15 binding conservation and management measures (CMM) for ensuring the long-term sustainability of fishery resources and mitigating significant adverse impacts (SAI) to VMEs in the Area[263].

Prior to SIOFA coming into force, Australia adopted precautionary management measures of deep-sea fish stocks, as stated in the FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas (FAO 2008)[264], and conducted a bottom fishing impact assessment (BFIA) which concluded the overall risk of vessels fishing with bottom trawls and bottom-sea auto-longlines was low, and the impact caused by midwater trawling and droplining was negligible [265]. This was updated in 2020 to assess the impacts of longline gears near Williams Ridge and potting gears in Australia's historical fishing footprint, both cases were concluded to have a low impact on target stocks, associated species and VMEs.

Under CMM 2019/01, all BFIA must be updated and submitted to the SIOFA Scientific Committee if any fishing activities have changed or new fisheries/fishing areas are being proposed. All BFIA must follow the SIOFA Bottom Fishing Impact Assessment Standard (BFIAS)[266]. Under CMM 2020/01, The Scientific Committee must also be notified of any new data, such as stock status or where VMEs are known or likely to occur, in order to advise the Meetings of the Parties on the formulation of measures regarding the monitoring of fishing activities, guidelines for evaluating and approving electronic observer programs for scientific data collection and standard protocol for future protected areas designations[267]. No party is exempt from any CMMs adopted by the Meeting of the Parties or as stated in the SIOFA Agreement, however, there no penalties exist for non-compliance.

SIOFA has established relationships with other RFMOs, such as CCAMLR; intergovernmental organizations, including The Agreement on the Conservation of Albatrosses and Petrels (ACAP) and the Southwest Indian Ocean Fisheries Commission (SWIOFC); and NGOs, including the Southern Indian Ocean Deepsea

[263] https://www.apsoi.org/cmm
[264] FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas
[265]https://www.apsoi.org/sites/default/files/files/Bottom%20Fishing%20Impact%20Assessment%20AUSTRALIA.pdf
[266] SIOFA Bottom Fishing Impact Assessment Standard
[267]https://www.apsoi.org/sites/default/files/documents/cmm/CMM%202020_01%20Interim%20Bottom%20Fishing%20Measures.pdf

Fishers Association (SIODFA), the Deep Sea Conservation Coalition (DSCC) and the Environmental Justice Foundation (EJF)[268].

South Pacific Regional Fisheries Management Organisation (SPRFMO)

In 2006, Australia was one of the first three countries, alongside Chile and New Zealand, to initiate international meetings and consultations to conserve and manage non-highly migratory fisheries and other biodiversity in the South Pacific Ocean. This resulted in the establishment of the South Pacific Regional Fisheries Management Organisation (SPRFMO) in 2009 which later came into force in 2012[269].

At present, the composition of SPRFMO participants includes 15 Commission Members, 3 Cooperating non-Contracting Parties, 5 participating States which attend SPRFMO meetings, 9 inter-governmental organisations, including other RFMOs such as CCAMLR and IATTC, and 16 non-governmental organisations.

There are 23 CMMs in place, all of which are binding to contracted parties. These measures detail the requirements for data collection and reporting; regulations for monitoring, control and surveillance and enforcement; and technical measures for certain fisheries. Currently, Australia and New Zealand are the only two Members currently authorized to fish in the established demersal fisheries in the SPRFMO Convention Area.

However, in 2019, CMM 03-2019 introduced a comprehensive set of rules for all Members based a spatial management approach to protect large areas where VME indicator taxa are predicted to be present. Within the CMM, three Management Areas were established for bottom-trawls, mid-water trawls and bottom line. No bottom fishing is permitted outside of these areas except for new and exploratory fisheries under CMM 13-2020. Additional measures included in CMM 03-2019 are move-on protocols and VME encounter thresholds whereby a temporary closure will be put in place if a specified weight of VME indicator species is caught in a trawl[270]. This is then reviewed by the flag State and Scientific Committee. Later in 2020, an updated version of CMM 03-2019 was issued to reduce the threshold for stony corals in the VME protocol and review observer coverage levels.

Before a Member can undertake DSF in one of the Management Areas, they must submit to the Scientific Committee a proposed assessment that meets the SPRFMO Bottom Fishery Impact Assessment Standard (SPRFMO BFIAS[271]) using the best available data and include mitigation measures to prevent such impacts. Once reviewed, the Scientific Committee will consult and advise the Commission on the proposal. The Commission will have the final say on whether the fishing should be authorized and if there are any additional measures which are required to prevent SAI on VMEs. An assessment must be submitted every three years and when a substantial change has occurred in the fishery e.g. risk or likely impact.

In 2011, Australia completed a BFIA to determine whether individual bottom-fishing activities would have an SAI on VMEs in the SPRFMO Convention Area with similar conclusions to the SIOFA BFIA stated above. In 2020, Australia and New Zealand updated their BIFA. Regarding VMEs, the report concluded that roughly 80% and 90% of suitable habitat or abundance of stony corals and other VME indicator taxa, respectively, are outside the Bottom Trawl Management Areas[272].

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[268] 7th Meetings of the Parties- List of Participants
[269] https://www.sprfmo.int/about/
[270]http://www.sprfmo.int/assets/2020-SC8/SC8-DW07-rev-1-Cumulative-Bottom-Fishery-Impact-Assessment-for-Australia-and-New-Zealand.pdf
[271] As approved by the seventh session of the Scientific Committee 2019, available at: https://www.sprfmo.int/assets/Fisheries/Science/SPRFMO-Bottom-Fishery-Impact-Assessment-Standard-2019.pdf
[272]http://www.sprfmo.int/assets/2020-SC8/SC8-DW07-rev-1-Cumulative-Bottom-Fishery-Impact-Assessment-for-Australia-and-New-Zealand.pdf

Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) was established in 1982 with the objective of conserving Antarctic marine life. Currently there are 26 Members, including Australia, with a further 10 acceding States. CCAMLR has adopted 69 CMM for the purpose of regulating compliance, fisheries, fishing gear, data reporting, research, bycatch, environmental protection and general measures. There are currently three CMM focused on protecting VMEs in the Convention Area.

The Commission is advised by its Scientific Committee which provides recommendations based on the best available scientific evidence. These data are obtained from fisheries monitoring, scientific observers on fishing vessels and ecosystem monitoring and marine debris programs. The Scientific Committee has also established five internal Working Groups which meet on an annual basis to assist in formulating advice on key areas such as fish stock assessments, bycatch and ecosystem monitoring and management[273].

Nothing in the literature has addressed the issues of integrated management with other marine activities. CCAMLR is integral to the Antarctic Treaty System which bans all forms of mining under the Environmental Protocol, as a result there has never been any commercial mining in Antarctica or the Southern Ocean.

-Assessment of data on fishery catches, landings, by-catch and VME indicator species from encounters-

In response to environmental legislation, such as the Fisheries Management Act 1991, the Environment Protection and Biodiversity Conservation Act (EPBC) 1999[274] and the Commonwealth Fisheries Bycatch Policy[275], ecological risk assessments and regular reporting is mandatory for Australian Commonwealth Fisheries. As such, every year a *Fishery status report* is published summarizing the performance of approximately 22 fisheries, covering 96 stocks, on their biological, economic and environmental status[276].

The biological status is separated for stocks managed solely by the Australian Government and those that are jointly managed with other countries. This enables an evaluation of national fisheries management to sustainably harvest stocks at MSY.

In addition to the *Fishery status reports*, the Fisheries Research and Development Corporation (FRDC) collaborates with ABARES to provide national assessments of key fish stocks which are documented in *Status of Australian fish stocks reports*[277].

The economic status of a fishery is evaluated against the economic objectives of the Fisheries Management Act 1991[278] to maximise net economic returns from fishery resources. Surveys are conducted by ABARES to assess if the stock biomass is consistent with achieving maximum economic yield (MEY) from the fishery. Data is collected from surveying the industry to assess the revenues earned and costs incurred e.g., fuel and labour, alongside other economic indicators.

Ecological risk assessments are conducted to inform the Australian Fisheries Management Authority (AFMA) using an ecological risk management (ERM) framework. Since 2018, fisheries are now obliged to report how they will address any impacts identified in risk assessment, particularly if this includes any impacts towards commercial, bycatch and threatened, endangered and protected species. AFMA also

[273] https://www.ccamlr.org/en/science/scientific-committee-0
[274] https://www.legislation.gov.au/Details/C2021C00182
[275]https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/fisheries/environment/bycatch/bycatch.pdf
[276] https://www.agriculture.gov.au/abares/research-topics/fisheries/fishery-status
[277] https://www.fish.gov.au/
[278] https://www.legislation.gov.au/Details/C2017C00363

produces quarterly reports on fishery interactions with protected species on behalf of Commonwealth fishing operators to the Department of Agriculture, Water and the Environment.

VME encounter protocols can also be used as a method of data collection to evidence the presence of VME taxa and mitigate SAIs on VMEs. Otherwise known as 'move-on rules', if a VME indicator species is encountered, vessels are required to cease fishing and move on from the area. All encounters must be recorded in the vessel logbook and reported to its flag State and RFMO Secretariat within 24 hours to take appropriate action. The notification must include details of the VME indicator taxa, location and fishing gear, and would normally be reported by the scientific observer onboard the vessel. An example of the information included in the notification is detailed in CCAMLR CMM 22-06 (2019) Annex B[279].

An inventory of all data records for each RFMO will be maintained and updated to reflect the location and type of all known VMEs and inform spatial management measures such as closed areas. The CCAMLR VME Registry contains all the records of the locations and taxa od VMEs and associated areas in the Convention Area. This can be downloaded from the CCAMLR website[280].These registries will contribute to the global database established under UNGA Resolution 61/105.

-Research programmes to collect data on VME on species and habitat characteristics-

Within the SIOFA region, the most extensive survey work has been conducted by Southern Indian Ocean Deepwater Fisheries Association (SIODFA) using **side-scan sonar imagery and cameras attached to bottom trawls** (Shotton, 2006)[281].

However, in the South Pacific, there is no dedicated research programmes to collect data on the abundance and distribution of VME species and habitat. Instead, scientific surveys are conducted to support and inform spatial management. Common techniques used to collect bathymetric data include **multibeam echo sounder surveys and towed underwater camera** for benthic VME indicator species (Rowden *et al*., 2017)[282]. **Benthic-sleds** towed over video transects provide observed seabed cover for VME indicator taxa, such as bryozoans, sponges and stony corals, and can also be used during gear-scale matching to compare catch-rates between different fishing gears, namely sleds and trawls, to investigate their impact on the seafloor (William *et al*., 2020)[283]. The collected data can also support **predictive modelling** of where VMEs are likely to occur based on **habitat suitability models (HSM)** to inform spatial management in the SPFRMO area, as recommended by the Scientific Committee.

However, there is uncertainty regarding the accuracy of HSM and current steps taken to improve their robustness include ground-truth model validations, ensemble models and use of high-resolution multibeam data and seafloor images (Howell *et al*., 2011)[284]. The efficacy of HSM for managing the impact of fishing on VMEs has led to SPFRMO's current approach of using **'move-on rules**' when VME taxa are

279 https://www.ccamlr.org/en/measure-22-06-2019
280 https://www.ccamlr.org/en/document/data/ccamlr-vme-registry
281 Shotton, R. (Comp.) 2006. Management of Demersal Fisheries Resources of the Southern Indian Ocean. FAO Fish. Circ. 1020. 90pp.
282 Rowden, A.A., Anderson, O.F., Georgian, S.E., Bowden, D.A., Clark, M.R., Pallentin, A. and Miller, A., 2017. High-resolution habitat suitability models for the conservation and management of vulnerable marine ecosystems on the Louisville Seamount Chain, South Pacific Ocean. Frontiers in Marine Science, 4, p.335.
283 Williams, A., F. Althaus, M. Green, K. Maguire, C. Untiedt, N. Mortimer, C.J. Jackett, M. Clark, N. Bax, R. Pitcher, and T. Schlacher. 2020. True size matters for conservation: A robust method to determine the size of deep-sea coral reefs shows they are typically small on seamounts in the southwest Pacific Ocean.*Frontiers in Marine Science 7:187,* https://doi.org/10.33hy89/fmars.2020.00187.
284 K.L.Howell,R.Holt,I.P.Endrino,H. Stewart When the species is also a habitat: comparing the predictively modelled distributions of Lophelia pertusa and the reef habitat it forms Biol. conserv., 144 (2011), pp. 2656-2665

unexpectantly caught as bycatch. The vessel must then comply with **VME encounter protocols** and immediately report it. Under SPRFMO CC 02-2021, wherever possible, a photograph of each VME indicator taxa should also be reported for all bottom fishing events, alongside its weight record for the specific fishing event.

These precautionary actions and reporting requirements are mandatory under the UNGA Resolution 61/105, adopted in 2007. As such, many RFMOs have implemented specific conservation measures (CMs), such as CCAMLR CM 22-06 and CM 22-07, to record and report any encounters with VME indicator taxa which have been caught as bycatch. The detection and protection of VMEs is now integrated into the management strategy of deep-sea fisheries operating in the high seas.

However, details of **VME encounter protocols vary between RFMOs and flag States**. For example, vessels are required to move 5nm from any point along the trawl track in the SPRFMO Convention Area and 2nm or 1nm (depending on gear type) in the SIOFA Convention Area[285]. Additionally, although SPRFMO has adopted specific taxa-specific weight thresholds, as defined in Annex 6A of CMM03-2021, indicating evidence of a VME encounter, New Zealand and Australia have implemented separate protocols. For New Zealand flagged-vessels, a scoring-system is used with threshold weights for primary species set at 50 kg for sponges, 30 kg for stony corals, 6 kg for hydrocorals, and 1 kg each for black corals and soft corals[286]. If the total score exceeds 3 or any three of the listed VME indicator taxa are caught, the move-on rule is triggered (Parker *et al*., 2009)[287]. In Australia, similar to CCAMLR protocol, there is a single bycatch weight threshold of 50kg of corals and/or sponges in a trawl shot or 10kg in a 1000 hook section of line for automatic longline operators. This risk area will then be closed to all fishing vessels under the Australian flag for the rest of the annual fishing permits, while in New Zealand the risk area will only remain active for that vessel and the duration of that particular fishing trip.

In the CCAMLR Convention Area, the move-on protocol is different as it relates to the number of indicator taxa per line segment. Under the interim measure CMM 22-07 (2013), vessels must stop fishing if 10 or more VME indicator units are recovered in one line segment and report the location of the midpoint of the line segment and number of VME taxa to the Secretariat and flag State. The Secretariat shall then close the 'Risk Area' to all fishing vessels until management actions are determined by the Commission. Defined areas of registered VMEs are outlined in Annex 22-09/A of CM 22-09[288] and closed to bottom fishing.

-VMS data-

Australian high-seas fishing permits require the implementation of vessel monitoring systems (VMS), as well as all fishing vessels operating within the Convention Area of RFMOs.

Example: As a Contracting party to CCAMLR, under CMM 10-04, all fishing vessel must be equipped with an Automatic Location Communicator (ALC) which is a satellite position transmitter working automatically and independently to provide the following VMS data:

(a) the ALC unique identifier;
(b) the current geographical position (latitude and longitude) of the vessel;
(c) the date and time (expressed in Coordinated Universal Time (UTC);
(d) the vessel's speed; and
(e) the vessel's course.

285 https://www.afma.gov.au/sites/default/files/uploads/2017/02/High-Seas-Management-Arrangements-Booklet-2017-FINAL.pdf
286 http://www.fao.org/3/i5952e/i5952e.pdf
287 Parker, S. J., Penney, A. J., and Clark, M. R. (2009). Detection criteria for managing trawl impacts on vulnerable marine ecosystems in high seas fisheries of the South Pacific Ocean. Mar. Ecol. Prog. Ser. 397, 309–317. doi: 10.3354/ meps08115
288 https://www.ccamlr.org/en/measure-22-09-2012

For all fisheries, data should be transmitted every hour to the Fisheries Monitoring Centre (FMC) (government authority or agency of a Flag State responsible for managing VMS for its flagged fishing vessels) while the fishing vessel is operating in the Convention Area. Each Contracting Party will then forward on VMS reports to the CCAMLR Secretariat as soon as possible. VMS data is securely stored by the Secretariat in electronic data processing facilities with limited access granted via a flexible user identification and password mechanism.

Similarly, under SPRFMO CMM 06-2020, the same procedures apply yet it is stated under paragraph 8, "*VMS data may also be used by the Scientific Committee for analysis to support specific scientific advice requested by the Commission for sound fisheries management decision-making in the Convention Area*."

Under paragraph 24 of SPRFMO CMM 06-2020 and paragraph 17 of CCAMLR CMM 10-04, the use and release of VMS data may only be granted to a Member or Cooperating non-Contracting Parties (CNCPs) for planning for active surveillance operations or inspections at sea and for supporting search and rescue activities carried out by a competent Maritime Rescue Coordination Centre (MRCC).

-Research reports available-

On the official Australian Government website, a ***Fishery Status Report*** is published **every year providing a detailed evaluation of the biological and economic performance of each fishery** managed jointly or entirely by the Australian Government.

Additionally, the **Australian Fisheries Management Authority (AFMA) commissions research programmes**, principally stock assessments and data gathering/monitoring on fisheries[289]. It is not stated how often these reports are published. However, for protected species, under the Environment Protection and Biodiversity Conservation (EPBC) Act 1999[290], the AFMA must report fishery interactions with protected species to the Department of Agriculture, Water and the Environment (DAWE) on a quarterly basis.

The *Fishery Status Reports* are **publicly available** and can be **accessed online on the Australian Government website**. Each report is divided into chapters, per fishery, and provides an update on the biological, economic and environmental status of a fish stock looking at past trends, stock assessments and its performance against economic objectives. All research reports commissioned by the AFMA are published in English and publicly available to view online[291].

Within these reports, data is summarized from a range of sources, both published and unpublished reports, and inputs from fisheries researchers, industry representatives, fishery managers and other members of resource assessment groups. For jointly managed fish stocks, data and stock assessments are sourced from RFMOs. Below is a list of data sources acknowledged on the Australian Government website[292]:

- Geoscience Australia—coastline, state boundaries, place names, bathymetric features, Australian Fishing Zone and Exclusive Economic Zone boundaries
- AFMA—Australian Government fisheries logbook, catch disposal and observer data; fisheries management boundaries
- Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)—CCAMLR statistical division boundaries
- Australian Government Department of Agriculture, Water and the Environment—boundaries of marine protected areas

[289] https://www.afma.gov.au/research
[290] Environment Protection and Biodiversity Conservation Act 1999
[291] https://www.afma.gov.au/research-reports
[292] https://www.agriculture.gov.au/abares/research-topics/fisheries/fishery-status/acknowledgements

- Commission for the Conservation of Southern Bluefin Tuna, Indian Ocean Tuna Commission, Western and Central Pacific Fisheries Commission—catch-and-effort data.

4.2 - Description of Sensitive Species and Habitats

Within the SPRFMO Convention Area, there is very little information regarding the biomass, depth and location of VME indicator taxa. Therefore, habitat suitability models (HSM) are used to predict the niche and distribution of species based on limited data.

The Scientific Committee estimated the percentage of 10 VME indicator taxa within the Evaluated Area and outside fishery management areas (FMA) using three post-accounting methods (SC8-DW07)[293], these results can be seen in Table 3. This shows the ROC (percent of suitable habitat estimated using a HSI cutoff estimated from the receiver operating characteristic (ROC) curve); the Linear (percent of total abundance estimated by assuming a linear relationship between habitat suitability indices (HSI) and abundance); the Power-Hi and Power-Lo (percent of total abundance estimated by assuming power relationships between HSI and abundance). Table 3 below shows that sponges (Hexactinellida and Demospongiae) and sea pens (Pennatulacea) are the most abundant taxon in the Evaluated Area.

Table 3. Estimated percentage of each modelled VME indicator taxon within the Evaluated Area but outside the FMAs for each of three post-accounting methods. ROC = percent of suitable habitat estimated using a HIS cut-off estimated from the receiver operating characteristic (ROC) curve; Linear = percent of total abundance estimated by assuming a linear relationship between habitat suitability indices (HSI) and abundance; PowerHi and Power-Lo = percent of total abundance estimated by assuming power relationships between HSI and abundance where Power-Lo is the mean estimated relationship minus 1 standard deviation and Power-Hi is the mean estimated relationship plus 1 standard deviation.

Group	Taxon	Name	ROC	Power-Lo	Lower-Hi	Linear
Stony coral species	ERO	*Enallopsammia rostrata*	14.54	16.01	9.67	52.59
	GDU	*Goniocorella dumosa*	17.53	55.76	55.76	54.70
	MOC	*Madrepora oculata*	41.44	51.62	45.65	62.58
	SVA	*Solenosmilia variabilis*	45.84	17.54	17.54	58.96
Other VME indicator taxa	COB	Antipatharia	24.39	31.84	18.95	52.90
	COR	Stylasteridae	45.29	53.44	52.81	61.02
	DEM	Demospongiae	54.25	69.70	74.97	65.81
	HEX	Hexactinellida	74.34	87.35	93.51	68.29
	PTU	Pennatulacea	69.46	78.11	80.29	66.78
	SOC	Gorgonian Alcyonacea	45.94	48.90	16.18	58.37

HSM was used to evaluate the performance of spatial management areas proposed by CMM 03-2019 compared with the existing management areas that had been implemented by Australia and New Zealand under CMM 03-2018 (COMM7-Prop 03.1)[294]. The results show an increase of protection for stony coral (62.0% up to 82.2% covered) and other VME indicator taxa (67.6% up to 84.2%) from bottom

[293] http://www.sprfmo.int/assets/2020-SC8/SC8-DW07-rev-1-Cumulative-Bottom-Fishery-Impact-Assessment-for-Australia-and-New-Zealand.pdf

[294] COMM7-Prop 03.1. A proposal for a revised Bottom Fishing Conservation and Management Measure for SPRFMO. 7th Meeting of the Commission, the Hague, The Netherlands, 23 to 27 January 2019.

fishing, as well as increased protection for a number of Ecological or Biological Significant Areas (EBSAs).

In 2013, research conducted by ABARES (Australian Bureau of Agricultural and Resource Economics and Sciences) identified vulnerable benthic taxa in the western SPRFMO Convention Area (Hansen *et al*., 2013)[295].

Within **waters under national jurisdiction**, with the exception of Heard and McDonald Islands (HIMI), there are no defined VME indicator species and data on the types and distributions of benthic habitat are generally scarce. Although no indicator species exist, risk assessments for benthic habitats are undertaken using methodology outlined in the Ecological Risk Assessment for the Effects of Fishing (ERAEF) (Hobday *et al*., 2007[296], 2011[297]; Smith *et al*., 2007[298]). This uses seabed imagery, where available, to classify habitats based on a SGF (sediment, geomorphology and fauna) score and the risk to each habitat then ranked according a number of attributes, as shown in Table 4.

Table 4. List of attributes used to undertake an ERAEF (adapted from Williams *et al.*, 2011)[299].

Primary characteristic	Aspect	Attribute
Productivity		Regeneration of fauna/flora (P1) Natural disturbance (P2)
Susceptibility	Availability	General depth range (A1)
	Encounterability	Depth zone and feature type (E1) Ruggedness (E2) Level of disturbance (E3)
	Selectivity	Removability/mortality of fauna/flora (S1) Areal extent Removability of substratum (S2) Substratum hardness (S3) Seabed slope (S4)

Seabed imagery used in the risk assessments is taken during surveys, for example habitat data for the assessment of the Western Deep-Water Trawl Fishery (WDWTF) otter trawl sub-fishery used data and images collected by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) during a survey in 2005. Where seabed imagery is not available an alternative methodology is used to develop an inferred list of potential habitat types that may be impacted by the fishery (Wayte *et al*., 2007)[300].
Heard and McDonald Islands (HIMI) lies in CCAMLR waters and use the CCAMLR VME guide to define indicator species. Some of the distribution has been observed directly through the use of underwater cameras, other areas it has been inferred.

[295] Hansen, S., Ward, P. and Penney, A., 2013. Identification of vulnerable benthic taxa in the western SPRFMO Convention Area and review of move-on rules for different gear types. SPRFMO Paper SC-01, 9.
[296] Hobday, A.J., Smith, A.D.M., Webb, H., Daley, R., Wayte, S., Bulman, C., Dowdney, J., Williams, A., Sporcic, M., Dambacher, J.M., Fuller, M., Walker, T., (2007). Ecological Risk Assessment for the Effects of Fishing: Methodology. ReportR04/1072 for the Australian Fisheries Management Authority, Canberra. July 2007, Available at http://www.afma.gov.au/environment/eco based/eras/docs/methodology.pdf.
[297] Hobday, A.J., Smith, A.D.M., Stobutzki, I.C., Bulman, C., Daley, R., Dambacher, J.M., Deng, R.A., Dowdney, J., Fuller, M., Furlani, D., Griffiths, S.P., Johnson, D., Kenyon, R., Knuckey, I.A., Ling, S.D., Pitcher, R., Sainsbury, K.J., Sporocic, M., Smith, T., Walker, T.I., Wayte, S.E., Webb, H., Williams, A., Wise, B.S., Zhou, S., (2011). Ecological risk assessment for the effects of fishing. Fish. Res., doi:10.1016/j.fishres. 2011.01.013.
[298] Smith, A.D. M., Hobday, A.J., Webb, H., Daley, R., Wayte, S., Bulman, C., Dowdney, J., Williams, A., Sporcic, M., Dambacher, J., Fuller, M., Furlani, D., Griffiths, S., Kenyon R., Walker T., 2007. Ecological Risk Assessment for the Effects of Fishing: Final Report R04/1072 for the Australian Fisheries Management Authority, Canberra. July (2007). http://www.csiro.au/science/fisheries-ecological-riskassessment.html
[299] Williams A., Dowdney L., Smith A., Hobday A., Fuller M. (2011). Evaluating impacts of fishing on benthic habitats: a risk assessment framework applied to Australian fisheries. Fisheries Research, 112. 154–167.
[300] Wayte, S., Dowdney, J., Williams, A., Bulman, C., Sporcic, M., Fuller, M., Smith, A., 2007. Ecological Risk Assessment for the Effects of Fishing: Otter trawl component of the Southern and Eastern Scalefish and Shark Fishery Report. Report for the Australian Fisheries Management Authority. Canberra, Australia

Within each of the RFMOs in which it operates, Australia uses the VME indicator species adopted by the RFMO and used by all members. Research has been undertaken by the RFMOs, through its members, to identify VME taxa in their area of jurisdiction which can be used to inform management such as move-on protocols and spatial closures. This has largely been based on the criteria and species grouped developed by the FAO in their deep-sea fisheries guidelines.

In 2009 New Zealand developed a list of 10 VME indicator taxa that could be used by observers to detect encounters with VMEs in the SPRFMO Convention Area (Parker *et al*., 2009)[301]. This has since been reviewed and updated to 15 VME taxa which are listed under Annex 5 of CMM 03-2022[302] and therefore apply to all SPRFMO Members and CNCPs fishing within the SPRFMO Convention Area. This list includes species such as sponges, coral, sea pens, anemones, hydrozoans, bryozoans and starfish.

In 2009, a CCAMLR VME taxa workshop developed a comprehensive list of 22 indicator species for observers, fishers and biologists to use as a quick on-deck guide to classify VME taxa caught as bycatch Table 5. This was based on the SPRFMO guide and includes cold-water corals, sponges, sea urchins, barnacles, hydroids and molluscs.

Table 5. List of CCAMLR VME Indicator Taxa[303].

Taxonomic Level	Common Names
Phylum Porifera	
Class Hexactinellida	Glass sponges
Class Demospongia	Siliceous sponges
Phylum Cnidaria	
Class Anthozoa	
Order Actinaria	Anemones
Order Scleractinia	Stony corals
Order Antipatharia	Black corals
Order Alcyonacea	Soft corals
Order Gorgonacea	Sea fans
Order Pennatulacea	Sea pens
Order Zoanthida	Zoanthid corals
Class Hydrozoa	
Subclass Hydroidolina	Hydroids
Family Stylasteridae	Hydrocorals
Phylum Bryozoa	Lace corals
Phylum Echinodermata	
Class Crinoidea	
Order Non-Comatulid	Stalked crinoids (sea lilies)
Class Echinoidea	
Order Cidaroida	Pencil sea urchins
Class Ophiuroidea	
Order Euryalida	Basket and snake stars
Phylum Chordata	
Class Ascidiacea	Ascidians

301 Parker, S.J., Penney, A.J. and Clark, M.R., 2009. Detection criteria for managing trawl impacts on vulnerable marine ecosystems in high seas fisheries of the South Pacific Ocean. Marine Ecology Progress Series, 397, pp.309-317.
302 https://www.sprfmo.int/measures/
303 https://www.ccamlr.org/en/system/files/VME-guide.pdf

Taxonomic Level	Common Names
Phylum Brachiopoda	Lamp shells
Phylum Annelida	
Family Serpulidae	Serpulid worms
Phylum Arthropoda	
Infraclass: Cirripedia	
Family Bathylasmatidae	Goose and acorn barnacles
Phylum Mollusca	
Family Pectinidae	
Adamussium colbecki	Antarctic scallop
Phylum Hemichordata	
Class Pterobranchia	Acorn worms
Domain Eukarya	
Phylum Foraminifera	
Class Xenophyophorea	Xenophyophores
Chemosynthetic communities	

SIOFA have developed a list of VME indicator Taxa (Annex 1 of CMM 2020_01) and a guide for use by observers, these are same as those used by CCAMLR.

With the exception of HIMI, which uses the CCAMLR definition, there **is no definition of a VME within waters under national jurisdiction**.

Under CCAMLR CM 22-06, VMEs include seamounts, hydrothermal vents, cold water corals and sponge fields.

In the SPRFMO Convention Area, the definition of VME is the same as the FAO description, as stated under paragraph 3 of SPRFMO CMM 03-2022, "the term 'vulnerable marine ecosystem' (VME) means a marine ecosystem that has the characteristics referred to in paragraph 42 and elaborated in the Annex of the FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas."

A recent project, funded by the New Zealand Ministry of Business, Innovation and Employment, has collated data from a range of sources, namely field observations, online data sources, research institutes and fisheries agencies (e.g. AFMA), to predict the occurrence of VMEs in the SPRFMO region[304]. To date, there are 202,836 VME occurrences recorded by human observation in the project's database[305]. Cnidaria were the most dominant phylum recorded (84%, of which stony corals made up 60.5%) followed by porifera (15%) and Echinodermata (1%).

In the CCAMLR region, there are 5718 records documented in the CCAMLR VME Registry, notified under CM 22-06 and CM22-07. The earliest records were uploaded in 2003. The majority of recorded taxa are cnidaria (50%, of which hydrocorals make up 22%), followed by porifera (49%) and other taxon (1%).

The **predominant life history characteristics** of species associated with VMEs are listed under paragraph 42 and elaborated in the **Annex of the FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas**[306].

These characteristics include:

1) Unique, rare or endemic species that have a limited distribution
2) Functionally significant

[304] https://www.gbif.org/dataset/be62fffc-d0e7-45f2-9404-d4bc4322bc57
[305] https://www.gbif.org/occurrence/search?dataset_key=be62fffc-d0e7-45f2-9404-d4bc4322bc57
[306] FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas

3) Fragile- highly susceptible to degradation by anthropogenic activities e.g. trawl gear
4) Particular life-history traits which make recovery difficult such as slow growth rates; late age of maturity; low or unpredictable recruitment; or long-lived.
5) Habitat-forming species

Research, management and conservation of VME features in the Case Study Area have mainly focused on the following habitat types: seamounts, submarine canyons, ridges, plateaus, continental slopes, pinnacles, hydrothermal vents, cold water corals and sponge fields [307,308,309].

With the exception of HIMI, there are no VMEs define within waters under national jurisdiction. The ERAEF for the WDWTF did identify bryozoan rich substrates between 120 meters and 300 meters, raising the concern that they may be impacted by trawling (Wayte *et al*., 2007)[310].

Within the Evaluated Area of the SPRFMO Convention Area, the distribution of VME indicator taxa has been mapped between depths of 200m and 3000m (Georgian *et al*., 2019)[311]. Bottom fishing rarely occurs deeper than 1250m and has never been reported deeper than 1400m therefore VME species and habitats are not likely impacted by trawl gear[312].

In the CCAMLR region, all currently-identified VMEs, confirmed by research-vessel surveys, occur in relatively shallow water within a depth rage od 42 to 695m. These VMEs are protected by designating Risk Areas, closed to bottom fishing, which have a depth range of 715 to 1882m[313].

Within areas of national jurisdiction, with the exception of HIMI, there are no VME areas defined. Habitat evaluations are undertaken as part of the ERAEF which uses oceanographic features as a factor when considering the risk of an impact from fishing.

In the South Pacific Ocean, bottom fisheries are mainly associated with major seamounts, ridges, canyons, pinnacles and plateaus, which are often areas of nutrient upwelling and higher productivity. Research by Georgian *et al*., (2019)[314] reported VME indicator taxa, such as cold-corals and sponges, were typically associated with elevated seafloor features with steep slopes and locally accelerated currents. As filter feeders, these currents create a suitable habitat by increasing food supply, larval delivery and the removal of sediment.

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[308] Williams, A., Dowdney, J., Smith, A.D.M., Hobday, A.J. and Fuller, M., 2011. Evaluating impacts of fishing on benthic habitats: a risk assessment framework applied to Australian fisheries. Fisheries Research, 112(3), pp.154-167.

[309] Williams, A., Althaus, F., Green, M., Maguire, K., Untiedt, C., Mortimer, N., Jackett, C.J., Clark, M., Bax, N., Pitcher, R. and Schlacher, T., 2020. True size matters for conservation: a robust method to determine the size of deep-sea coral reefs shows they are typically small on seamounts in the southwest Pacific Ocean. Frontiers in Marine Science, 7, p.187.

[310] Wayte, S., Dowdney, J., Williams, A. Fuller, M., Bulman, C., Sporcic, M., Smith, A. (2007) Ecological Risk Assessment for the Effects of Fishing: Report for the Western Deepwater Trawl Fishery. Report for the Australian Fisheries Management Authority, Canberra.

[311] Georgian, S.E., Anderson, O.F., Rowden, A.A. (2019). Ensemble habitat suitability modelling of vulnerable marine ecosystem indicator taxa to inform deep-sea fisheries management in the South Pacific Ocean. Fisheries Research 211:256-274.

[312] http://www.sprfmo.int/assets/2020-SC8/SC8-DW07-rev-1-Cumulative-Bottom-Fishery-Impact-Assessment-for-Australia-and-New-Zealand.pdf

[313] http://www.fao.org/3/i5952e/i5952e.pdf

[314] Georgian, S. E., Anderson, O. F., and Rowden, A. A. 2019. Ensemble habitat suitability modeling of vulnerable marine ecosystem indicator taxa to inform deep-sea fisheries management in the South Pacific Ocean. Fisheries Research, 211: 256–274.

4.3 - Assessment of bottom fishing impacts

-Main bottom fisheries in Australian fishing zone-

Australia's fishing zone (Figure 1) covers over eight million square kilometres, making it the world's third largest. It contains around 3700 known species of fish, over 2800 species of mollusc and over 2300 species of crustaceans. Only a small proportion of these species are commercially fished. **The Australian Government generally manages fisheries in waters between three and 200 nautical miles from the Australian coast**. This area is referred to as the **Australian Fishing Zone**. State and territory entities typically manage fisheries out to three nautical miles from the coastline. **Nine fisheries are managed solely by the Australian Fisheries Management Authority (AFMA) on behalf of the Australian Government**. **Seven fisheries are managed jointly by AFMA and regional or international partners** (such as Western and Central Pacific Fisheries Commission, Commission for the Conservation of Southern Bluefin Tuna, Indian Ocean Tuna Commission, Commission for the Conservation of Antarctic Marine Living Resources, Norfolk Island Regional Council, etc).

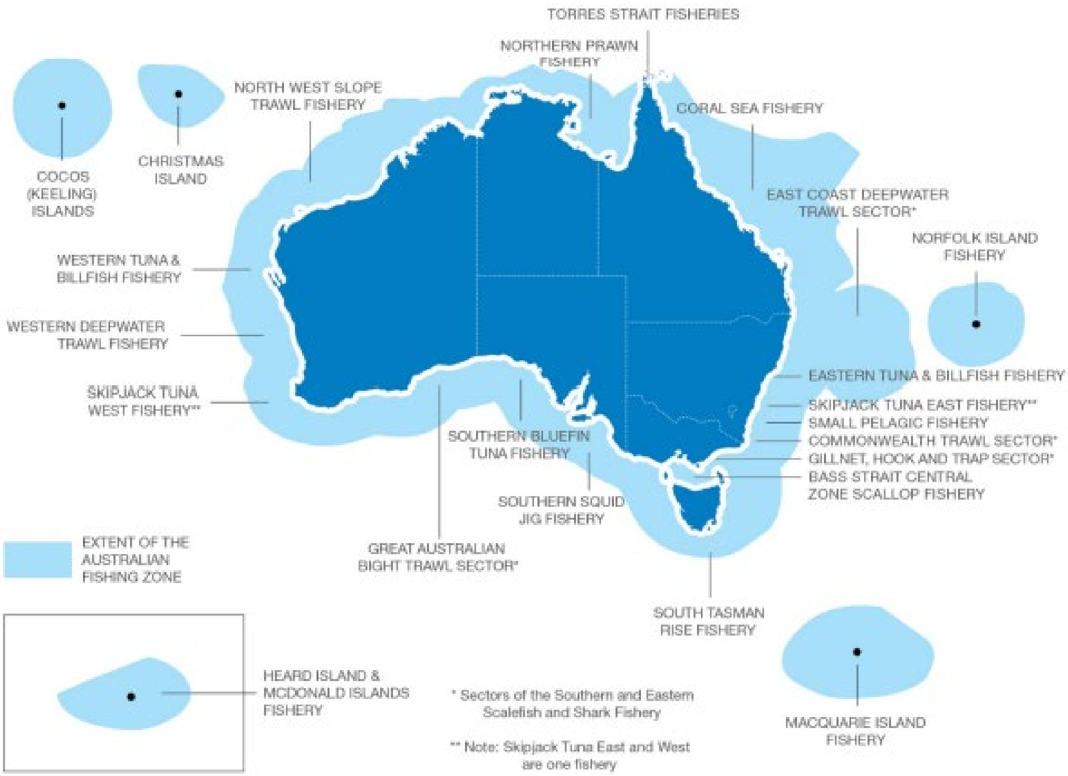

Figure 1. Australian fishing zone — Commonwealth fishery locations (Source: AFMA)

Details of the main bottom fisheries within the area under national jurisdiction are summarized in Table 6. In addition, Australia also operate longline vessels and a trawler targeting toothfish in CCAMLR waters, and longline vessels in SIOFA and SPRFMO.

Table 6. Summary of the main fisheries in Australia based on the 2019 ABARES Fishery Status reports. Fishery statistics given for 2018-2019 season.

Fishery	Target species	Region/ Depth	Method	No. of active vessels	Fishing effort	Total catch	Management Methods
SESSF Commonwealth Trawl Sector	Mixed Finfish species, particularly Pink Ling, Blue Grenadier, Flathead and Silver Warehou	Covers almost half of the Australian Fishing Zone	Otter trawl and Danish seine	48 vessels	58,298 hours of trawling; 10,340 shots using Danish seine	7,575 t for quota and non-quota stocks	Input controls: limited entry, gear restrictions, area closures Output controls: TACs, ITQs, trip limits
SESSF Gillnet, Hook and Trap Sector	Mixed fish species, particularly Pink Ling, Blue-eye Trevalla and Gummy Sharks	This sector includes waters from the New South Wales/Victorian border westward to the South Australian/Western Australian border, including the waters around Tasmania, from the low water mark to the extent of the Australian Fishing Zone.	Demersal gillnet, demersal longline, dropline and trotline	Gillnet: 41 Hook:37	Gillnet: 32,008 km of net hauled Hook: 2,165,571 hooks set	740 t	Input controls: gear restrictions, closed areas Output controls: ITQs, school shark/gummy shark catch ratio restriction, size limits, trip limits
SESSF Great Australian Bight Trawl Sector	Deepwater Flathead and Bight Redfish	The GABTS can be divided into a continental-shelf fishery (at depths of less than 200 m), an upper continental-slope fishery (at depths of about 200–700 m) and a deepwater fishery (on the mid-slope to lower slope, depth 700–1,000 m).	Otter trawl and Danish-seine	4 trawl; 1 seine	12,421 trawl-hours; 451 shots	919 t	Input controls: limited entry, area closures, gear restrictions Output controls: ITQs, TACs, trigger limits

Fishery	Target species	Region/ Depth	Method	No. of active vessels	Fishing effort	Total catch	Management Methods
Macquarie Island Toothfish Fishery	Patagonian toothfish	1,500 km south of Tasmania (up to 2000 m depth)	Longline	1	95 days	448 t (toothfish)	Input controls: limited entry, gear restrictions, closures Output controls: TACs, ITQ
Heard Island and McDonals Islands Fishery	Mackerel icefish, Patagonian toothfish	South Indian Ocean within CCAMLR area	Demersal longline; trawl	4 (2017-18 season)	51 trawl-days 16,415,948 hooks (2017-18 season)	519 t (icefish); 3,138 t (toothfish) (2017-18 season)	Input controls: limited entry, gear restrictions, temporal and spatial closures Output controls: TACs, ITQs Other: move-on provisions if bycatch thresholds are reached.
Western Deepwater Trawl Fishery	Mixed Finfish species	>200 m off the coast of Western Australian from Exmouth to Augusta	Demersal trawl	3 (2017-18 season)	100 days, 1,108.3 trawl-hours (2017-18 season)	101.9 t total fishery (2017-18 season)	Input controls: limited entry (11 permits), gear restrictions Catch controls: trigger limits for key commercial species
North West Slope Trawl Fishery	Scampi	Coast of the Prince Regent National Park to Exmouth between the 200m depth contour to the outer limit of the Australian Fishing Zone.	Otter trawl	4 (2017-18 season)	219 days; 3,731 trawl-hours (2017-18 season)	55.2 t (scampi); 79.7 t (total fishery)	Input controls: limited entry, gear restrictions Output controls: harvest strategy contains catch trigger for scampi, deepwater prawns and some finfish (redspot emperor and saddletail snapper)
South Tasman Rise	Orange Roughy, Smooth Oreodory and Spikey Oreodory	NA	Deepwater demersal trawl	Closed	Closed	NA	

AFMA carries out **Ecological Risk Assessments (ERA)** for all of its major fisheries. The impact of bottom trawls on bycatch species and habitats has been assessed as part of the ERA. AFMA mitigates, or reduces, that impact through its ecological risk management (ERM) strategy. The ERM details a number of management arrangements and strategies which aim to reduce the impact of fishing on the environment, including minimum mesh sizes for otter board trawls to reduce the catch of small and juvenile fish, mitigation devices to reduce interactions with threatened, endangered and protected species and spatial closures to protect vulnerable species and habitats. AFMA reports annually on the rate of fishing gear interactions with protected species to the Department of the Environment.

Main species targeted by bottom trawls are: i) Flathead; ii) Pink ling; iii) Blue grenadier; iv) Silver warehou and v) Prawns.

Flathead (*Neoplatycephalus richardsoni* also known as *Platycephalus richarsoni*- PHI)

Management of catch: The Commonwealth catch of tiger flathead is managed by quota and this means the catch of this fish by commercial fishers is restricted by weight. The quota includes catches of other flathead species but because tiger flathead make up about 95 per cent of the catch and the different species cannot be distinguished in historical data only tiger flathead is assessed.
Commercial fishermen are required to fill in records of their catches, during each fishing trip and when they land their catch in a port. This helps us keep records of how much is being caught.

AFMA decides on the amount that can be caught each year from expert advice and recommendations from fisheries managers, industry members, scientist and researchers.

Area caught and habitat: Tiger flathead are caught along the south east Australian coast from Coffs Harbor in New South Wales to Portland in Victoria, and have been reported as far west as the southern coast of Western Australia. Tiger flathead are mainly caught in the Commonwealth Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery and smaller catches of tiger flathead are from the Gillnet, Hook and Trap Sector.

Tiger flathead are a demersal species that is found at depths of 10-400 metres. Juveniles inhabit shallow waters of the continental shelf and move into the deeper outer shelf zone as they reach maturity. They are not an active species and normally rest in areas of mud and sand on the sea bed during the day, and move into the water column at night to feed. There is evidence that mature fish migrate to shallower waters prior to the spawning period.

Fishery	Gear	Catch of this species is targeted or incidental
Southern and Eastern Scalefish and Shark Fishery – Commonwealth Trawl Sector	Bottom trawl, danish seine	Targeted
Southern and Eastern Scalefish and Shark Fishery – Gillnet Hook and Trap Sector	Gillnet	Incidental

Fishing gear and environmental impacts: The main fishing method used to catch tiger flathead is bottom trawl and danish seine. They are also incidentally caught using gillnets. Sometimes, bottom trawling can catch unwanted species of fish (bycatch) and it is monitored by on-board fishery observers who assess the environmental impact of the trawling. Although it is not physically possible to trawl on reef structures, significant long-term damage can occur if sensitive habitat areas like

corals, sponges and seagrass beds are trawled. To ensure these sensitive habitat areas are protected from trawling, management arrangements such as area closures are extensively used. AFMA's management of commercial trawl fisheries aims to ensure trawl fishing has the least impact possible on the environment.
Gillnets have a minimal impact on the seafloor as they are stationary when set. Gillnets have the potential to interact with marine mammals, although when set properly, larger predatory sharks and marine mammals will bounce off the firm netting.
The danish seine method of fishing has minimal impacts on the environment. The most recent ecological risk assessment identified one species, the Australian fur seal, as at risk from danish seine fishing. There is currently a code of practice to minimise interaction with seals in this fishery. The overall impact of danish seine fishing on habitats is quite low with only three identified as at risk. These habitats are generally on smooth bottom and support epifauna such as large sponges. In the Commonwealth Trawl Sector, ecological risk management measures include minimum mesh sizes for bottom trawls to reduce the catch of small and juvenile fish, mitigation devices to reduce interactions with threatened, endangered and protected species and spatial closures to protect vulnerable species and habitats.

Pink ling *(Genypterus blacodes*-CUS*)*

Management of catch: The Commonwealth catch of pink ling around the south east of Australia is managed by quota. Which means the catch of this fish by commercial fishers is restricted by weight. Commercial fishermen are required to fill in records of their catches, during each fishing trip and when they land their catch in a port. This helps us keep records of how much is being caught. AFMA decide on the amount that can be caught each year from expert advice and recommendations from fisheries managers, industry members, scientist and researchers.

Area caught and habitat: Pink ling is found in New South Wales, Victoria, Tasmania, South Australia and southern Western Australia however they are mainly caught in the Southern and Eastern Scalefish and Shark Fishery.

Pink ling are a demersal species that inhabits the continental shelf and slope. They can be found at depths of 20-1000 metres. Juveniles tend to occur in shallower waters than adults. Pink ling occur over a variety of substrates, from rock ground to soft sand and mud in which they burrow. Aside with some movement associated with spawning, pink ling are thought to be relatively sedentary.

Fishery	Gear	Catch of this species is targeted or incidental
Southern and Eastern Scalefish and Shark Fishery – South East Trawl Sector	Bottom trawl	Targeted
Southern and Eastern Scalefish and Shark Fishery – Gillnet, Hook and Trap Sector	Bottom longline and dropline	Targeted
Southern and Eastern Scalefish and Shark Fishery – Great Australian Bight Trawl Sector	Bottom trawl	Incidental

Fishing gear and environmental impacts: Fishers catch pink ling using trawl nets, longlines and droplines.

Blue grenadier (*Macruronus novaezelandiae*-GRN)

Management of catch: The Commonwealth catch of blue grenadier is managed by: i) quota (restricted by weight); ii) the number of boats allowed to fish; iii) the area open to fishing and iv) gear type and amount.

Commercial fishermen are required to fill in records of their catches, during each fishing trip and when they land their catch in a port. This helps us keep records of how much is being caught. AFMA decide on the amount that can be caught each year from expert advice and recommendations from fisheries managers, industry members, scientist and researchers.

Area caught and habitat: Blue grenadier is a deepwater fish but migrates into the water column during the night. Adults are found on the continental slope in depths of 200-700 metres, and juveniles in southern Tasmanian bays and inlets. Blue grenadier is found in New South Wales, Victoria, Tasmania, South Australia and southern Western Australia however they are mainly caught off western and eastern Tasmania. The majority of blue grenadier catches come from western Tasmanian waters during the winter.

Blue grenadier are a deepwater species that occurs on the continental slope. They can be found at depths of 200-700 metres. Juveniles often occur in shallower bays and inlets. Blue grenadier aggregate near the sea bed during the day and move up into the water column at night.

Fishery	Gear	Catch of this species is targeted or incidental
Southern and Eastern Scalefish and Shark Fishery – South East Trawl Sector	Bottom trawl	Targeted
Southern and Eastern Scalefish and Shark Fishery – South East Trawl Winter Sector	Bottom trawl and midwater trawl	Targeted
Southern and Eastern Scalefish and Shark Fishery – Gillnet, Hook and Trap Sector	Longline and dropline	Incidental
Southern and Eastern Scalefish and Shark Fishery – Great Australian Bight Trawl Sector	Bottom trawl	Incidental

Fishing gear and environmental impacts: Sometimes fishing interactions may take place with seabirds. To try and reduce these interactions, it is mandatory for all trawl boats in the fishery catching blue grenadier to apply a vessel specific seabird management plan. To protected seals and dolphins, freezer trawl boats are required to use seal exclusion devices.

Bottom trawl gear can sometimes impact bycatch species and habitats. Management arrangements and strategies to reduce the impact of fishing on the environment include: i) a minimum mesh size for bottom trawls to reduce the catch of small and juvenile fish; ii) mitigation devices to reduce interactions with threatened endangered and protected species and iii) area closures to protect vulnerable species and

Silver warehou (*Seriolella punctata*-SEP)

Management of catch: The Commonwealth catch of silver warehou is managed by quota, meaning that the catch of this fish by commercial fishers is restricted by weight. Commercial fishermen are required to fill in records of their catches, during each fishing trip and when they land their catch in a port. This helps us keep records of how much is being caught. AFMA decide on the amount that can be caught each year from expert advice and recommendations from fisheries managers, industry members, scientist and researchers.

Area caught and habitat: Silver warehou are found along the south east Australian coast from South Australia to New South Wales and Tasmania. Silver warehou are predominantly caught in the Commonwealth Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery. They are most commonly caught between 100 and 700 metres.

Fishery	Gear	Catch of this species is targeted or incidental
Southern and Eastern Scalefish and Shark Fishery – Commonwealth Trawl Sector	Bottom trawl	Targeted

Fishing gear and environmental impacts: The main fishing method used to catch silver warehou is bottom trawl in the Commonwealth Trawl Sector. Sometimes, bottom trawling can catch unwanted species of fish (bycatch) and it is monitored by on-board fishery observers who assess the environmental impact of the trawling.

Although it is not physically possible to trawl on reef structures, significant long-term damage can occur if sensitive habitat areas like corals, sponges and seagrass beds are trawled. To ensure these sensitive habitat areas are protected from trawling, management arrangements such as area closures are extensively used. AFMA's management of commercial trawl fisheries aims to ensure trawl fishing has the least impact possible on the environment.

Prawns

Management of catch: AFMA manages prawn catches by putting rules around the size and number of nets (and sometimes boats) fishers use, and where and when they can fish. There are different rules about what fishing gear can be used in each fishery. We also limit how many boats can fish in each fishery and close areas to fishing to protect important habitats, such as nursery grounds. Fishers monitor how many prawns are caught by filling in logbooks. This information along with other research information is reviewed by resource and management advisory groups to assess how much fishing can occur within the fishery and ensure its continued sustainability.

Area caught: Tropical prawn species are mainly found in tropical and sub-tropical waters around Australia. They occur from Shark Bay in Western Australia along the Northern Territory and Queensland coastlines (including waters in Torres Strait between Australia and Papua New Guinea) and midway down the New South Wales coast.

Species	Fishery	Gear	Catch of this species is targeted or incidental
Tiger prawn (*Penaeus esculentus*-PRB and *Penaeus semisulcatus*-TIP)	Northern Prawn Fishery Torres Strait Prawn Fishery	Bottom trawl	Targeted
Banana prawn (*Penaeus indicus*-PNI and *Penaeus merguiensis*-PBA)	Northern Prawn Fishery	Bottom trawl	Targeted
Endeavour prawn (*Metapenaeus endeavouri*-ENS and *Metapenaeus ensis*-MPE)	Northern Prawn Fishery Torres Strait Prawn Fishery	Bottom trawl	Targeted

Fishing gear and environmental impacts: Prawns are caught in our fisheries using bottom trawl nets (also called otter trawls). Fishers in the Northern Prawn Fishery use either two, three or four trawl nets. Fishers in the Torres Strait Prawn Fishery usually use four nets. Prawns are also caught in some state managed commercial fisheries using similar types of trawl gear.

Sometimes, bottom trawling can catch unwanted species of fish. This is known as bycatch and it is monitored by on-board fishery observers. While it is not physically possible to trawl on coral reef, other sensitive habitats such as seagrass beds could be damaged from trawling. Most of these areas are protected by being closed to fishing. These areas are monitored through satellite tracking devices. AFMA aims to minimise the effects that fishing for prawns has on the environment by assessing the risks and developing management responses. We work with the Department of the Environment to ensure that our fisheries meet strict environmental guidelines. AFMA manages the risks for each fishery differently depending on the impacts and types of fishing gear. Some management responses include gear restrictions and modifications, area closures and mechanical devices to eliminate or reduce bycatch. Ecological risk assessments and management reports are available for each fishery.

The Northern Prawn Fishery also gained Marine Stewardship Council certification in November 2012. This means the fishery meets the highest international standards for environmental sustainability.

-Scientific expert groups/committes-
South East Resource Assessment Group (SERAG) is the key research and scientific committee for management of the Southern and Eastern Scalefish and Shark Fishery. The group provides advice to the South East Management Advisory Committee (SEMAC) on the status of fish stocks, sub stocks, species (target and non-target), the impact of fishing on the marine environment and the type of information needed for stock assessments. This group provides advice on the recommended biological catch for the quota groups or species that occur on the continental shelf and slope. They also evaluate the impact over time of different harvest strategies, stock depletion and recovery rates, confidence levels for fishery assessments and risks to the success of fishery objectives. Economic factors affecting the fishery are also evaluated and reported on by the group. This group provides an avenue for consultation between industry members, fishery managers, fishery economists, fishery scientists and other interest groups. SERAG was formed in 2016 as an amalgamation of the former ShelfRAG and SlopeRAG.

The South East Management Advisory Committee (SEMAC) is the overarching committee that provides management advice to AFMA for the following fisheries: i)

Southern and Eastern Scalefish and Shark Fishery (including the Gillnet Hook and Trap Sector and the South Eastern Trawl Sector); ii) Small Pelagic Fishery and iii) Southern Squid Jig Fishery.

SEMAC provides management advice to the AFMA Commission and AFMA management on efficient and cost effective fisheries management, and provides an avenue for consultation between industry, policy, conservation, state and territory governments, recreational and research fields. SEMAC receives scientific advice from the Southern and Eastern Scalefish and Shark Fishery Resource Assessment group, Squid Resource Assessment Group, Small Pelagic Fishery Resource Assessment Group and Stakeholder Forums, South East Resource Assessment Group and the Shark Resource Assessment Group. The committee uses this scientific advice to inform their management advice.

The Northern Prawn Fishery Resource Assessment Group (NPRAG) is the research and scientific committee for management of the Northern Prawn Fishery. The group provides advice to the AFMA, the Commission and the Northern Prawn Fishery Management Advisory Committee on the status of target stocks (including the type of information and research needed to support the stock assessments) and on fishing impacts upon byproduct, bycatch and the marine environment. The group also evaluates alternative harvest options like the impact over time of different harvest strategies, effort levels, confidence levels for fishery assessments and risks to the success of fishery objectives. Economic factors affecting the fishery are a key consideration for the assessments. This group provides an avenue for consultation between industry members, fishery managers, economists, scientists and other interest groups.

The Northern Prawn Fishery Management Advisory Committee is the main forum for discussing fisheries management issues relating to the Northern Prawn Fishery, identifying problems and developing possible solutions. The committee provides management advice to the AFMA Commission and AFMA management on efficient and cost effective fisheries management. The committee provides an opportunity for consultation between industry, managers, researchers, environment and conservation groups, and state government officers. The Northern Prawn Fishery Resource Assessment Group provides scientific advice to the committee, AFMA management and the AFMA Commission. The committee uses this advice to inform their management advice.

-Protected species management-

AFMA manages commercial fishers operating in Commonwealth waters. Strict rules apply where commercial fishers encounter (interact with) protected species.

Protected species are listed under the *Environment Protection and Biodiversity Conservation Act 1999*[315] (the EPBC Act) which is administered by the Department of the Environment. All Commonwealth commercial fisheries are accredited by the Department of the Environment and AFMA and the fishing industry take all reasonable steps to minimise interactions with protected species. Commonwealth commercial fishers must report all interactions with protected species to AFMA. Marine species listed under the EPBC Act include seals and sea lions, sharks, turtles, seabirds and cetaceans (whales and dolphins).

Species listed fall into four main categories:

1. a member of a listed threatened species or listed threatened ecological community
2. a member of a listed migratory species
3. a member of a listed marine species
4. a cetacean

[315] https://www.legislation.gov.au/Series/C2004A00485

-Environmental impacts and management-

Sometimes, bottom trawling can catch unwanted species of fish or other sea creatures. This is known as bycatch and it is monitored by on-board fishery observers. Although it is not physically possible to trawl on reef structures, significant damage can occur if sensitive habitat areas like corals, sponges and seagrass beds are trawled. To ensure these sensitive habitat areas are protected from trawling, management arrangements such as area closures are extensively used. Physical devices, such as excluder and bycatch reduction devices within trawl nets, are used by fishers to divert unwanted species out of the net. This is important as it allows small fish, larger animals and protected species to escape the net.

AFMA's management of commercial trawl fisheries aims to **ensure trawl fishing has the least impact possible on the environment**.

-Main fisheries under High Seas Permits-

High Seas Permits may be issued to Australian flagged vessels to fish for non-highly migratory species the areas of waters outside of the Australian Fishing Zone and the exclusive economic zone of any country. High Seas Permits only allow fishing in areas that will fall in the area of competence of the **Southern Indian Ocean Fisheries Agreement** (SIOFA) and the **South Pacific Regional Fisheries Management Organisation** (SPRFMO). High Seas Permits specify conditions on fishing and are granted for a maximum of one year until the end of each calendar year. Permit holders are required to re-apply each year.

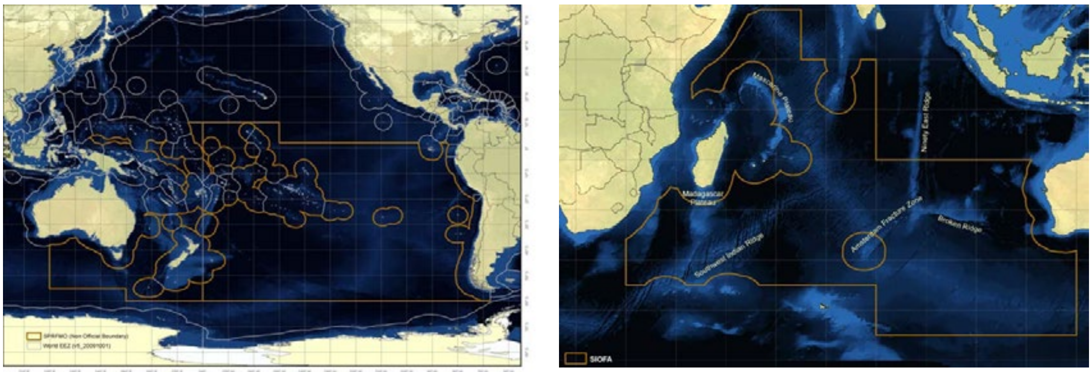

Figure 2. South Pacific Regional Fisheries Management Organisation (SPRFMO) (left) and Southern Indian Ocean Fisheries Agreement (SIOFA) (right) maps.

When fishing on the high seas, vessels must ensure that they comply with all obligations relating to the permit including the following:

i) The boat nominated to fish under the High Seas Permit is clearly marked with its international radio call sign according to internationally recognised standards;
ii) AFMA has been provided with good quality, high resolution photographs of the boat that are no older than five years;
iii) all fishing gear is properly stowed when transiting areas closed to fishing in the permit conditions or through another country's Exclusive Economic Zone (EEZ);
iv) vessels do not fish in another country's EEZ and
v) the boat nominated to fish under the High Seas Permit has an International Maritime Organization (IMO) number issued to it if the boat is at least 100 Gross Tonnage or 100 Gross Register Tonnage in size.

At least 48 hours before the nominated boat leaves port with the intention of entering high seas, they must provide AFMA the following information:

i) The name and international distinguishing symbol of the boat;
ii) the estimated time and date of departure;
iii) the port of departure and
iv) the fishing destination.

AFMA requires **100 per cent observer coverage** for all trawl operations under High Seas Permits. For other methods, such as automatic longline, AFMA requires mandatory observer coverage for the first trip of each season and ongoing coverage of at least 10 per cent annually within SPRFMO, or 20 per cent annually within SIOFA.

-Move on rule SPRFMO (VME trigger levels)-

Any evidence of a vulnerable marine ecosystem such as coral or sponges in a fishing shot must be recorded in logbooks.

If the combined catch of coral or sponge in any one shot exceeds: i) 50 kilograms of corals and sponges in a trawl shot; or ii) 10 kilograms bycatch of corals and sponges in a 1000 hook section of line for automatic longline operators vessel must stop fishing immediately and not fish using the same method at any point within a five nautical mile radius of any part of that shot until AFMA notifies otherwise. Encounter must be reported to AFMA within 24 hours of the shot. The notification must include details of the shot including the location, as outlined in Annex 1 of the SPRFMO; Conservation and Management Measure (CMM) for the Management of Bottom Fishing in the SPRFMO Convention Area.

-Move on rule SIOFA (VME trigger levels)-

Any vessel flying their flag must cease bottom fishing activities within:

(a) For bottom or mid water trawling, or fishing with any other net - two (2) nautical miles either side of a trawl track extended by two (2) nautical miles at each end;
(b) For longline and trap activities - a radius of one (1) nautical mile from the midpoint of the line segment;
(c) For all other bottom fishing gear types - a radius of one (1) nautical mile from the midpoint of the operation
if the combined catch of coral or sponge in any one shot exceeds: i) 50 kilograms of corals and sponges in a trawl shot; or ii) 10 kilograms bycatch of corals and sponges in a 1000 hook section of line for automatic longline operators.

Vessels must also report the encounter to AFMA within 24 hours of the shot. The notification must include details of the shot including the location, as outlined in Annex 1 of the SIOFA CMM 2016/01; Conservation and Management Measure for the Interim Management of Bottom Fishing in the SIOFA Agreement Area.

-Fishing footprint-

Under the permit conditions, vessels must only fish within specified areas. Indicative maps of the fishing areas for SPRFMO and SIOFA are shown in Figures 3 and 4.

Vessels should not fish in: i) the Australian Fishing Zone (AFZ); ii) another country's EEZ and iii) the South Tasman Rise (this area is defined in permit conditions).

Vessels may fish in both the AFZ and high seas on a single trip, subject to 100 per cent monitoring and written approval from AFMA.

Fishing by Australian vessels is restricted to areas previously fished during the historical reference period of **2002-2006 in the SPRFMO area** (as defined by the SPRFMO interim measures) and **1999 – 2009 in the SIOFA area**. The inclusion of a **restrictive fishing footprint** is a significant step particularly in the SIOFA area of waters where Australia is implementing these restrictions unilaterally in an area where vessels flagged to other countries are not subject to such restrictions. Australian operators in the SIOFA area have agreed to further restrict fishing areas to exclude areas voluntarily closed by members of the Southern Indian Ocean Deepsea Fishers Association.

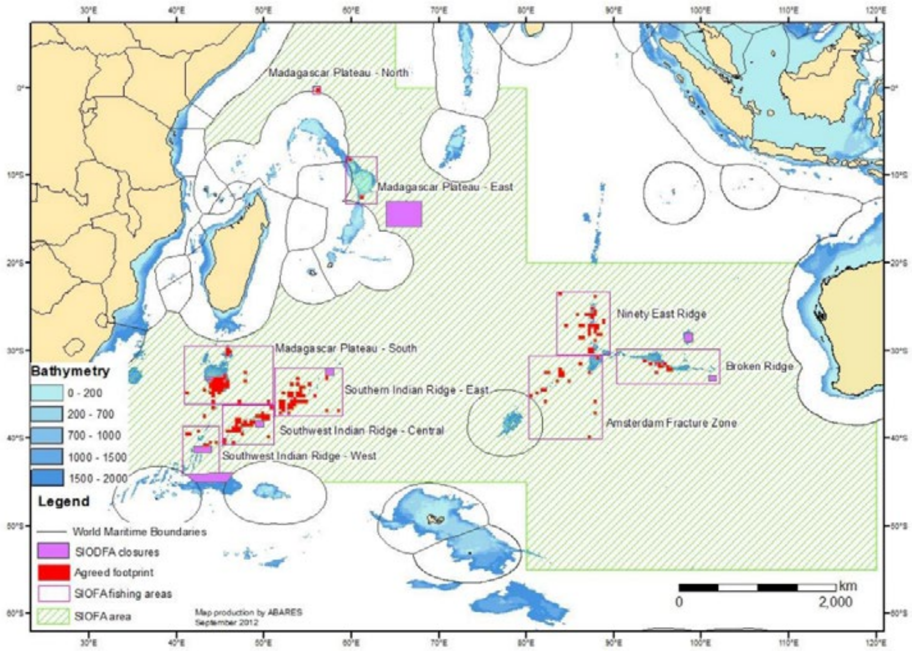

Figure 3. Indicative map of Australia's permitted fishing areas (Australia's fishing footprint 1999-2009) within the SIOFA Area. (Source: Woodhams, J, Stobutzki, I, Noriega, R & Roach, J 2012, Sustainability of harvest levels by Australian flagged vessels in the high seas areas of the South Pacific Ocean and South Indian Ocean, ABARES report to client prepared for the Australian Fisheries Management Authority, Canberra, November 2012).

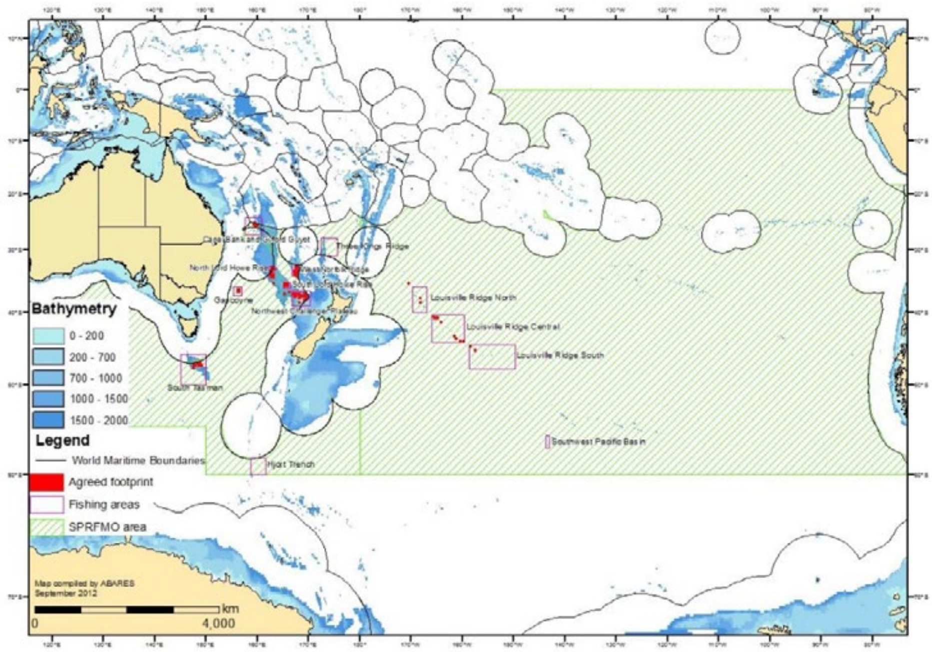

Figure 4. Indicative map of Australia's permitted fishing areas (Australia's fishing footprint) within the SPRFMO Area. (Source: Woodhams, J, Stobutzki, I, Noriega, R & Roach, J 2012, Sustainability of harvest levels by Australian flagged vessels in the high seas areas of the South Pacific Ocean and South Indian Ocean, ABARES report to client prepared for the Australian Fisheries Management Authority, Canberra, November 2012).

The Commonwealth Scientific and Industrial Research Organisation (CSIRO)[316] estimate that that the **current trawl footprint is 1.1% of the entire continental EEZ** where a state has special rights regarding the exploration and use of marine

[316] https://www.csiro.au/

resources. 58.4% of the EEZ is protected from trawling by various fishery closures and reserves. Trawling occurs on the shelf and slope within the EEZ to a maximum depth of 1,500m, within this range the footprint is estimated to be 3.4%, 37.9% of this area is protected[317]. Table 7 gives the area trawled by region and shows that the eastern areas have the highest trawl footprints and have been prioritised for a detailed assessment of habitat risk. It also shows that the majority of trawling effort takes place at depths shallower than 200m.

Table 7. Trawling footprint by region, depths 0-1000m (adapted from Amoroso Ricardo O. *et al*., 2018)[318]

Area	Area trawled 0-1,000m (10^3 km^2)	Area trawled 0-200m (10^3 km^2)	Area trawled 200-1000m (10^3 km^2)	SAR*
Southeast Australian Shelf	268	230	38	0.134
Northeast Australian Shelf	557	337	220	0.112
Southwest Australian Shelf	338	283	55	0.034
Northwest Australian Shelf	686	474	212	0.023
North Australian Shelf	794	792	2	0.026

*SAR – Swept Area Ratio = the ratio of total swept area trawled annually to total area trawled, a metric of trawling intensity.

Trawl footprints have been mapped and reported for bioregions at the subregional scale under the Integrated Marine and Coastal Regionalisation of Australia (IMCRA). The effort data were taken between 2007 and 2012 and converted into a common scale of swept area per km^2 which allowed a quantification of the footprint for all demersal trawling as a percentage of each bioregion, this is shown in Figure 5.

The footprint differs significantly between bioregions, half the bioregions have footprints between 0 and 2.5% and two thirds less than 5%, the highest region, at 43%, is off western Tasmania (Evans *et al*., 2016)[319].

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[317] https://www.csiro.au/en/research/animals/Fisheries/Sustainable-trawling

[318] Amoroso Ricardo O. *et al.* (2018) 'Bottom trawl fishing footprints on the world's continental shelves', *Proceedings of the National Academy of Sciences*, 115(43), pp. E10275–E10282. doi:10.1073/pnas.1802379115.

[319] Evans K, Bax NJ, Smith DC (2016). Marine environment: Commercial and recreational fishing. In: Australia state of the environment 2016, Australian Government Department of the Environment and Energy, Canberra, https://soe.environment.gov.au/theme/marine-environment/topic/2016/commercial-and-recreational-fishing, DOI 10.4226/94/58b657ea7c296.

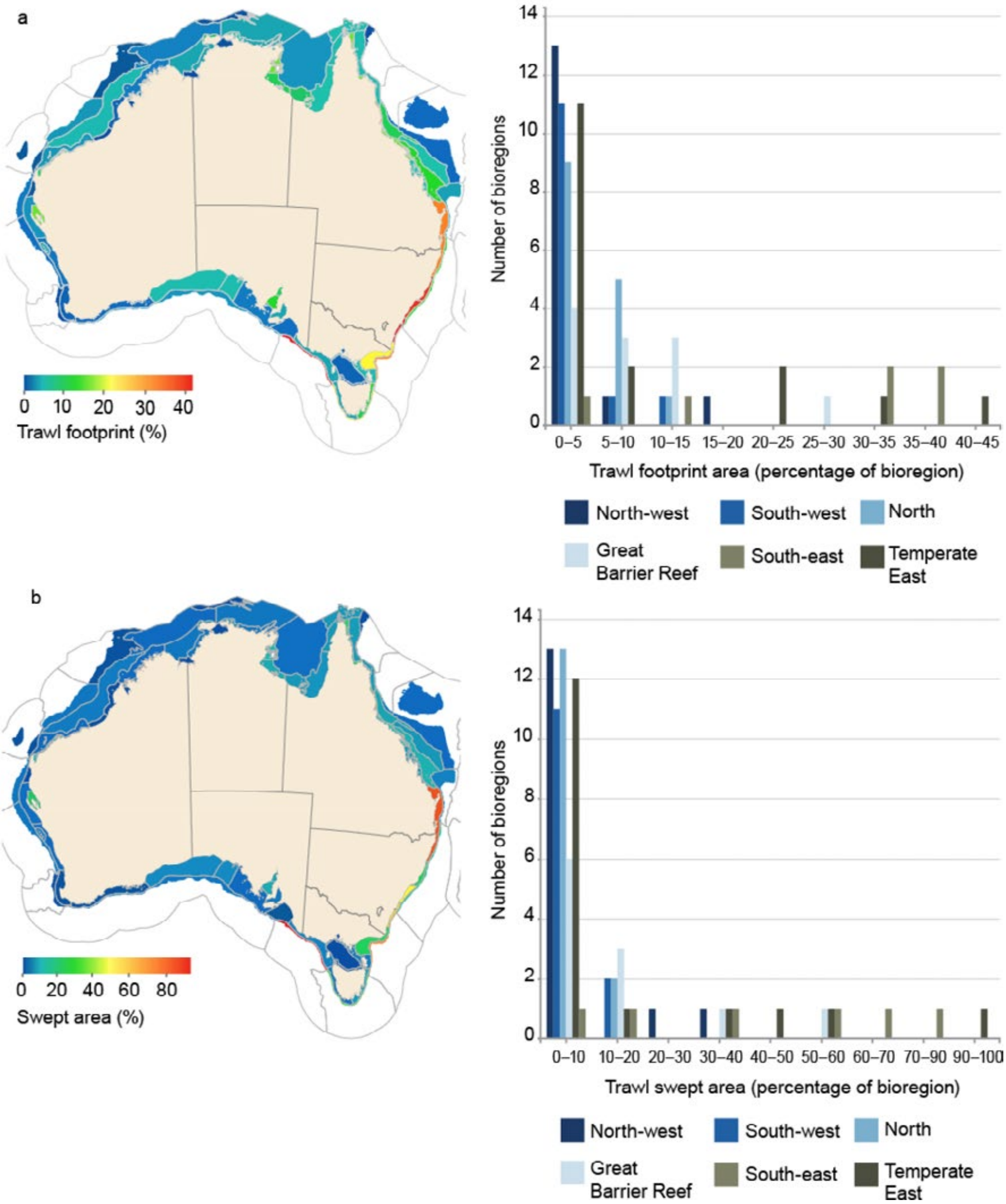

Figure 5. (a) Footprint of Australian commercial demersal trawl and dredge fisheries as a percentage of IMCRA bioregions; (b) trawl swept area as a percentage of IMCRA bioregions as an indicator of intensity within footprints; insets—bar charts of bioregion footprint and swept area by marine region (Source Evans *et al*., 2016)[320].

Within SPRFMO, From 2007 until 28 April 2019, and in accordance with SPRFMO CMM 03-2018, Australia restricted fishing in the SPRFMO Convention Area to within its 2002–2006 bottom-fishing footprint. In 2019, a revised bottom-fishing CMM (03-2019) was implemented in the SPRFMO Convention area. The revised CMM adopts a spatial management approach that uses predictive models to close areas with a high likelihood of vulnerable marine ecosystem (VME) habitat suitability in conjunction

[320] Evans K, Bax NJ, Smith DC (2016). Marine environment: Commercial and recreational fishing. In: Australia state of the environment 2016, Australian Government Department of the Environment and Energy, Canberra, https://soe.environment.gov.au/theme/marine-environment/topic/2016/commercial-and-recreational-fishing, DOI: 10.4226/94/58b657ea7c296.

with zoning to allow fishing to continue in key productive areas. Under the revised CMM, catch of species other than orange roughy is limited to the average annual level between 2002 and 2006.

-Bottom fishing impacts-

Research on the impacts of fishing on the seabed ecosystem is undertaken by CSIRO, the aims of this research are outlined below[321]:

- experiments that quantify trawl impacts on different seabed biota
- monitoring of recovery rates of sensitive biota after trawling
- studies of trawl bycatch, devices to reduce bycatch, and bycatch risk assessment
- surveys and mapping of regional distributions of seabed habitats & biota
- simulation modelling of trawl fisheries, impacts and management to assess seabed status and compare alternative management actions
- building of comprehensive national databases of seabed biota distributions and trawl fishing effort across Australia
- quantification and mapping of trawl footprints and intensity regionally and Australia-wide
- mapping of national seabed assemblages and regional seabed invertebrate communities to quantify exposure of seabed biodiversity to bottom trawling and protection in reserves & fishery closures
- development of quantitative models for risk assessment of trawling, including simpler methods that can be used in data-limited situations

A full list of surveys undertaken by CSIRO and other agencies can be found in Appendix 2 of Pitcher *et al*., (2018)[322]. Available data from surveys, showing locations, is shown in Figure 6.

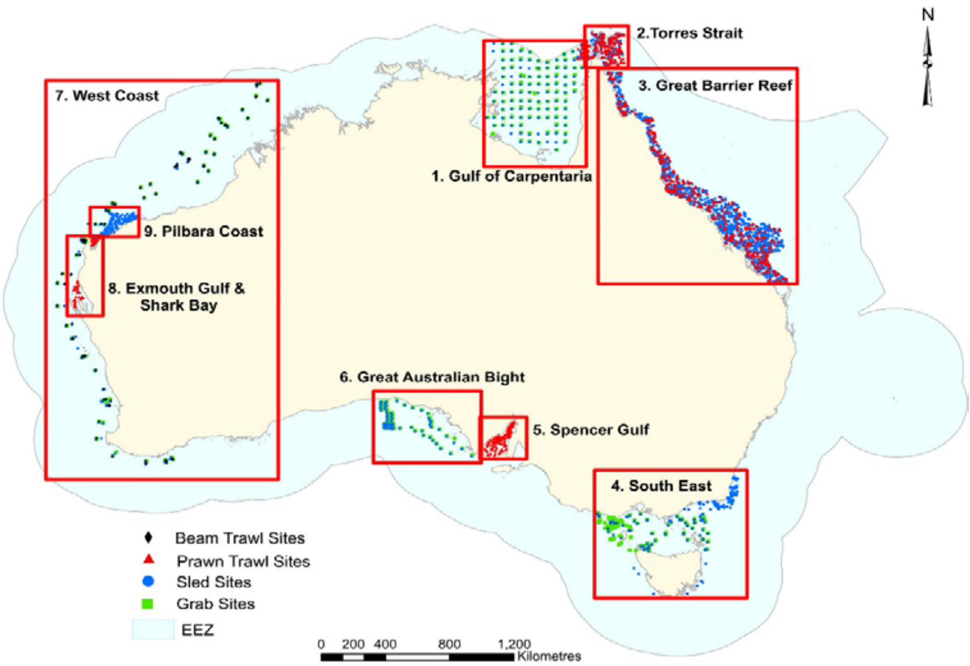

Figure 6. Map of nine study regions around Australia showing locations of sites sampled by one or more of four gear types.

-Scientific observer data-

Scientific observer data are collected and the amount of coverage of scientific observers are reported for each fishery and fishing season in the 2019 Fishery Status

321 https://www.csiro.au/en/research/animals/Fisheries/Sustainable-trawling
322 https://www.frdc.com.au/sites/default/files/products/2016-039-DLD.pdf

ABARES report. Consistent with this and other SPRFMO CMMs, Australian high-seas fishing permits require the **implementation of vessel monitoring systems**, **mandatory 100% observer coverage on all trawl vessels and a minimum of 10% observer coverage per vessel on all non-trawl vessels**.

Scientific observers are required to collect **biological data** including length frequencies and catch composition of target species, and **by-catch monitoring**. The observer is also involved with the process of determining if by-catch of **VME taxa exceeds the trigger limits** (**currently > 50 kg of coral and sponges**). On return from a voyage, the observer is required to present a report to AFMA and the collected data is entered in to the **AFMA observer database**.

Surveys are undertaken using trawls, epibenthic sleds and video / photos. Results of these are published on the CSIRO site.

-Assessing Significant Adverse Impacts on VME-

Within waters under national jurisdiction there is no definition of an SAI, however risk assessments are undertaken using the methodology outlined in the ERAEF.

Within the RFMOs and CCAMLR, Australia follow the definitions as prescribed by the RFMO.

<u>SIOFA</u>

In the Australia report for SIOFA, Williams *et al*., (2011a)[323] define an SAI as 'impacts which compromise ecosystem integrity in a manner that impairs the ability of affected populations to replace themselves and that degrades the long-term natural productivity of habitats, or causes on more than a temporary basis significant loss of species richness, habitat or community types'.

In 2011, Australia completed a bottom fishery impact assessment in the SIOFA area to examine whether individual bottom-fishing activities by Australian vessels have significant adverse impacts on VMEs (Williams *et al*., 2011a). The study concluded that the current overall risk of significant adverse impacts on VMEs by Australian bottom trawl and bottom longline operations is low, and the impact caused by midwater trawling and drop-lining is negligible (Williams *et al*., 2011a).

Australia's commitment to avoiding SAI resulting from its fishing activities in the Southern Indian Ocean are exemplified by its actions in 2011, prior to the entry into force of the SIOFA in 2012 and the first bottom fishing measures being adopted in 2016, of taking precautionary measures including:

- Prohibiting of the use of deep-water gillnets;
- Interim limitation of all bottom fishing activities to the historical fishing footprint of Australian vessels using bottom trawl and longline gears between 1999 and 2009;
- Providing a detailed Bottom Fishing Impact Assessment (BFIA) of historical and proposed bottom fishing activities using trawls and longlines in 2017 (Williams et al. 2011; Delegation of Australia 2018), and managing fishing activities accordingly.

Under SIOFA CMM 2019/01, paragraph 24 (e): "*All BFIA, including the SIOFA BFIA, shall be updated when a substantial change in the fishery has occurred, such that it is likely that the risk or impacts of the fishery may have changed*." SIOFA have therefore developed the following document, following the SIOFA Bottom Fishing Impact Assessment Standard (BFIAS), to supplement and update the BFIA presented in 2018. SIOFA have revised the historic Australian fishing footprint to include low levels of fishing effort not included in the original footprint presented to SIOFA

[323] Williams A., Althaus D., Fuller M., Klaer N., Barker B. (2011a) Bottom fishery impact assessment – Australian report for SPRFMO. Commercial-in-confidence Report by CSIRO to AFMA. Hobart, Australia. 86pp

(Williams *et al*., 2011; Delegation of Australia 2018), and take into account updated bathymetric data. SIOFA also provide an assessment of Australia's intention to undertake fishing using integrated weight longline to target Patagonian toothfish (*Dissostichus eleginoides*) on Williams Ridge, according to CMM 2019/05, and potting for spiny lobsters (Palinurus spp. and *Jasus paulensis*) within its historical fishing footprint, from 2020/21.

Australia already implements CMM 2019-02, but will voluntarily implement additional data collection measures, consistent with CCAMLR CM 22-07, including requiring comprehensive collection of data on bycatch of VME indicator species by line segment. Noting that pots are unlikely to retain bycatch of VME indicators, even where there are interactions on the seafloor, vessel crew will also opportunistically deploy of camera attached to pots, which have been successfully used to characterise the habitat where fishing is undertaken and to quantify the nature and extent of any interactions with benthic organisms (Kilpatrick *et al*., 2011[324]; Welsford *et al*., 2014[325]; Lamb *et al*., 2019)[326].

Australia considers that the residual risk of Australian vessels' activities using longlines in the SIOFA area causing or contributing to SAI to VMEs is low, and using pots is very low, and hence we are confident that the measures will effectively prevent SAIs on VMEs. This assessment will be revised when a new assessment on the composition, distribution and abundance of VME indicator species becomes available (Welsford *et al*., 2020)[327].

SPRFMO

Under Australia's risk assessment strategy for VMEs, an assessment of risk to an asset by a potentially threatening process, e.g. risk of a SAI by bottom fishing on VMEs, need to take account of the potential impact of each threatening process, the asset's vulnerability, the effect of impacts on the asset, past and future exposure of the asset to the threat, and the cumulative effects of impacts through time and space. To determine the level of risk posed by an activity (low, medium and high), the elements evaluated are: intensity of the impact at specific site; duration of impact; spatial extent of impact relative to the VME extent; cumulative impact that will influence the risk. Weaknesses of this approach include the lack of quantitative data available to define each of the elements mentioned (e.g. qualitative judgements are used to supplement data-poor VMEs; insufficient resolved effort distribution data to accurately map impact extent and hence overlap with VME indicators at finer scales).

The framework used for Australian BFIA in the SPRFMO area is predominantly qualitative due to a combination of key uncertainties, untested assumptions and coarsely resolved data, which restricts the value of detailed calculation of bottom contact. Rankings are substantiated with quantitative estimates of particular elements (overlaps of effort and VME indicators) and key uncertainties in underlying data identified. SPRFMO follow approaches in CCAMLR in seeking to define and quantify as clearly as possible, the nature, extent, and spatial distribution of potential

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[324] Kilpatrick, R., Ewing, G., Lamb, T., Welsford, D., Constable, A., 2011. Autonomous video camera system for monitoring impacts to benthic habitats from demersal fishing gear, including longlines. Deep-Sea Res. Part I: Oceanogr. Res. Pap. 58, 486–491.https://doi.org/10.1016/j.dsr.2011.02.006.

[325] Welsford, D,C. *et al*., (2014) Demersal fishing interactions with marine benthos in the Australian EEZ of the Southern Ocean: An assessment of the vulnerability of benthic habitats to impact by demersal gears. The Department of the Environment, Australian Antarctic Division and the Fisheries Research and Development Corporation. Final Report FRDC Project 2006/042.

[326] Lamb, P. D., Hunter, E., Pinnegar, J. K., Doyle, T. K., Creer, S., and Taylor, M. I. Inclusion of jellyfish in 30þ years of Ecopath with Ecosimmodels. – ICES Journal of Marine Science, 76: 1941–1950.

[327] Welsford D., Ziegler P., Maschette D. and Sumner M. (2020). Bottom Fishing Impact Assessment (BFIA) for planned fishing activities by Australia in the Southern Indian Ocean Fisheries Agreement (SIOFA) Area – 2020 Update. Australian Antarctic Division, Department of Agriculture, Water and the Environment. SIOFA Document SC-05-17

impacts by Australian fisheries on VMEs, but without reference to the anticipated ecological consequences to communities (Williams *et al*., 2011b)[328].

Australia implemented a VME encounter (SC8-DW07 rev 1 13) protocol where if combined catch of coral or sponge in any one shot exceeded 50 kg of corals and sponges in a trawl shot or 10 kg bycatch of corals and sponges in a 1000 hook section of line for automatic longline operations, then fishers were required to stop fishing immediately and not fish using the same method at any point within a 5 NM radius of any part of the shot until the Australian Fisheries Management Authority (AFMA) notified otherwise. Any evidence of a VME such as coral or sponges in a fishing shot was required to be recorded in logbooks. These measures also required 100% observer coverage for all trawl operations, and for all other methods, mandatory observer coverage for the first trip of each season and ongoing coverage of at least 10% annually. In 2011, Australia completed a bottom fishery impact assessment in the SPRFMO Convention Area to examine whether individual bottom-fishing activities by Australian vessels would have significant adverse impacts on VMEs (Williams *et al.*, 2011b)[329]. The study concluded that the overall risk of significant adverse impacts on VMEs by Australian bottom trawl and bottom longline operations was low, and the impact caused by midwater trawling and drop-lining was negligible (Williams *et al*., 2011b).

4.4 - Mapping of sensitive species and habitats

AFMA Resource Assessment Groups (RAGs) and Management Advisory Committees (MACs) identify the research requirements for the year in an annual research plan and evaluate any research proposals against it. Research is funded jointly through the Fisheries Research and Development Fund (FRDC) which is a co-funded partnership between its two stakeholders, the Australian Government and the fishing and aquaculture sectors.

Stratified trawl surveys are conducted on an annual basis **since 1998 around Heard and McDonald islands (CCAMLR Division 58.5.2)**. Although the primary aim of these is to collect data for stock assessments for icefish (*Champsocephalus gunnari*) and juvenile Patagonian toothfish (*Dissostichus eleginoides*) benthic data are collected. The surveys are run by the AFMA and CSIRO, working in close conjunction with the AAD. There is a data sharing arrangement between Australia and France to conduct complementary research on the Kerguelen Plateau, including data on the ecosystem as a whole as they share a number of resources.

All fishing areas with the within the **Australian EEZ have undergone an Ecological Risk Assessment (ERA)**, the case of **Heard and McDonald Islands** this is for both the **demersal trawl** (Sporcic *et al*., 2018)[330] and the **longline fishery** (Bulman *et al*., 2018)[331]. They use data mainly from between 2010 and 2015 but also information gained prior to this. The reports[332] refer to an eight year study undertaken for the AAD for the AAD (Welsford *et al*., 2014)[333] in which stills and

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[328] Williams A., Dowdney J., Smith A.D.M., Hobday A.J., Fuller M. (2011b). Evaluating impacts of fishing on benthic habitats: a risk assessment framework applied to Australian fisheries. Fisheries Research, doi:10.1016/j.fishres.2011.01.028.

[329] Williams A., Dowdney J., Smith A.D.M., Hobday A.J., Fuller M. (2011b). Evaluating impacts of fishing on benthic habitats: a risk assessment framework applied to Australian fisheries. Fisheries Research, doi:10.1016/j.fishres.2011.01.028.

[330] Sporcic, M., Pethybridge, H., Bulman, C.M., Hobday, A., Fuller, M. (2018). Ecological Risk Assessment for the Effects of Fishing Final report for Heard Island and McDonald Islands Fishery: midwater trawl sub-fishery 2010/11 to 2014/15. Report for the Australian Fisheries Management Authority. 118 pp.

[331] Bulman, C.M., M. Sporcic, H. Pethybridge and A. Hobday. 2018. Ecological Risk Assessment for Effects of Fishing. Final Report for the Demersal Longline sub-fishery of the Heard Island and McDonald Islands Fishery 2010/11-2014/15. CSIRO/AFMA, Hobart: 126 pp.

[332] https://www.antarctica.gov.au/site/assets/files/36066/bottom_fishing_welsford_et_al_2014.pdf

[333] Welsford, D,C. *et al*., (2014) Demersal fishing interactions with marine benthos in the Australian EEZ of the Southern Ocean: An assessment of the vulnerability of benthic habitats to impact by demersal

Remote Operated Vehicles (ROVs) were deployed to assess the vulnerability and potential impact to benthic communities from trawls longlines or traps. In addition, the research aimed to provide data to assist with the development of deep-sea camera technologies that can be easily deployed during fishing operations.

In addition, within **CCAMLR Divisions 58.4.1 and 58.4.2 (East Antarctica)** Australia have been working on a **multi-member research programme**, with **France, Japan, Republic of Korea and Spain**, on the **exploratory research fishery for Antarctic toothfish** (*Dissostichus mawsoni*). It includes as an objective to '*Identify the spatial distribution of toothfish, important habitats and vulnerable marine ecosystems (VME) in order to inform spatial management approaches'* (WG-SAM-2019/05). To achieve this benthic video cameras were attached to five of the vessels to cover 50% of their longline sets.

Australia have also been instrumental in the proposal for designating an East Antarctica MPA within CCAMLR, along with the EU, Uruguay and Norway which has required mapping sensitive areas using underwater cameras and ROVs.

Surveys are also undertaken within the SPRFMO area using both non-invasive methods (towed video cameras) and invasive methods (trawls), as reviewed in SC7-DW21_rev1. This has contributed towards the bottom fishing impact assessment with New Zealand for the SPRFMO Convention Area (SC8-DW07 rev1).

Australian fishing effort with SIOFA has been low, with only one longline vessel participating in 2020 (SC-06-14). No surveys have been undertaken by Australia in this area, however they did conduct an impact assessment based on available data in 2011 (Williams *et al*., 2011b)[334].

Other Deep Water Fisheries (DWF) within the EEZ include the South Eastern Scalefish and shark Fishery (SESSF) Commonwealth Trawl Sector, SESSF Gillnet, hook and trap sector, SESSF Great Australian Bight trawl sector, western deepwater trawl, north west slope trawl and south Tasman rise. They have all been subject to ERAs that include surveys to assess the impact on the benthic environment.

Data from scientific surveys are summarised in various reports produced by AFMA, CCAMLR, SPRFMO and SIOFA but are not publicly available. There is no record of any data sources being considered better than others, although it is acknowledged that older camera footage is not as reliable for identification due to the lower resolution of the images.

Vessels operating in New and Exploratory fisheries within CCAMLR (in the case of Australia Subareas 88.1 and 88.2) collect **data on VME species according to the protocols laid out the CCAMLR Scheme of International Scientific Observation (SISO),** these data are submitted to CCAMLR via AFMA and data on individual species are available on request though the CCAMLR Secretariat. VME areas (that contain 10 kg or 10 litres from a fixed length of line) and risk areas (that contain between 5 and 10 kg or litres from a fixed length of line) can be publicly accessed from the CCAMLR site and plotted using the CCAMLR GIS portal. They cannot be linked directly to an Australian vessel. Vessels fishing in established fisheries, in the case of Australia CCAMLR Division 58.4.2, observers to not follow the SISO protocol for recording VME taxa but do record benthic data caught on longlines / in trawls during their tally periods.

Within **SPRFMO** and **SIOFA** data on **VME species are also collected by observers and submitted to the Secretariat via AFMA**. In both cases samples should be preserved and retained if requested, where possible. Data are available on request.

gears. The Department of the Environment, Australian Antarctic Division and the Fisheries Research and Development Corporation. Final Report FRDC Project 2006/042.

[334] Williams A., Dowdney J., Smith A.D.M., Hobday A.J., Fuller M. (2011b). Evaluating impacts of fishing on benthic habitats: a risk assessment framework applied to Australian fisheries. Fisheries Research, doi:10.1016/j.fishres.2011.01.028.

In the case of SIOFA the VME data submitted to the Secretariat, combined with data from the Global Biodiversity Information Facility (GBIF), the Ocean Biogeographic Information System (OBIS), NOAA Deep-Sea Coral Data Portal and the Smithsonian National Museum of Natural History were mapped in 2021 (PAEWG-03-06). Depths of the VME were between 200m and 1,000m. The objective was to define bioregions in the Indian Ocean based on VME indicator species distribution data.

For other fisheries within the EEZ there are no specific VME protocols in place but observers do record benthic species that are captured. These data are submitted to AFMA and not publicly available.

The AFMA programmes are jointly funded through FDRC which in turn receives funding from the Australian Government (~20%) and the fishing and aquaculture industry (~80%) (MRAG 2004).

There is no record of data being treated differently, all data are checked independently before submission.

-Other surveys (not related with fisheries research)-

By law, no petroleum or greenhouse gas activity can take place before the environmental plan (EP) has been evaluated by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). The EP will only be accepted if it meets all the requirements of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009. Regulation 13 requires an environmental assessment to be carried out on the environment that may be affected (EMBA) with a particular focus in any biologically important areas (BIAs). This requires a description of the environment that may be affected by the activity, including details of the relevant values and sensitivities. This may either use existing data from previous surveys or the company may commission their own survey if sufficient data do not exist. The EP does not mention VMEs specifically but do map out the general habitats (coral reef, seagrass etc.) along with a general description of the habitat. The EPs are available from the NOPSEMA site, either approved (https://info.nopsema.gov.au/home/approved_projects_and_activities) or under assessment (https://info.nopsema.gov.au/home/under_assessment).

The EP and any subsequent required survey will be paid for the by the company submitting the application. The EP will need to meet a certain standard before being approved by NOPSEMA and standards may vary even amongst those approved but it is not possible to state which ones are better.

-Habitat sutability models-

As part of a study into the impacts of trawling on seabed fauna, Mazor *et al*., (2017) [335] used a combination of survey data and predictive modelling to map the distribution of seabed invertebrates (benthos) in nine regions around Australia. The distributions were modelled and predicted using Random Forests (RF), an ensemble of decision trees with binary splits. Analyses were implemented using R Core Team, 2015 using the package "randomForest".

4.5 - Impact mitigation and protection measures

There are no VME encounter rules within waters under national jurisdiction, there are areas that are closed to trawling to protect benthos in general, shown in Figure 7.

[335] Mazor TK, Pitcher CR, Ellis N, et al. Trawl exposure and protection of seabed fauna at large spatial scales. Divers Distrib. 2017;23:1280–1291. https://doi.org/10.1111/ddi.12622

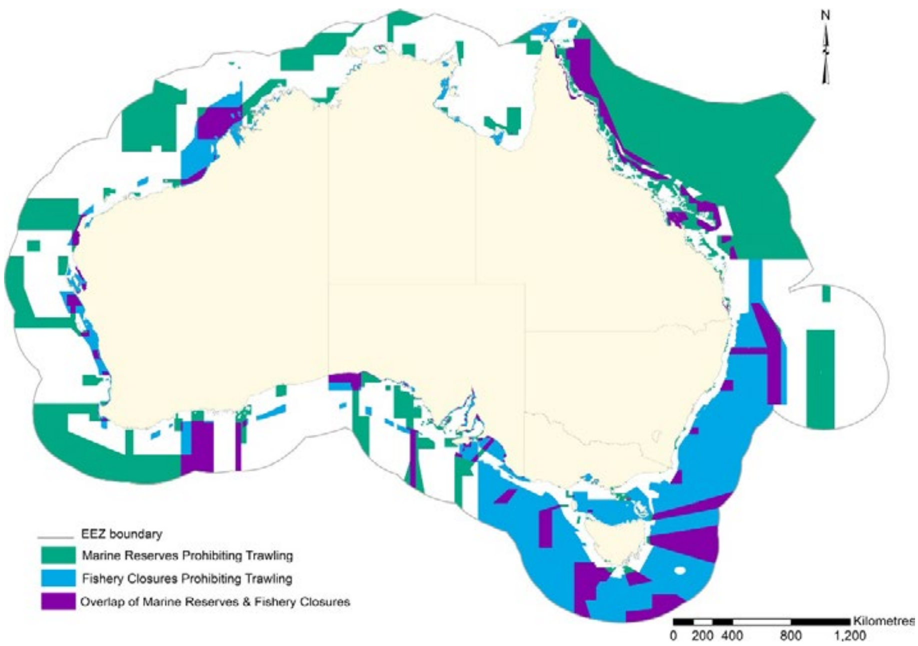

Figure 7. Map of areas where trawling is prohibited within Australia's Exclusive Economic Zone EEZ (Source: Mazor *et al*., 2017)[336]

CCAMLR

There are currently 23 categories of benthic organisms classed as VME indicator species at various taxonomic levels, as defined by CCAMLR (2009a). These are shown in Table 5 with the actual organism recorded by the observer and vessel highlighted in bold. The help with identification CCAMLR have also developed a guide (CCAMLR 2009b) which is given to observers operation in exploratory fisheries (Subareas 88.1 and 88.2).

The VME encounter rules and thresholds are laid out in Conservation Measure (CM) 22-07. Encounter rules are triggered when a defined level VME indicator units are captured and hauled on board the vessel from a line segment. Indicator units are defined as:

> '*Either one litre of VME indicator organisms that can be placed in a 10-litre container; or one kilogram of those VME indicator organisms that do not fit into a 10-litre container*.'

A line segment is defined as:

> '*…a 1 000-hook section of line or a 1 200 m section of line, whichever is the shorter, and for pot lines a 1 200 m section*.'

Should the vessel haul more than ten indicator units then it must notify the CCAMLR Secretariat and the area is designated as a 'Risk Area', the vessel must haul its lines and move away, not setting any lines within 1nm of the mid-point of the line segment. The area will remain closed until reviewed by the Scientific Committee and management actions decided by the Commission. Research will be permitted once approved by the Scientific Committee.

A vessel hauling more the five indicator units must also notify the Secretariat, if five or more notifications are received within a single fine-scale rectangle (defined as an area of 0.5° latitude by 1° longitude). All Flag States with vessels operating in that fishery will be notified, indicating the potential for VMEs in that area, they shall still be permitted to fish following the reporting procedures outlined above. Persistent

[336] Mazor TK, Pitcher CR, Ellis N, *et a*l. Trawl exposure and protection of seabed fauna at large spatial scales. Divers Distrib. 2017; 23:1280–1291. https://doi.org/10.1111/ddi.12622

encounters with VMEs in these rectangles will lead it to being declared as a VME fine scale rectangle.

With Subarea 88.1 and 88.2 there have been a 78 Risk Areas notified to CCAMLR between 2009 and 2021, and nine VME fine scale rectangles endorsed in 88.1 by the Scientific Committee. It is unclear which countries notified these however it is unlikely any of these were submitted by Australia as their fishing effort in these areas has been relatively low with vessels only entering the fishery in 2015 and 2017 onwards (CCAMLR Statistical Bulletin Vol. 31).

According to CM 22-06 the Scientific Committee would review the effectiveness of the relevant Conservation Measures every two years, staring in 2009. This would be based on data submitted but has fallen behind. Recognising this CCAMLR are currently undergoing are review of their VME work including line section marking/recording and develop a standard protocol, no level of data has been defined but it will be open for all members, including Australia, to contribute to.

SPRFMO

Australia and New Zealand are the only Member States to bottom fish in the SPRFMO area, as there were no formal guide lines from SPRFMO on VME indicators or threshold levels both countries used different bycatch weight thresholds. Australia used corals and sponges as its threshold unit with and followed the CCAMLR guidelines of over 50kg to trigger an action. New Zealand used a scoring system for eight primary taxa and two habitat indicators (Table 8) which has since been adopted by SPRFMO in 2019 and is currently in force under CMM 03-2020. It is subsequently in use by Australian vessels.

Table 8. List of VME indicator taxa with weight thresholds (A) in one tow for single indicator VME indicator and (B) one two for three or more indicator taxa (adapted from CMM 03-2020).

Phylum	Class	Taxonomic level	Common name	(A)	(B)
Porifera			**Sponges**	50	5
Cnidaria					
	Anthozoa				
		Scleractinia	**Stony corals**	80	5
		Antipatharia	**Black corals**	5	1
		Alcyonacea	**True soft corals**	60	1
		Gorgonacea	**Sea fans, octocoral**	15	1
		Pennatulacea	**Sea pens**		1
		Actiniaria	**Anemones**	40	5
	Hydrozoa				
		Anthoathecatae			
		Stylasteridae	**Hydrocorals**		1
Habitat indicators					
Echinodermata					
	Asteroidea				
		Brisingida	**Armless stars**		1
	Crinoidea		**Sea Lillies**		1

There have been no reports on the encounter thresholds being met by Australian vessels, although there was no trawl fishing in 2018 and the 2019 observer data were not available at the time for the Scientific Committee.

SIOFA

SIOFA uses the same list of VME Taxa as CCAMLR (Table 5) and for longlines (both hooks and traps) has the same thresholds in place that will trigger a move on rule with the same restriction on fishing to two nautical miles from the midpoint of the fishing operation.

Bottom and midwater trawling have a threshold of 60kg of live corals and/or 300kg of sponges in any tow. If this is encountered then the vessel should move away two nautical miles from either side of the trawl track, extended by two nautical miles at each end (CMM 2020/01).

Australia´s EEZ extent

The extent of Australia's EEZ is shown in Table 9. It includes the offshore territories but not the EEZ of the Australian Antarctic Territory, which is approximately another 2 million square kilometres.

Table 9. Area of Australia's EEZ, including off shore territories (Source: AMBIS 2001).

EEZ	Area (Km^2)
Heard and McDonald Islands	410 722
Cocos Islands	463 371
Christmas Island	325 021
Norfolk Island	428 618
Macquarie Island	471 837
Australia	6 048 681
TOTAL	8 148 250

Within the EEZ there is an EBSA (due south of Great Australian Bight - https://chm.cbd.int/database/record?documentID=204024) although this has been put in place to protect seabirds and fish.

-Closed areas and Marine Protected Areas (MPAs)-

Closed areas are in place, although not specifically to protect VME species.
Australia has a number of Marine Parks, world and heritage sites in place, categorised below.

-Australian Marine Parks-

- Sanctuary Zone (IUCN Ia)
- National Park Zone (IUCN II) (Marine National Park Zone (IUCN II) in the SE)
- Recreational Use Zone (IUCN IV)
- Habitat Protection Zone (Lord Howe) (IUCN IV)
- Habitat Protection Zone (Reefs) (IUCN IV)
- Habitat Protection Zone (IUCN IV
- Multiple Use Zone (IUCN VI)
- Special Purpose Zone (Norfolk) (IUCN VI)
- Special Purpose Zone (Mining Exclusion) (IUCN VI)
- Special Purpose Zone (Trawl) (IUCN VI)
- Special Purpose Zone (Trawl) (IUCN VI)
- Special Purpose Zone (IUCN VI)

-World Heritage Areas-

- World Heritage Area Declared
- World Heritage Area Buffer

-Commonwealth Heritage Areas-

- Commonwealth Heritage Sites

Information on these are managed by the Department of the Environment and CISRO as part of the Australian Marine Spatial Information System (AMSIS). Shapefiles can be downloaded and an be viewed on an interactive map[337] [338].

A number of marine parks and marine reserves have also been designated, although many of these are to protect wildlife other than the benthic environment, these can

[337] https://www.nespmarine.edu.au/australian-marine-parks-wha
[338] http://maps.ga.gov.au/interactive-maps/#/theme/amsis

be found in the management booklets (see for example AFMA 2012) and from the SEWPaC website (www.environment.gov.au/).

-Bottom Fishing Impact Assessments (BFIAs)-

Australia have conducted BFIAs for their fishing activity within CCAMLR, SIOFA and SPRFMO. Within the Australian EEZ ERAs have been undertaken for all the major fisheries (for Deep Water Fisheries (DWF), Smith *et al*., 2007[339], Wayte *et al*., 2007)[340], the protocols for these were developed by Hobday *et al*., (2007)[341] and were updated in 2017 (AFMA 2017). They include the ERAEF, which gives an assessment of risk of Commonwealth commercial fisheries to species populations, currently under review. Updates to the guide will include more detailed assessments to habitats and communities. The processes of assessment requires the following phases (AFMA 2017):

- Scoping - This phase identifies the fishery context, species lists, ecological sustainability objectives, and hazards (fishery activities that may impact the ecosystem).
- Level 1 Scale and intensity consequence analysis (SICA) - A comprehensive but qualitative analysis of risk in which the most vulnerable "unit" 31 in each component (eg: group of species) is assessed. This phase serves to exclude "low risk" components from analysis at Level 2, as if the most vulnerable species is low risk, so will all the less vulnerable species.
- Level 2 Productivity Susceptibility Analysis (PSA) - A species specific (or habitat/community specific) semi-quantitative approach which assesses fishery risks to each unit (eg: species) carried forward from Level 1. Units assessed to be at high risk at Level 2 can either be managed directly or carried forward to Level 3 for fully quantitative assessment.
- Level 3 - A unit-specific, quantitative "*model-based*" approach that accounts for spatial and temporal dynamics of units and fisheries and quantifies uncertainties around stock status.

The majority of Australia's fisheries have undergone and ERA up to level 2, specific guidelines regarding habitats and community impacts will be considered in ore detail as part of the Australian Government's development of specific policy guidelines.

-Exploratory Fishery Protocols-

The Australian Government are currently reviewing their exploratory fisheries policy (AFMA 2020) and the draft guidelines are undergoing a public consultation. The guidelines set out the policy and processes '…for the exploration and development of new, unallocated or unexploited fish resources in the Commonwealth fisheries jurisdiction.

AFMA require all applicants for exploratory fisheries to submit an application that includes, among other information, applicants to highlight areas of significance including '…*benthic areas, breeding areas, migration paths or any other relevant information in the proposed fishing areas*;' (AFMA 2020).

The policy includes all fishing industry-initiated exploratory fishing and fishery development within the Australian Fishing Zone (AFZ) and managed by AFMA under

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[339] Smith, A.D. M., Hobday, A.J., Webb, H., Daley, R., Wayte, S., Bulman, C., Dowdney, J., Williams, A., Sporcic, M., Dambacher, J., Fuller, M., Furlani, D., Griffiths, S., Kenyon R., Walker T., 2007. Ecological Risk Assessment for the Effects of Fishing: Final Report R04/1072 for the Australian Fisheries Management Authority, Canberra. July (2007). http://www.csiro.au/science/fisheries-ecological-riskassessment.html.

[340] Wayte, S., Dowdney, J., Williams, A. Fuller, M., Bulman, C., Sporcic, M., Smith, A. (2007) Ecological Risk Assessment for the Effects of Fishing: Report for the Western Deepwater Trawl Fishery. Report for the Australian Fisheries Management Authority, Canberra

[341] Hobday, A.J., Smith, A.D.M., Webb, H., Daley, R., Wayte, S., Bulman, C., Dowdney, J., Williams, A., Sporcic, M., Dambacher, J.M., Fuller, M., Walker, T., (2007). Ecological Risk Assessment for the Effects of Fishing: Methodology. ReportR04/1072 for the Australian Fisheries Management Authority, Canberra. July 2007, Available at http://www.afma.gov.au/environment/eco based/eras/docs/methodology.pdf.

the Fisheries Management Act 1991 (FMA) and the Fisheries Administration Act 1991 (FAA). Stocks to be considered under this policy include those that are:

- caught using different method(s); and/or
- in new location(s); and/or
- new/unallocated or unexploited species/stocks.

Through the revised process, AFMA will follow a process that will manage risk to both the environment and the potential target stock, the application for any of above fisheries will be based on the principles listed below:

- fishing will be undertaken in line with Ecological Risk Assessment and Management (ERM) principles;
- the precautionary principle will be applied when setting catch limits and managing environmental risks to ensure sustainable harvests;
- management decisions will be based on the best available science;
- costs will be recovered from industry in line with the Australian Government Charging Framework and AFMA's Cost Recovery Implementation Statement;
- AFMA will consult, as appropriate, to ensure the interests of affected stakeholders (including recreational and Indigenous fishers) are taken into account prior to decision making;
- AFMA will appropriately monitor fishing activity and may cease fishing at any time in the process of developing a fishery for example due to sustainability reasons or if the resource is not large enough to support a fishery;
- any fishery developed under this policy will be managed in accordance with legislative objectives;
- any allocations of ongoing access will consider both pioneers and other concession owners with existing access; and
- information gathered about marine resources may be made public to enable other users of the Australian-owned resource to benefit from this information.

AFMA require all applicants for exploratory fisheries to submit an application that includes, among other information, applicants to highlight areas of significance including '…*benthic areas, breeding areas, migration paths or any other relevant information in the proposed fishing areas*;' (AFMA 2020).

-Gear/Depth restrictions-

The Management guidelines the various domestic fisheries that take place within the EEZ are laid out in the various management plans. Although not related to benthic impacts, the North West Slope Trawl Fishery and Western Deepwater Trawl Fishery place a restriction on mesh size and require 100% observer coverage on any fisheries taking place shallower than 200m (AFMA 2012).

The Southern and Eastern Scalefish and Shark Fishery (SESSF) operates a number of different fishing gears for deep water species. These include demersal longlines, droplines, trotlines, hand-reels, bottom set gillnets and traps. Within this fishery there are a three trawl exclusion zones that have been put in place to protect benthic habitats, East Coast, Eastern South Australia and Portland, although only the East Coast exclusion zone is exclusively for benthos. Gear restrictions in place include limits on soak times for hand reels, limits on hooks for longlines, limits on headrope lengths and mesh sizes for bottom set gill nets, restrictions on trap sizes and numbers which vary depending on the target species. The gear restrictions are more focussed around target and bycatch species rather than benthic impacts (AFMA 2021).

The Macquarie Island Toothfish Fishery (MITF) is an MSC certified fishery operating off the Australian offshore territory of Macquarie Island. Its management plan was last updated in 2016 (AFMA 2016). There are gear limitations in place for trawl fishing (although this no longer operates, only longlines are used) and not all are related exclusively to protection of the benthos. These include a minimum mesh size of 120mm, bobbins should have a diameter less than 520mm and, if using a rockhopper system, the rubber disk should be less than 400m. Although out of the CCAMLR area the minimum depth limit of 550 meters still applies to all fishing gear.

-VMEs impact assessments-

There are no guidelines specific to VMEs, all companies wishing to undertake offshore energy activities must submit an environmental plan under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Environment Regulations) which include an assessment on the impacts to the ecosystem and are assessed by NOPSEMA.

4.6 – Monitoring of VME Impacts

Within Australia's area of jurisdiction, with the exception of HIMI, there is no routine monitoring of VMEs, although benthic surveys[342] are undertaken on an *ad-hoc* basis by CSIRO and other organisations.

Within HIMI, Australia conducted annual surveys using camera systems as part of an eight year monitoring programme to monitor the vulnerability of benthic habitats to impact by demersal gears (Welsford *et al*., 2014)[343]. The programme ran between 2006 and 2014 and was conducted by Australian Antarctic Division (AAD) and the Fisheries Research and Development Corporation (FRDC). The surveys took place in CCAMLR waters, within the Australian EEZ around the HIMI and VME indicator species were identified using the CCAMLR VME Taxa Classification Guide.

The information from this was combined with effort data from the fishery, observer data and other scientific sampling of the types and abundance of benthic organisms across a range of habitat types. From this an assessment model was developed to estimate the disturbance caused by the fishery.

The majority of these benthic surveys rely on the deployment of a camera system which was deployed on both trawls and longlines (the two gear types used commercially in the area). Surveys are also conducted using sleds and trawls.

None outlined within areas of national jurisdiction specific to VMEs. Impacts to the benthic habitat in general are monitored through surveys. Monitoring of VMEs within RFMOs is still under development.

Environmental plans must be submitted and reviewed by NOPSEMA prior to any offshore activities taking place, however these do not include long term monitoring plans.

[342] Benthic surveys that are undertaken on an ad-hoc basis by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and other organisations.

[343] Welsford, D,C. *et al*., (2014) Demersal fishing interactions with marine benthos in the Australian EEZ of the Southern Ocean: An assessment of the vulnerability of benthic habitats to impact by demersal gears. The Department of the Environment, Australian Antarctic Division and the Fisheries Research and Development Corporation. Final Report FRDC Project 2006/042.

List of Acronyms

AAD	Australian Antarctic Division
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ACAP	The Agreement on the Conservation of Albatrosses and Petrels
AFMA	Austalian Fisheries Management Authority
AFZ	Australian Fishing Zone
AIS	Automatic Identification System
ALC	Automatic Location Communicator
AMSIS	Australian Maritime Spatial Information System
ARC	AFMA Research Committee
AUV	Autonomous Underwater Vehicle
BFIA	Bottom Fishing Impact Assessment
BFIAS	Bottom Fishing Impact Assessment Standard
CA	Catch Area
CCAMLR	The Convention on the Conservation of Antarctic Marine Living Resources
CMM	Conservation and Management Measures
CNCP	Cooperating non-Contracting Parties
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAWE	Department of Agriculture, Water, and the Environment
DG MARE	Directorate-General Maritime Affairs and Fisheries
DSCC	Deep-sea Conservation Coalition
DSF	Deep-sea Fisheries
DWF	Deep-water Fisheries
EBM	Ecosystem Based Management
EBSAs	Ecological or Biological Significant Areas
EEZ	Exclusive Economic Zone
EJF	Environmental Justice Foundation
EP	Environmental Plan
EPBC	Environmental Protection and Biodiversity Act
ERAEF	Ecological Risk Assessment for the Effects of Fishing
ERM	Ecological Risk Management
FAA	Fisheries Administration Act
FAO	Food and Agriculture Organisations
FMA	Fisheries Management Act
FMC	Fisheries Monitoring Centre
FRDC	Fisheries Research and Development Corporation
GBIF	Global Biodiversity Information Facility
HIMI	Heard and McDonald Islands
HIS	Habitat Suitability Indices
HSM	Habitat Suitability Models
IATTC	Inter-American Tropical Tuna Commission
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
ITQ	Individual Transferable Quota
IUCN	International Union for Conservation of Nature
MAC	Management Advisory Committee
MEY	Maximum Economic Yield
MITF	Macquarie Island Toothfish Fishery
MPA	Marine Protected Area

MRCC	Maritime Rescue Coordination Centre
NGO	Non-Governmantal Organisation
NOAA	National Oceanic and Atmospheric Administration
NOPSEMA	National Offshore Petroleum Safety and Environmental Management
OBIS	Ocean Biogeographic Information System
PSA	Productivity Susceptibility Analysis
PZJA	Protected Zone Joint Authority
RA	Regulatory Area
RAGs	Resource Assessment Groups
RFMO	Regional Fishereies Management Organisations
ROC	Receiver Operating Characteristic
ROV	Remotely Operated Vehicle
SAI	Significant Adverse Impacts
SAR	Swept Area Ratio
SESSF	Southern and Eastern Scalefish and Shark Fishery
SEWPaC	Department of Sustainability, Environment, Water, Population and
SGF	Sediment, Geomorphology and Fauna
SICA	Scale and Intensity Consequence Analysis
SIODFA	Southern Indian Ocean Deepsea Fisheries Association
SIOFA	Southern Indian Ocean Fisheries Agreement
SISO	Scheme of International Scientific Observation
SPRFMO	South Pacific Regional Fisheries Management Organisation
SWIOFC	Southwest Indian Ocean Fisheries Commission
TAC	Total Allowable Catch
UNGA	United National General Assembly
UTC	Coordinated Universal Time
VME	Vulnerable Marine Ecosystem
VMS	Vessel Monitoring System
WDWTF	Western Deep-Water Trawl Fishery
WG	Working Group

CASE STUDY 5 - NEW ZEALAND

5.1 – Data availability and governance frameworks

The Ministry for Primary Industries (MPI) is structured into 5 business units and 4 functional areas (www.mpi.govt.nz). One of the "5 business units" is Fisheries New Zealand (www.mpi.govt.nz/fishing-aquaculture). Direct fisheries management is the responsibility of **Fisheries New Zealand (FNZ)**, and the wider context of fisheries sustainability is a significant part of their work, in collaboration with the **Department of Conservation** and the **Ministry for the Environment**. **Regional councils** also have the ability to strongly influence the marine environment both through control of land-based activities and by management of the marine space itself (within the territorial sea, 0-12 nautical miles offshore).

- **Fisheries New Zealand** is the key regulator tasked with guiding the sustainable use of fisheries resources to the greatest overall benefit to New Zealanders. This focus includes the sustainability of New Zealand's wild fish stocks, aquaculture, and the wider aquatic environment. Key legislation Fisheries New Zealand administers includes:
    - Fisheries Act 1996 and regulations
    - Fisheries Act 1983 (residual parts)
    - Treaty of Waitangi (Fisheries Claims) Settlement Act 1992
    - Fisheries (Quota Operations Validation) Act 1997
    - Māori Fisheries Act 2004
    - Māori Commercial Aquaculture Claims Settlement Act 2004
    - Aquaculture Reform (Repeals and Transitional Provisions) Act 2004
    - Driftnet Prohibition Act 1991
    - Antarctic Marine Living Resources Act 1981
- **The Department of Conservation (DOC)** is the key regulator for species protection and biodiversity in the marine environment, which includes marine reserves and parks, mammal sanctuaries, protection of protected or threatened species, and protection of biodiversity, and developing the New Zealand Coastal Policy Statement. This role is undertaken through a number of legislative instruments:
    - Wildlife Act 1953
    - Conservation Act 1987
    - Hauraki Gulf Marine Park Act 2000
    - Marine Mammals Protection Act 1978
    - Marine Reserves Act 1971
    - National Parks Act 1980
- **Ministry for the Environment (MfE),** is responsible for national environmental reporting, including the marine environment, and promoting the sustainable management of natural resources in our EEZ and continental shelf. Key legislation the Ministry for the Environment administers includes:
    - Resource Management Act 1991
    - Environmental Reporting Act 2015
    - EEZ and Continental Shelf (Environmental Effects) Act 2012
    - Fiordland (Te Moana o Atawhenua) Marine Management Act 2005
- **Regional councils.** There are 11 regional councils responsible for managing the territorial sea (out to 12 nautical miles). This includes land use and its impacts on the marine environment. Regional councils are empowered in the marine space through the:
    - Resource Management Act 1991
    - Marine Transport Act 1994

- There are many **other regulators** of activities in the marine environment covering issues like health and safety, oil and gas licensing, marine transport and discussion and participation in international agreements around ocean governance and fisheries management:
    - **Ministry of Foreign Affairs and Trade** represents New Zealand in global discussions to ensure successful implementation of international agreements on ocean governance and fisheries management.
    - **Ministry of Business, Innovation and Employment** is responsible for health and safety in the marine environment. This includes managing permits and licences for oil, gas and minerals (via New Zealand Petroleum and Minerals).
    - **Environmental Protection Authority** is responsible for consenting, monitoring and enforcement under the EEZ Act.
    - **Ministry of Transport** is responsible for the Maritime Transport Act 1994.
    - **Maritime New Zealand** is responsible for managing maritime transport and its effects.
    - **National Maritime Coordination Centre** is responsible for managing Aotearoa[344] New Zealand's maritime surveillance. It is part of the New Zealand Customs Service.
    - **Many other ministries have adjacent or supporting roles:** Te Arawhiti, Department of Prime Minister and Cabinet, Te Puni Kōkiri, Ministry for Culture and Heritage, New Zealand Defence Force, Ministry of Health, Ministry of Justice, Stats NZ, and Land Information New Zealand.

Fisheries New Zealand (FNZ) is the key regulator tasked with guiding the sustainable use of fisheries resources to the greatest overall benefit to New Zealanders. They do so under the Fisheries Act 1996. This focus includes the sustainability of New Zealand's wild fish stocks, marine biodiversity, and the wider aquatic environment. A central and significant part of fisheries management is the Quota Management System (QMS), but this is only one element of the overall approach that Aotearoa New Zealand takes to managing fisheries. The key parts of this system are outlined in this section, including:

- **Environmental principles**: The Fisheries Act 1996 requires that people undertaking fishing activities or making decisions covered by the Act "take into account" three environmental principles. These are:
    a. Associated or dependent species should be maintained above a level that ensures their long-term viability.
    b. Biological diversity of the aquatic environment should be maintained.
    c. Habitats of particular significance for fisheries management should be protected.
- **Setting catch limits and allocating catch allowance**: The QMS allocates shares in each fish stock as quota. Quota generates an entitlement to catch a proportion of the TACC each year (ACE) within the relevant QMA. The Minister for Oceans and Fisheries sets the TAC, guided by the Harvest Strategy Standard.
- **Integrated fisheries plans**: Fisheries New Zealand produces integrated fisheries plans focusing on each of three fisheries:
    - inshore finfish fisheries (under development);
    - deepwater and middle-depth fisheries; and
    - highly migratory species fisheries.

[344]The Māori name for New Zealand.

- **Targeted management of fisheries through action plans or strategies**: Fisheries New Zealand works in collaboration with others to develop management plans to provide targeted support to fisheries that are not meeting sustainability expectations and need closer management or to outline management frameworks for protected species impacted by fisheries.
- **Managing impacts on marine species through management plans**: Fisheries New Zealand works in collaboration with others to develop management plans or strategies to provide targeted support to provide protection for species impacted by fishing.

Table 1. Ecosystem approach to fisheries management principles and relevant Fisheries Act 1996 provisions. The abbreviation sX refers to the section of the Fisheries Act 1996

Principles	Key Fisheries Act provisions
1. Ensuring the sustainability of fish stocks	s11 sustainability measures; s13 total allowable catch (TAC); s14 and s14A alternative TACs.
2. Rebuilding depleted stocks	s11 sustainability measures; s13 TAC
3. Ecosystem integrity: safeguarding biodiversity and ecosystem structure and functioning	s8 purpose; s9 environmental principles; s11 sustainability measures.
4. Taking account of species interactions	s9 environmental principles; s13 TAC; s15 fishing-related mortality of marine mammals and other wildlife.
5. Minimising impacts on non-target species	s9 environmental principles; s11 sustainability measures; s15 fishing-related mortality of marine mammals and other wildlife; s72 dumping of fish prohibited.
6. Protecting fisheries habitats	s9 environmental principles; s11 sustainability measures.
7. Managing at appropriate spatial scale	s19 (QMS introduction); s11 sustainability measures; s11A fisheries plans; Part 9 taiāpure-local fisheries and customary fishing.
8. Considering trans-boundary effects	s5 application of international obligations; s17A highly migratory species taken outside NZ fisheries waters; Part 6A high seas fishing; Schedule 1A (fish stocks agreement).
9. Managing at appropriate temporal scale	s8 purpose; s9 environmental principles; s13 TAC; s11 sustainability measures; s11A fisheries plan.
10. Adopting a precautionary approach	s5 application of international obligations; s8 purpose; s9 environmental principles; s10 information principles; s13 TAC.

Principles	Key Fisheries Act provisions
11. Using science and diverse forms of knowledge	s12 consultation; Part 10 record keeping and reporting; Part 12 observer programme.
12. Broadening stakeholder participation	s12 consultation; various specific consultation provisions; s11A fisheries plans; various provisions enabling active stakeholder involvement; s5 application of Treaty of Waitangi (Fisheries Claims) Settlement Act 1992.
13. Recognising and providing for Indigenous rights	s5 application of Treaty of Waitangi (Fisheries Claims) Settlement Act 1992; s12 consultation; s44 (settlement allocation); Part 9 taiāpure-local fisheries and customary fishing.
14. Balancing utilisation and sustainability	s8 purpose.
15. Taking account of social and economic factors	s8 purpose; s13 TAC; s14A alternative TAC; Part 9 taiāpure-local fisheries and customary fishing; s123 dispute resolution; Part 14 cost recovery.
16. Taking account of environmental influences on fisheries	s11 sustainability measures; s13 TAC; s16 emergency measures.
17. Encouraging integrated management	s6 application of RMA; s11 sustainability measures; s15 fishing-related mortality of marine mammals and other wildlife.

The ***online fishing data portal***[345] launched in 2020, allows public access to spatial data relating to the commercial fishing regulations. Updated data sets include coordinates for fisheries management areas, general statistical areas, and quota management areas. The portal also has regulation information on current: (i) commercial fishing, including closed seamount areas, (ii) benthic protection areas, (iii) fishery notices, including certain temporary closures, (iv) marine reserves, (v) marine mammal sanctuary, (vi) ministerial decisions and (vii) submarine cables and pipeline protection zones.

National Fisheries Plan for Deepwater and Middle-depth Fisheries

The first **National Plans for deepwater and middle-depth fisheries** and **highly migratory species fisheries** were approved by the Minister in September 2010. Fisheries New Zealand is currently reviewing the plans and is, or will be, consulting on such reviews. Fisheries plans establish management objectives for each fishery, including those related to the environmental effects of fishing.

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[345] https://www.mpi.govt.nz/legal/legislation-standards-and-reviews/fisheries-legislation/maps-of-nz-fisheries/

The management of New Zealand's commercial deepwater fisheries is a collaborative arrangement between Fisheries New Zealand (representing the Crown and its statutory obligations to the public) and the commercial fishing industry, represented by **Deepwater Group** (DWG)[346]. This arrangement allows for the Management Objectives outlined in the National Fisheries Plan for Deepwater and Middle-depth Fisheries 2019 to be achieved by drawing on the combined knowledge, experience, capabilities and perspectives of both organisations. For this arrangement, the first **Memorandum of Understanding (MOU)** was signed in 2006 between both parties.

Deepwater Fisheries Plan

This Deepwater Fisheries Plan sets the objectives to guide the management of deepwater and middle-depth (deepwater) fisheries within New Zealand's waters, consistent with the legislative framework provided by the Fisheries Act 1996.

This Plan includes criteria and objectives to guide the management of deepwater and middle depth fisheries within New Zealand fisheries waters. For deepwater and middle-depth fisheries, this mainly impacts those fisheries operating within the Exclusive Economic Zone (EEZ) from 12-200 nautical miles (NM) from shore.

This Deepwater Fisheries Plan consists of three parts, which are divided into strategic direction and objective-setting (Parts 1A and 1B) and annual operational cycles (Parts 2 and 3).

Part 1 Deepwater Fisheries Plan: Part 1 outlines the framework and objectives for the management of New Zealand's deepwater fisheries. It is divided into Part 1A and Part 1B.

- **Part 1A** details the overall strategic direction for New Zealand's deepwater fisheries. Specifically it describes:
    - The strategic context and operating environment that fisheries plans are part of, including legislative requirements and government priorities;
    - Management objectives that will apply across all deepwater fisheries; and
    - How the fisheries plan will be implemented, including the approach to engaging with stakeholders. Part 1A has been approved by the Minister of Fisheries under Section 11A of the Fisheries Act 1996.
- **Part 1B** is comprised of the fishery-specific chapters of the Deepwater Fisheries Plan, which provide management objectives at the fishery level, in line with the management objectives outlined in Part 1A. These chapters describe operational objectives for target fisheries and key bycatch species, and how performance against objectives will be assessed at the fishery level. Fishery-specific chapters will be provided to the Minister of Fisheries, as they are developed, for approval.

Part 2: The **Annual Operational Plan (AOP)** details the management actions that will be implemented on an annual basis for deepwater fisheries. The Annual Operational Plan includes the required services, delivery mechanisms, and service prioritisation factors that must be considered each financial year.

Part 3: The **Annual Review Report (ARR)** assesses the annual performance of deepwater fisheries against the actions specified in the previous Annual Operational Plan and reports on progress towards meeting objectives described in Part 1A.

The management of deepwater fisheries encompasses all target stocks, bycatch stocks, and the environmental effects of fishing. All deepwater species in the quota management system (QMS) have been categorised into two tiers according to their commercial value and volume of catch (Table 1). Tier 1 fisheries are high volume and/or high value fisheries and are typically targeted. They deliver significant export revenue, which is reflected in the high quota value associated with these species. Tier 2 fisheries are typically less commercially valuable, comprise bycatch fisheries, or are only targeted periodically throughout the year.

[346] Shareholders of DWG collectively hold over 90% of deepwater quota shares.

There are many international obligations that Aotearoa New Zealand is party to that influence managenent. The obligations relate both to the marine environment within the EEZ, and to aspects of international fisheries (outside of EEZ and highly migratory species within EEZ).

Key agreements related to sustainable fisheries include:

- The United Nations Convention on the Law of the Sea (UNCLOS). UNCLOS is a comprehensive regime of law and order in the world's oceans and seas establishing rules governing all uses of the oceans and their resources.
- The United Nations Fish Stocks Agreement (UNFSA). UNFSA sets out principles for the conservation and management of straddling fish stocks and highly migratory fish stocks and establishes that such management must be based on the precautionary approach and the best available scientific information.
- Convention on Biological Diversity (CBD). CBD has three main objectives: the conservation of biological diversity; the sustainable use of the components of biological diversity; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. It includes goals relevant to fisheries management.
- Sustainable Development Goals. The United Nations signed up to 17 SDGs that bring together three dimensions of sustainable development (economic, social, and environmental). SDG 14 is to "Conserve and sustainably use the oceans, seas and marine resources for sustainable development."

Aotearoa New Zealand is a member of several Regional Fisheries Management Organisations (RFMO), which relate to access to fisheries and also fisheries conservation and management measures. Some examples of RFMOs include the South Pacific RFMO and Western and Central Pacific Fisheries Commission (WCPFC). The WCPFC seeks to address problems, including the management of high seas fisheries from unregulated fishing, insufficiently selective gear, unreliable databases, and insufficient multilateral cooperation with respect to conservation and management of highly migratory fish stocks. Aotearoa New Zealand implements the objectives of the conservation and management measures, for example, by limiting catch for key highly migratory shark species.

In 1993, New Zealand, enacted the Fisheries (Satellite Vessel Monitoring) Regulations 1993, whereby it was required that by 1 April 1994 an Automatic location communicator (ALC) should be installed and carried on board the vessels. ALC is a satellite position transmitter working automatically and independently to provide the following VMS data:

- Unique ID.
- Date/time/position: In UTC using 24-hour clock (i.e. YYYYMMDDHHMMSS).
- Latitude of position: decimal latitude WGS84 to 4 decimal places (e.g. -36.3458).
- Longitude of position: decimal longitude WGS84 to 4 decimal places (e.g. 177.4567)
- Speed over ground: knots, to at least 1 decimal place.
- Heading, or course over ground.

Regarding with the *frequency of position reports*, New Zealand regulations as regards systems using GPS provide that the VTU (Vessel Track Unit) must be capable of supplying position information at pre-set intervals using unreserved or reserved access over the data reporting channel and specify that the minimum range of reporting intervals must be between *15 minutes and 24 hours*[347]. Finally, it is important to keep in mind that frequency of position reports may vary, within the range of reporting intervals set in the regulations, in relation to the type of fishing gears used (longlining, trawling, seining, etc.) or according to the target species (e.g., species subject to quotas).

New Zealand fisheries VMS regulations state that VMS reports, including catch reporting, notice of port call and test report, be sent in *binary format*.
In New Zealand, Regulation 8 of the Fisheries (*Satellite Vessel Monitoring*) Regulations 1993[348] defines the different categories of offences relating to VMS. These include:

a) The removal of the VTU from a fishing vessel without prior approval of the Director-General;
b) Interference with VTU to an extent that such device no longer complies with the type approval granted in respect of the device, or no longer operates in accordance with the manufacturer's specifications;
c) Failure to notify the Director-General of any matter required by or under these regulations; and
d) Communication of false or misleading information.

The Fisheries (Geospatial Position Reporting) Regulations 2017 require operators and masters of vessels to use a Geospatial Position Reporting (GPR) device to provide information to the Ministry for Primary Industries about their position while fishing.

GPR device uses the Automatic Identification System and creates position reports and transmits them to MPI via a principal communication provider.

In 2015 Fisheries New Zealand undertook a Fisheries Management System review, and from this review they developed a major work programme to enhance and update the fisheries system. This programme, called the Fisheries Change Programme, is currently underway.

The Fisheries Change Programme aims to:

- Strengthen and make more modern the way manage the fisheries.
- Ensure the sustainability of Aotearoa New Zealand's fisheries.

The programme has three parts:

- **Electronic catch and position reporting**. Introducing mandatory electronic catch and position reporting to improve the collection and reliability of fisheries information.
- **On-board cameras**. Improving monitoring and verification capabilities, including the use of on-board cameras, to better observe fishing practice.
- **Fishing rules**. Changing fishing rules and policies to make them simpler, fairer and more responsive, while also incentivising better fishing practices.

Since 2019, all commercial fishers have been required to report catch electronically. There are now more than 1,000 vessels tracked in Aotearoa New Zealand through the electronic catch and position reporting system, which allows Fisheries New Zealand staff to track vessels in real time. In 2017 there were over 1,500 commercial fishing vessels registered in Aotearoa New Zealand.

These improvements in digital monitoring enable:

- More timely and accurate data.
- Verification of when and where fishing occurs.

A key focus of this activity is on gathering data for compliance purposes. There is potential to expand to use the data for more environmental and commercial

[347]Section 2.1.2.1, Ministry of Agriculture and Fisheries, Vessel Monitoring Systems, Circular One on Certification Requirements for Inmarsat-C Automatic Location Communicators (December 1993*)*.
[348] Fisheries (Satellite Vessel Monitoring) Regulations 1993.

purposes. With the drastically increased frequency of reporting there are significant opportunities to enhance the use of fisheries catch data and increase transparency in fishing practices. This in turn will enable faster response in fisheries management practice in response to change.

The position reporting shows where fishing has taken place as the speed and direction of a vessel provide information on when a fishing event occurred, and whether this was in an area where that type of fishing is allowed. This observation is independent of fisher reporting (though the type of fishing/gear used is reliant on fisher reporting). In circumstances where this real-time information is being monitored, this allows for compliance action (such as meeting the vessel at port to verify catch in person). There is also the possibility for discarded catch to be traced back to the vessel if it was released from in some circumstances. There have already been significant advances in the detection of illegal activity and consequent prosecution.

5.2 – Description of sensitive species and habitats

In June 2013, the Department of Conservation held an expert workshop to assess New Zealand's marine invertebrates using the ***New Zealand Threat Classification System*** **(NZTCS)** criteria (Townsend *et al.,* 2008)[349], updating a previous listing process from 2009 (Freeman *et al.,* 2009)[350]. The Conservation Services Programme (CSP, see the CSP Strategic Statement[351]) undertakes research to understand and address the effects of commercial fishing on protected species in New Zealand waters. The 2010 amendment of Schedule 7A of the Wildlife Act 1953 protects most corals in New Zealand waters, which are comprised of four main groups: stony corals (all species in the Order Scleractinia), black corals (all species in the Order Antipatharia), gorgonian corals (most species in the Order Alcyonacea), and some hydrocorals (all species in the Family Stylasteridae). Indicative protected species numbers are detailed in Table 2.

Table 2. Protected coral taxa found in the New Zealand EEZ. The number of species is indicative as of 2019 (as reported in the 2019 report[352]), and does not include more recent discoveries of species pending description or non-protected taxa.

Order	Common name	N° of species
Order Scleractinia	Stony corals (cup and branching forms)	116
Order Antipatharia	Black corals	33
Order Alcyonacea	Sea fans, sea whips, bubblegum corals (there are at least 12 families containing deep-water structure- forming gorgonian octocorals).	167
Order Anthoathecata: Family Stylasteridae	stylasterids, lace corals	56
	Total	372

[349] Townsend, A.J.; de Lange, P.J.; Duffy, C.A.J.; Miskelly, C.M.; Molloy, J.; Norton, D.A. 2008: New Zealand Threat Classification System manual. Department of Conservation, Wellington, New Zealand. 35 p

[350] DJ Freeman, BA Marshall, ST Ahyong, SR Wing and RA Hitchmough. 2010. Conservation status of New Zealand marine invertebrates, 2009, New Zealand Journal of Marine and Freshwater Research, 44:3, 129-148.

[351] https://www.doc.govt.nz/our-work/conservation-services-programme/csp-plans/csp-strategic-statement/

[352] https://niwa.co.nz/sites/niwa.co.nz/files/Deepsea-corals-NZ-2019-NIWA-SciTechSeries-84.pdf

The **CSP Coral Plan** focuses on deep water corals and the impact of trawling on them, as most interaction data and bycatch samples available stem from these fisheries. Coral taxa found in shallower habitats (e.g., Fiordland, Port Pegasus) or that interact with other fishing methods (e.g. rock lobster potting, bottom long-lining) generally have a lack of observer coverage and interaction data. Broader coral research that relates to threats other than the direct and indirect effects of commercial fishing (e.g., coral disease, ocean acidification) falls outside the scope and mandate of CSP and is not included in this plan.

Unlike protected seabirds and sharks, protected corals do not have a National Plan of Action and associated risk assessment framework to guide management actions and research planning. In the interim until such a Plan is developed, the CSP Coral Plan acts as research guiding framework.

The last 20 years have seen a significant increase in knowledge of the distribution of underwater features around New Zealand (Ramillien and Wright, 2000[353]). Multi-beam echosounder (MBES) data have produced detailed bathymetry of habitats relevant to deep-sea corals, in particular seamount features (seamounts, knolls, hills, pinnacles). These are well known as important topography for deep-sea corals (e.g., see review by Clark *et al.,* 2010[354], Tracey *et al.,* 2011[355], Rowden *et al.,* 2010[356]). Information on these features specifically have been compiled since 1999 when new research became focused on assessing the diversity and ecology of seamount benthic macroinvertebrate fauna. The "seamount database" (Mackay, 2006[357], Rowden *et al.,* 2008[358]) presents a synopsis of the physical characteristics of seamounts within the New Zealand region.

The *Exclusive Economic Zone and Continental Shelf* (Environmental Effects—Permitted Activities) Regulations 2013, provide for the management of the environmental effects of permitted activities in the EEZ if they occur in areas of sensitive marine benthic environments; Schedule 6 of these regulations includes a list of indicators of the existence of sensitive environments. Table 3 lists those sensitive environments relevant to those for corals and sea pens.

A review by MacDiarmid *et al*., (2013)[359] was used as the basis for developing this list and provides a description, distribution, and definition of 13 sensitive marine benthic habitats, including stony coral thickets or reefs. More recently, as part of MfE's State of the Environment reporting, Anderson *et al.,* (2019)[360], provide a review of New Zealand's key biogenic habitats (many of which are also defined as sensitive marine benthic habitats in MacDiarmid *et al.,* (2013)[14]. The 15 key biogenic habitats examined in Anderson *et al.,* (2019)[15] includes 'Stony-coral thickets, and other

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[353] Ramillien, G.; Wright, I.C. (2000). Predicted seafloor topography of the New Zealand region: A nonlinear least squares inversion of satellite altimetry data. Journal of Geophysical Research: Solid Earth, 105(B7), pp.16

[354] Clark, M.; Bowden, D.; Baird, S.; Stewart, R. 2010. Effects of fishing on the benthic biodiversity of seamounts of the "Graveyard" complex, northern Chatham Rise. New Zealand Aquatic Environment and Biodiversity Report No. 46. 40p.

[355] Tracey, D.; Rowden, A.; Mackay, K.; Compton, T. 2011. Habitat-forming cold-water corals show affinity for seamounts in the New Zealand region. Marine Ecology Progress Series, 430: 1–22.

[356] Rowden, A. A.; Schnabel, K. E.; Schlacher, T. A.; Macpherson, E.; Ahyong, S. T.; Richer de Forges, B. 2010. Species composition of benthic assemblages on seamounts is distinct from some but not all deep-sea habitats. Marine Ecology, 31: 63–83.

[357] Mackay, K. 2006. Database Documentation - Seamounts database (Seamount). NIWA Internal Report https://www.mpi.govt.nz/dms-document/15604-database-documentation-seamount

[358] Rowden, A.; Clark, M. 2008. Benthic biodiversity of seven seamounts on the southern end of the Kermadec volcanic arc, northeast New Zealand. New Zealand Aquatic Environment and Biodiversity Report No. 62. 31 p.

[359] MacDiarmid, A.; Bowden, D.; Cummings, V.; Morrison, M.; Jones, E.; Kelly, M.; Neil, H.; Nelson, W.; Rowden, A. (2013). Sensitive marine benthic habitats defined. NIWA Client Report WLG2013-18. 72 p.

[360] Anderson, T.; Morrison, Mark.; MacDiarmid, A.; D'Archino, R.; Nelson, W.; Tracey, D.; Clark, M.; Gordon, D.; Read, G.; Morrisey, D.; Kettles, H.; Wood, A.; Anderson, O.; Smith, A.; Page, M.; Paul-Burke, K.; Schnabel, K.; Wadhwa, S. (2018). Review of New Zealand's Key Biogenic Habitats. NIWA client report prepared for the Ministry for the Environment Project MFE18301. 184 p.

habitat-forming corals'. The review, which includes current knowledge on biogeographic distribution, ecosystem services, stressors and threats, and the current and likely future projected condition of these habitats, also identified the importance of non-thicket forming coral groups (black corals, octocorals and hydrocorals) as structural habitats for benthic communities as well as their vulnerability to disturbance and likely slow recovery times following disturbance.

Table 3. Sensitive environments identified in the Exclusive Economic Zone and Continental Shelf (Environmental Effects—Permitted Activities) Regulations 2013. Listed here are those relevant to this report, corals and sea pens.

Sensitive environment	Identification criteria
Stony coral thickets or reefs	A stony coral reef or thicket exists if: a colony of a structure-forming species (ie, *Madrepora oculata*, *Solenosmilia variabilis*, *Goniocorella dumosa*, *Enallopsammia rostrata*, *Oculina virgosa*) covers 15% or more of the seabed in a visual imaging survey of 100 m2 or more; or • a specimen of a thicket-forming species is found in 2 successive point samples; or • a specimen of a structure-forming species is found in a sample collected using towed gear.
Sea pen field	A sea pen field exists if: • a specimen of sea pen is found in successive point samples; or • 2 or more specimens of sea pen per m2 are found in a visual imaging survey or a survey collected using towed gear.

In 2007, New Zealand (supported by the fishing industry) developed a set of criteria for defining benthic protection areas (BPAs) which protects relatively pristine areas with an aim to protect a variety of habitat and environment types. BPAs are defined based on the following criteria (Deepwater Group Ltd, 2018)[361]:

- Unmodified – largely unfished or otherwise impacted by human activity;
- Large – both as individual parcels and cumulatively;
- Simple in form – to facilitate ease of interpretation and compliance;
- Consistent with Government policy – to protect not less than 10% of each of the identified marine environments within the EEZ;
- Representative of:
    a. Marine environment classification areas and biodiversity areas;
    b. Geological and oceanographic regions;
    c. Depth ranges; or
    d. Underwater topographical features

[361] Deepwater Group Ltd. (2018) New Zealand's Marine Protected Areas. Available at: https://deepwatergroup.org/wp-content/uploads/2018/06/NZ-MPAs.pdf.

5.3 – Assessment of bottom fishing impacts

New Zealand's commercial fisheries are based on the Individual Transferable Quota (ITQ) system operated under the Quota Management System (QMS). The QMS was introduced in 1986. Before then, it was difficult for the New Zealand government to limit the number of fish from commercial species being caught. Now, FNZ has more information on the health of New Zealand's fisheries, which helps them to set limits that keep fishing sustainable. The total allowable catch limits they set are based on the best available information, which includes:

- Research
- reporting from the fishing industry.

Fisheries New Zealand's *Harvest Strategy Standard* (HSS) provides guidance on the performance measures used when assessing and managing fish stocks under the QMS.

Each year, FNZ convenes many Stock Assessment Working Group meetings to assess the status of fish stocks using:

- scientific research (from contracted research providers)
- validated catch and fishing effort reports from commercial fisheries
- data from their on-board observer programme
- other relevant information.

Stocks are assessed against 4 performance measures:

- **A hard limit**– a biomass level below which a stock is deemed to be collapsed and fishery closures should be considered to rebuild the stock at the fastest possible rate.
- **A soft limit**– a biomass level below which a stock is deemed to be overfished or depleted and needs to be actively rebuilt using a formal, time constrained rebuilding plan.
- **A management target**– the level of biomass or a fishing mortality rate that stocks are expected to fluctuate around for the best balance between use and sustainability, while allowing for environmental variation.
- **Overfishing threshold**– a rate of extraction (percentage of a stock removed each year) that should not be exceeded as it will ultimately lead to stock biomass falling below other performance measures.

The New Zealand exclusive economic zone (EEZ) is partitioned in 10 fishery management areas (FMAs) (Figure 1). The management areas specific to each stock are referred to as the quota management areas (QMA), and they usually consist of 1 or a combination of several FMAs.

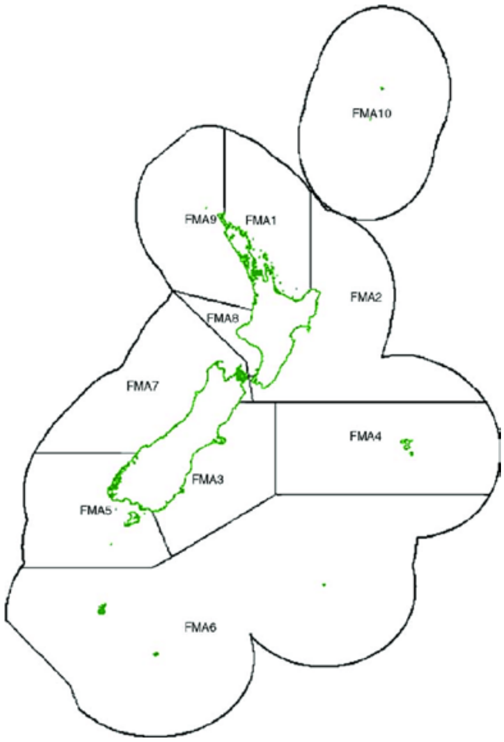

Figure 1. The New Zealand exclusive economic zone (EEZ) divided in 10 Fishery Management Area (FMA).

The management of deepwater fisheries encompasses all target stocks, bycatch stocks, and the environmental effects of fishing. All deepwater species in the quota management system (QMS) have been categorised into two tiers according to their commercial value and volume of catch (Table 4).

Tier 1 fisheries are high volume and/or high value fisheries and are typically targeted. They deliver significant export revenue, which is reflected in the high quota value associated with these species. Tier 2 fisheries are typically less commercially valuable, comprise bycatch fisheries, or are only targeted periodically throughout the year. Additionally, the Tier 3 comprises those stocks that are outside of the QMS[362].

[362] Tier 3 species are those caught as bycatch that are not managed through the QMS. https://www.mpi.govt.nz/dmsdocument/39770-Annual-Review-Report-for-Deepwater-Fisheries-2018-19

Table 4: Categorisation of deepwater fish stocks by tier

	Stocks[363]	
Tier 1	Hake: all Hoki: all Jack mackerel: JMA3, JMA7 Ling: LIN3 - LIN7 Orange roughy: all	Oreos: all Scampi: all Southern blue whiting: all Squid: all
Tier 2	Alfonsino: all Barracouta: BAR4, BAR5, BAR7 Black cardinalfish: all Deepwater crabs (CHC/GSC/KIC): all English mackerel: EMA3, EMA7 Frostfish: FRO3-FRO9 Gemfish: SKI3, SKI7 Ghost shark, dark: GSH4-GSH6 Ghost shark, pale: all Lookdown dory: all	Patagonian toothfish: all Prawn killer: all Redbait: all Ribaldo: RIB3-RIB8 Rubyfish: all Sea perch: SPE3-SPE7 Silver warehou: all Spiny dogfish: SPD4, SPD5 White warehou: all
Tier 3	Non-QMS species	

Under the Fisheries Act 1996, Fisheries New Zealand must manage the adverse effects of fishing on the aquatic environment. This includes any effects on protected species. To do this, FNZ works with the Department of Conservation (DOC, and stakeholders (like commercial fishers).

FNZ monitors the impact of fishing on protected species to see when they need to intervene. They also look at whether current management approaches are working well.

This is done in 4 stages:

1. gathering information
2. making a scientific assessment
3. deciding how to manage impacts
4. monitoring and evaluating

The information collected by FNZ is: the number of protected species that are impacted by fishing and the consequences of this impact.

Fisheries New Zealand finds out how many protected species are impacted by fishing from:

- Fishers: Commercial fishers are required to report on captures of protected species. Fisheries New Zealand usually receives reports within 24 hours of the capture.
- Fisheries observers: Fisheries New Zealand employs around 100 Fisheries Observers. Forty-five (45) are deployed at any one time. They work on commercial fishing vessels to collect data and verify fishing-related activities, including interactions with protected species.
- On-board cameras: In 2019, trawl and set net vessels operating in core Māui dolphin habitats were fitted with onboard cameras as part of a proof-of-concept camera project. In 2022, it will begin a wider roll-out of cameras, which will see cameras used in those inshore fisheries most likely to capture protected species.

[363] Management of stocks for some species falls under the Deepwater Fisheries Plan while the remainder are managed under the draft National Fisheries Plan for Inshore Finfish.

- DOC fisheries liaison programmes: The fishing industry voluntarily reports additional information on protected species captures.

Once the information has gathered, Fisheries New Zealand works with DOC to detect trends in the number of protected species that are captured by commercial fishing, making a scientific assessment and deciding how to manage the impacts. Every 3 months, FNZ release information gathered from the daily self-reports from commercial fishers. These reports inform about their catches – the species, the fishing methods they are using, and where they are fishing and about accidental catches of marine mammals (like seals and dolphins), seabirds, reptiles, protected fish, and corals, sponges, and bryozoans.

Research on the impacts of fisheries on protected and non-target species, as well as the marine environment, especially benthic (sea floor) organisms and communities is undertaken by NIWA[364]. The research directions are:

1. Assessment methodologies: developing methodologies to assess the effects of fishing on the ecosystem. This includes both targeted and non-targeted species, protected species, habitats, and communities.

2. Monitoring and analysis: NIWA monitors and analyses the impact of commercial fishing activity on species that aren't targeted by fishing (bycatch). This monitoring and analysis comprises:

- Other fish species,
- Invertebrates, such as protected corals.
- Seabirds, including modelling how fishing practices affects their population.

3. Habitats of particular significance or vulnerability:

- Habitats of particular significance or vulnerability include waters where spawning, pupping, and egg-laying occur or where nursery grounds exist. The concentration of fish in the early part of their life in these areas means small environmental impacts on them can have a large effect on fish populations later on.
- Evaluating the effectiveness of changes in fishing practices to reduce the harm of fishing on vulnerable habitats and improve sustainability of fisheries.
- Use this knowledge to develop better methods to protect vulnerable habitats or species e.g., spatial management tools such as networks of protected areas. By protecting a few key areas, which are connected by biological processes such as plant propagation and fish migration during their life cycle, a network of protected areas can have a much greater positive effect than the same area lumped into one reserve. Understanding these processes allows the best balance between protecting economic activity and preserving fishery and ecosystem health.

New Zealand continues to be actively engaged in developing, improving, and implementing measures to sustainably manage deep-sea fish stocks and prevent significant adverse impacts from bottom fishing on vulnerable marine ecosystems (VMEs), both in its own exclusive economic zone and on the high seas. New Zealand is a member of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and the South Pacific Regional Fisheries Management Organisation (SPRFMO). On the high seas, New Zealand flagged fishing vessels undertake bottom fishing in the CCAMLR Convention Area and the SPRFMO Convention Area. Consistent with CCAMLR CM 22-06, New Zealand has continued to submit to CCAMLR an annual preliminary assessment with the best available information of the known and anticipated impacts of its bottom fishing activities on VMEs in the CCAMLR Convention Area. In SPRFMO, as required under CMM 03-2022, New Zealand and Australia conducted a joint cumulative quantitative bottom fishing

[364] https://niwa.co.nz/fisheries/programmes/fisheries-environmental-impacts

impact assessment based on an updated Bottom Fishing Impact Assessment Standard adopted by the Commission in 2021. Updated impact assessments are to be submitted to the Scientific Committee and Commission at least every three years and/or when a substantial change in the fishery has occurred, such that it is likely that the risk or impact of the fishery may have changed.

Bottom Fishing Footprint

New Zealand's deepwater and middle depths trawl fisheries are ranked into three tiers: Tier 1 are high volume, Quota Management System (QMS) stocks targeted by commercial fishers; Tier 2 are QMS species that are less commercially valuable (typically taken as bycatch) or are only targeted at certain times of the year; and Tier 3 are non-QMS bycatch species (Ministry for Primary Industries 2017). Trawl fishing for the deepwater Tier 1 and Tier 2 fishstocks within the 200 n. mile New Zealand Exclusive Economic Zone (EEZ) includes the use of bottom contacting trawl gears, that is bottom trawls and midwater trawls used within a metre of the seafloor. Masters of trawl vessels operating these gears are required to fill out Trawl Catch Effort and Processing Returns (TCEPRs) if the vessel is over 28 m in overall length or if the vessel is required by the Director-General of Fisheries to furnish a TCEPR (as required by the Fisheries (Reporting) Regulations 1990). These returns usually relate to trawl operations undertaken at depths greater than 200 m. However, masters of smaller trawl vessels (less than 28 m in length that generally fish shallow, inshore waters) may also report effort on TCEPRs[365] and, since October 2007, on Trawl Catch Effort Returns (TCERs) – the forms that replaced the Catch Effort Landing Returns previously used to report catch and effort from small inshore trawlers.

The data collected on the TCER and TCEPR forms are used to generate annual trawl footprints that represent the area of the seafloor contacted by trawl gear. Assessment of the annual trawl footprint is a monitoring requirement for Deepwater Fisheries Management Objective 7: *Manage deepwater and middle-depth fisheries to avoid, remedy or mitigate the impacts of deepwater fisheries on the benthic habitat* (Ministry for Primary Industries 2017)[366].

In 2019 under the overall BEN2017-01 project objective that aimed to monitor the "footprint" of trawl fishing for deepwater species on or near the seabed. This work367 was the first use of the *CatchMapper tool*, developed by MPI, to generate the bottom-contacting trawl footprint. This tool was developed to map the commercial catch reported by commercial fishers to forecast the quantity of displaced fishing activity (Osborne 2018)[368]. Effort, catch, and landings data are aggregated into gear-species clusters based on Statistical Areas and depth to provide a spatial distribution. The data used by CatchMapper were extracted from the MPI Enterprise Data Warehouse (EDW) database. In this work, the footprint of commercial trawl fishing reported on Trawl Catch Effort Returns (TCERs) and Trawl Catch Effort and Processing Returns (TCEPRs) was generated for bottom-contacting effort that targeted deepwater Tier 1 and Tier 2 fishstocks in the Territorial Sea (TS) and 200 n. mile Exclusive Economic Zone (TS+EEZ). The footprint analysis included 283 100 bottom-contacting tows reported during 2008–17 (see Figure 2). The extent of the bottom-contacting trawl footprint for the 10 fishing years was 180 100 km^2, equivalent to 4.4% of the total

[365] Baird, S.J.; Wood, B.A.; Bagley, N.W. (2011). Nature and extent of commercial fishing effort on or near the seafloor within the New Zealand 200 n. mile Exclusive Economic Zone, 1989–90 to 2004–05. *New Zealand Aquatic Environment and Biodiversity Report No. 73*. 143 p.

[366] Ministry for Primary Industries (2017). National Fisheries Plan for Deepwater and Middle-depth Fisheries – Part 1A. MPI Discussion Paper No: 2017/26. Prepared for public consultation by the Deepwater Fisheries team. 37 p.

[367] Baird, S.J. and Mules. R. (2019). Extent of bottom contact by New Zealand commercial trawl fishing for deepwater Tier 1 and Tier 2 target species determined using CatchMapper software, fishing years 2008–17*. New Zealand Aquatic Environment and Biodiversity Report No.229*.http://www.mpi.govt.nz/news-and-resources/publications

[368] Osborne, T.A. (2018). Forecasting quantity of displaced fishing Part 2: CatchMapper – Mapping EEZ catch and effort. *New Zealand Aquatic Environment and Biodiversity Report No. 200.* 168 p.

TS+EEZ seafloor area, 13.0% of the 'fishable' seafloor area open to bottom-contacting trawling in waters shallower than 1600 m, and 11% of seafloor area in 0–1600 m depths. Tier 1 fishstocks contributed to about 87% of the overall footprint, which gave an overlap of 3.8% of the TS+EEZ, 11.4% of the 'fishable' area, and 10% of 0–1600 m depths. During 2008–17, about 1.2% of the TS+EEZ seafloor and 3.6% of the 'fishable' area seafloor was contacted annually. Effort targeting the hoki fishstock produced the greatest swept area each fishing year and this fishery was the only stock to show a steady increase over the 10 fishing years.

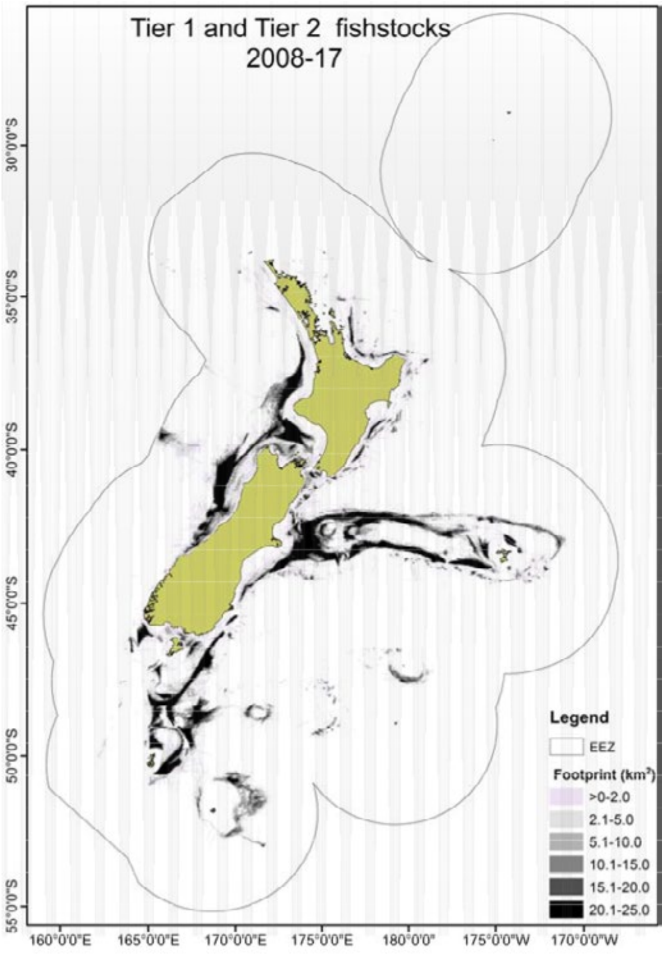

Figure 2. Distribution of the total footprint area (Km^2) for all deepwater Tier 1 and Tier 2 targets for 2008-2017.

Maps of New Zealand fisheries, including commercial fishing, customary fisheries, and marine protected areas are publicly available from the National Aquatic Biodiversity Information System[369] (NABIS) fishery mapping tool. NABIS is an online interactive mapping tool that allows to make maps and get statistics for: (i) fishing areas for different stocks, (ii) commercial fishing events, (iii) fishing methods, (iv) some non-commercial fishing, and (v) restricted areas.

Bottom Fishing Vessels

As of 2018, the fleet that operates in the deepwater fisheries in New Zealand comprises trawl and bottom longline vessels. The majority of the deepwater fleet are factory trawlers that use a mixture of bottom and mid-water trawl gear. These vessels are up to 105 metres in length and are capable of spending weeks at sea, processing and freezing fish on board.

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[369] https://www.mpi.govt.nz/legal/legislation-standards-and-reviews/fisheries-legislation/maps-of-nz-fisheries/

Deepwater factory trawlers are generally further categorised based on aspects of the vessels and their operations.

1. Big Autonomous Trawler Reefer (large Soviet-era fishing vessels known by their Russian acronym – BATM; the largest fishing vessels operating in the deepwater fleet) which generally use midwater trawl gear, all have fish meal plants, and can tow gear faster than other vessels.

2. Domestic freezer vessels – these vessels use a mixture of midwater and bottom trawl gear and mostly have fish meal plants on board. These vessels are all owned by domestic fishing companies.

3. Scampi vessels – targeting scampi requires a specific gear set up, and there are around ten vessels that target scampi year-round, freezing product at sea.

4. The last category is made up of older vessels without fish meal plants that generally use only bottom trawl gear and are generally foreign owned.

The deepwater fleet also includes a number of vessels that do not freeze product at sea. Known as 'freshers', these vessels often spend less time at sea per trip as product must be offloaded more regularly.

There are generally two categories of **bottom longline vessel** that operate as part of the deepwater fleet.

1. Autoliners are vessels that use automatic baiting machines to bait the hooks during the setting of bottom longlines. This enables them to set larger numbers of hooks per set/day.

2. Hand-liners are smaller vessels where hooks are baited by hand which can limit the number of hooks per set/day.

Historically, there were a number of squid jig vessels that operated in New Zealand, however, there has not been any squid jig effort since 2016.

Any vessel that is foreign owned (as defined under the Overseas Investment Act 2006) must be registered to fish in New Zealand with the consent of the Director-General of MPI. The trawl fleet has undergone significant changes in recent years, with the passage of legislation requiring that all vessels operating in New Zealand's EEZ be flagged to New Zealand from 1 May 2016. This change resulted in a number of foreign-flagged vessels leaving New Zealand's waters.

Fisheries observers

Fisheries observers join commercial fishing boat trips to collect data. They collect data on:

- what fish the fishers are catching
- how many fish they're catching
- information on marine mammal and seabirds (by-catch and sightings)
- biological information to help with assessing fish stocks
- unusual specimens for museums
- information about vessel safety and employment
- fish processing information.

The data that observers collect is independent. They compare it against data from the fishing boats. They keep a separate logbook recording catch and effort. This includes:

- catch information and amounts for all species caught
- details of fishing operations, like:
- start and finish times
- positions and places where fish were caught
- fishing and bottom depths

- devices and practices to protect protected species (like seabirds and marine mammals)
- catch data for each tow or set.

5.4 – Mapping of sensitive species and habitats

Since 2007, as part of the requirements of the Department of Conservation (DOC) Marine Conservation Services (MCS) Conservation Services Programme (CSP), observers have recorded and collected samples of any coral taxa that (1) are protected, (2) that strongly resemble protected coral fauna[370], or (3) that have been proposed for protection. This instruction was to ensure legal obligations of the Wildlife Act (1953) could be met. Observers photograph coral specimens at sea and all samples, or a sub-sample of the colony, are returned to NIWA (frozen) for identification and curation. Corals are identified to the lowest possible taxonomic level and resulting data are entered into the Ministry of Fisheries (MFish) Centralised Observer Database (cod) that is maintained by NIWA. This activity has been carried out under previous CSP Projects (INT200703/DOC08309, INT200802/DOC09305, INT200903/DOC10304). The focus of the 2007–2010 projects was on fishing vessels targeting the deepwater fisheries for orange roughy (*Hoplostethus atlanticus*), black oreo (*Allocyttus niger*), smooth oreo (*Pseudocyttus maculatus*), and black cardinalfish (Epigonus telescopus). Any coral samples retained from these projects are held under stewardship at NIWA and species identification information is also loaded into the NIWA Invertebrate Collection (NIC) Specify database.

Government observers on commercial fishing vessels have instructions and procedures for retaining benthic invertebrates caught during fishing activities. Standardised methods are followed to assess each trawl tow or longline set for the presence of invertebrates, including corals (Class Anthozoa, Phylum Cnidaria). Observers record presence and weight data on the Benthic Materials Form (previously these data were recorded on the Catch Form).

Tracey *et al.,* (2011)[371] analysed the distribution of nine groups (see table 5) of protected corals based on bycatch records from observed trawl effort for 1007-10. The observed data included attributes recorded on catch-effort logbooks on a tow-by-tow or set-by-set basis. The primary effort attributes used described the start and finish tow/set time, date, location, and depth; target species; and fishing method and gear type. Each tow/set has an identifier for the vessel and observer(s). The catch data included the greenweights of the total catch, the target species, and the coral taxon or taxon groups.

[370] A measure of accuracy of the observer coral identification is assessed by comparing the at-sea coral identifications of returned samples with expert identifications made later in the laboratory. Distribution of protected corals in relation to fishing effort and assessment of accuracy of observer identification. 2011. NIWA.

[371] Tracey, D.; Baird, S.J.; Sanders, B.M.; Smith, M.H. 2011. Distribution of protected corals in relation to fishing effort and assessment of accuracy of observer identification. NIWA Client Report No: WLG2011-33 prepared for Department of Conservation, Wellington. 74 p.

Table 5. The coral groups used to represent the distribution of corals caught during observed fishing events, 2007–08 to 2009–10.

Name	Combined coral code	Coral Codes
Black corals	COB	COB, TPT, CIR, LSE, LEI, BTP, DEN, PTP
Stony corals	SIA	SIA, CBB
CBD Stony corals - branching	CBR	CBR, ERO, GDU, MOC, SVA
Stony corals - cup	CUP	DDI, CAY, STP, COF, CUP
Gorgonian corals	GOC	GOC, MTL, IRI, CHR, PLE, THO, PMN, NAR, PRI, CLG, CTP, PLL
Precious coral	CLL	CLL
Bamboo corals	ISI	ACN, ISI, LLE, BOO
Bubblegum coral	PAB	PAB
Hydrocorals	COR	COR, LPT, ERR, CRE

The distributions of the main coral groups listed in Table 5, based on the observed trawl data for 2007–08 to 2009–10 are represented in the followed Figures 3-11.

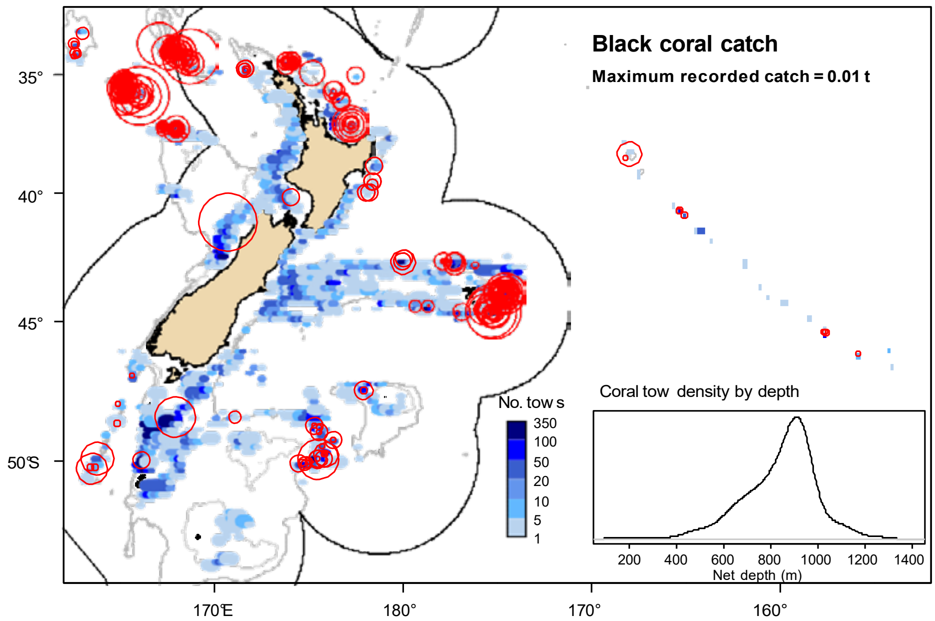

Figure 3. Distribution of observed tow effort (by 0.2° latitude x 0.2° longitude cells) and black coral tow catch weights (t) (red circles: size is proportional to the maximum recorded catch), based on the reported start locations, for 2007–08 to 2009–10. The inset shows the depth distribution of observed tows with black coral catch.

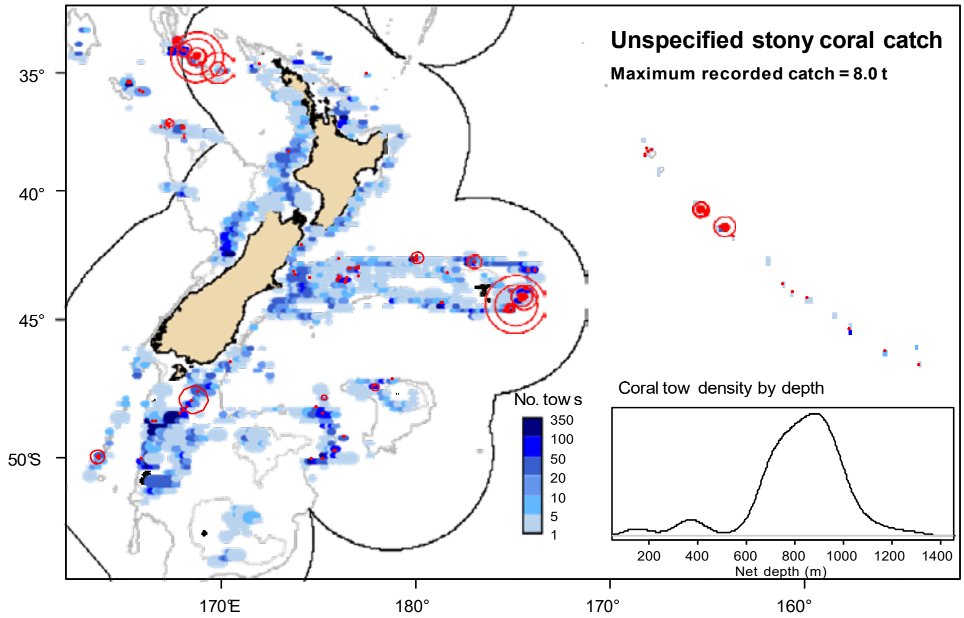

Figure 4. Distribution of observed tow effort (by 0.2° latitude x 0.2° longitude cells) and the SIA stony coral tow catch weights (t) (red circles: size is proportional to the maximum recorded catch), based on the reported start locations, for 2007–08 to 2009–10. The inset shows the depth distribution of observed tows with SIA coral catch.

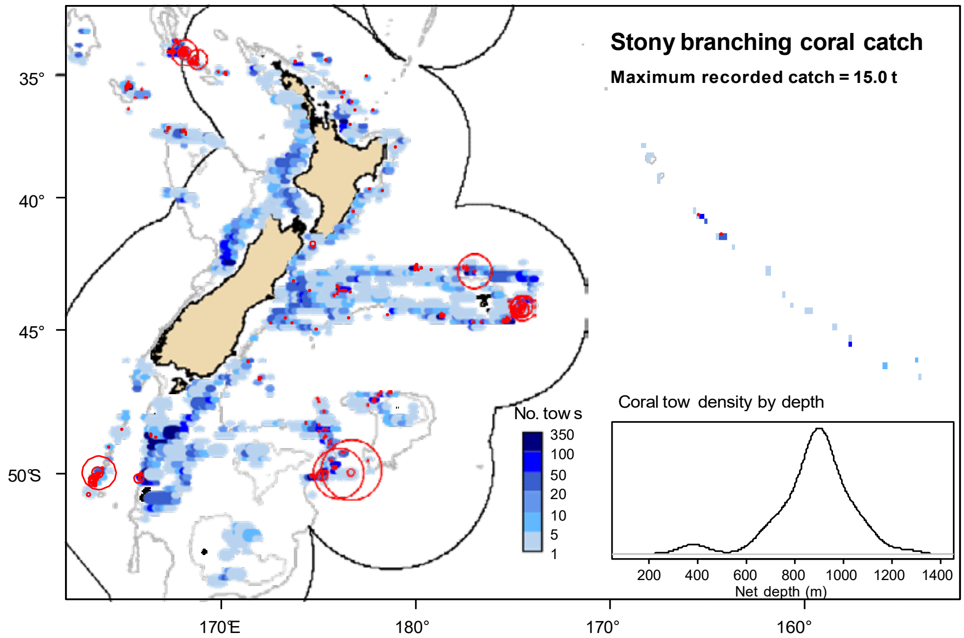

Figure 5. Distribution of observed tow effort (by 0.2° latitude x 0.2° longitude cells) and the stony branching coral tow catch weights (t) (red circles: size is proportional to the maximum recorded catch), based on the reported start locations, for 2007–08 to 2009–10. The inset shows the depth distribution of observed tows with stony branching coral catch.

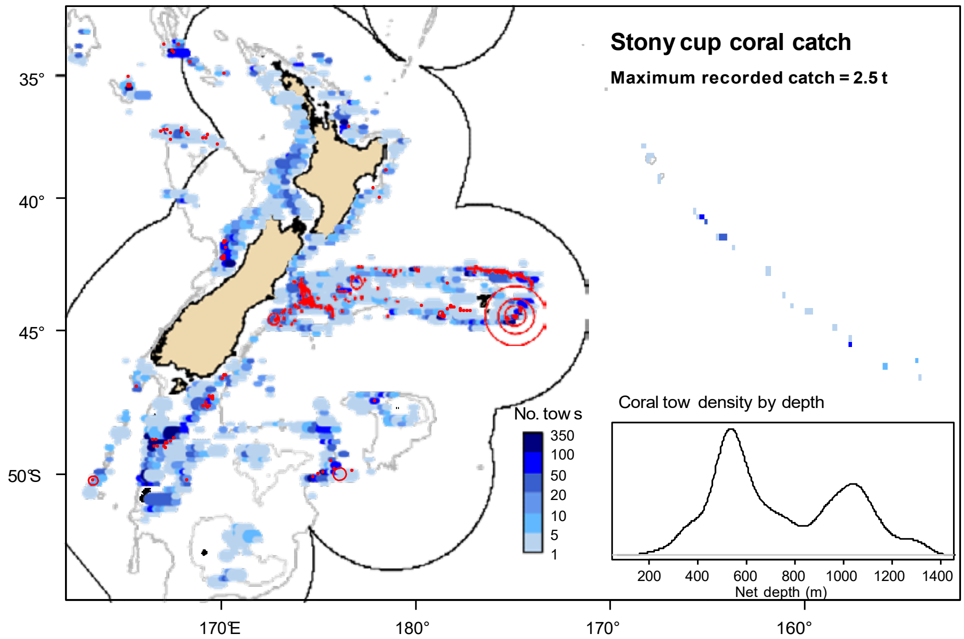

Figure 6. Distribution of observed tow effort (by 0.2° latitude x 0.2° longitude cells) and the stony cup coral tow catch weights (t) (red circles: size is proportional to the maximum recorded catch), based on the reported start locations, for 2007–08 to 2009–10. The inset shows the depth distribution of observed tows with stony cup coral catch.

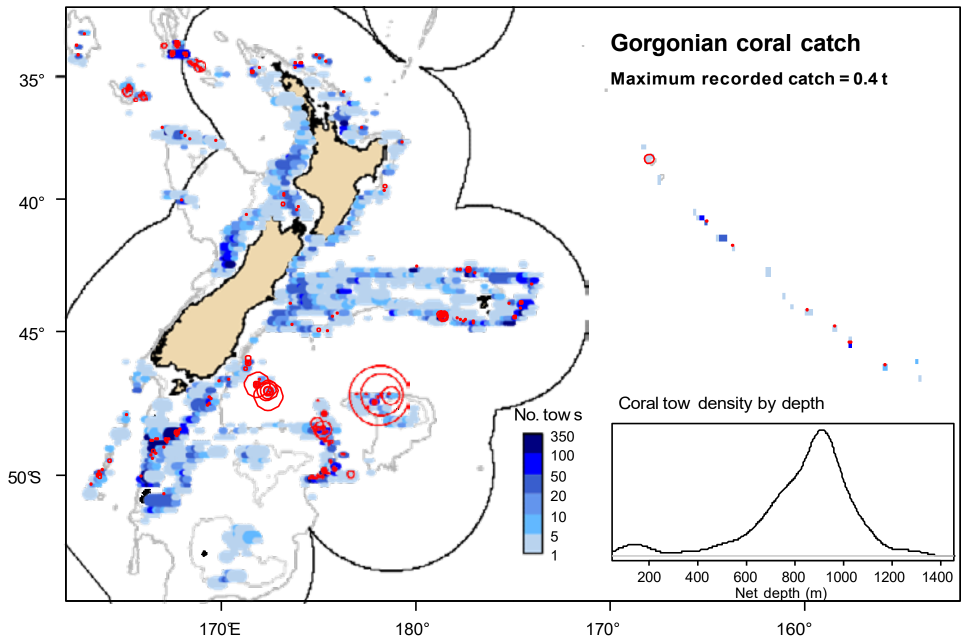

Figure 7. Distribution of observed tow effort (by 0.2° latitude x 0.2° longitude cells) and the gorgonian coral tow catch weights (t) (red circles: size is proportional to the maximum recorded catch), based on the reported start locations, for 2007–08 to 2009–10. The inset shows the depth distribution of observed tows with gorgonian coral catch.

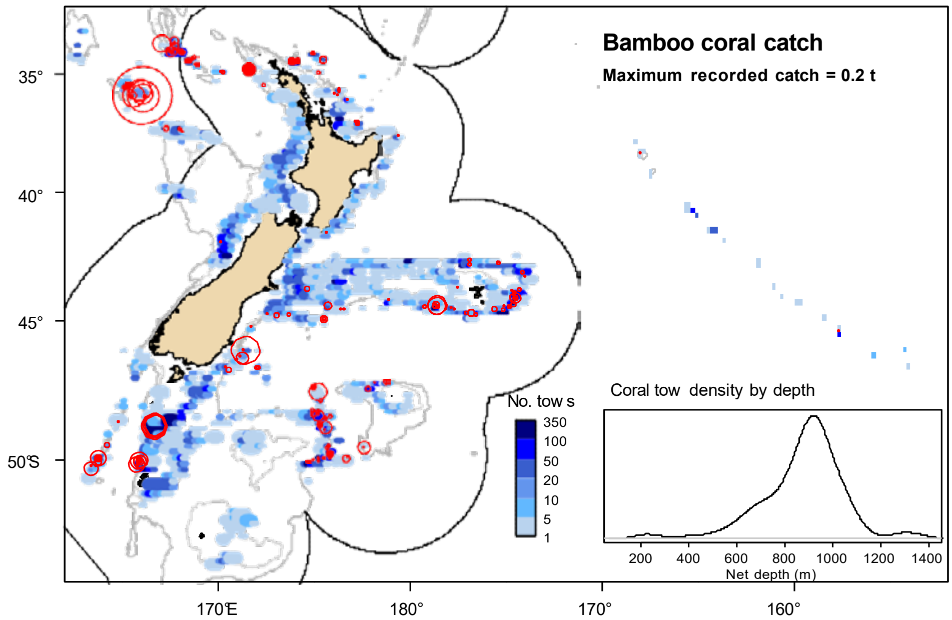

Figure 8. Distribution of observed tow effort (by 0.2° latitude x 0.2° longitude cells) and the bamboo coral tow catch weights (t) (red circles: size is proportional to the maximum recorded catch), based on the reported start locations, for 2007–08 to 2009–10. The inset shows the depth distribution of observed tows with bamboo coral catch.

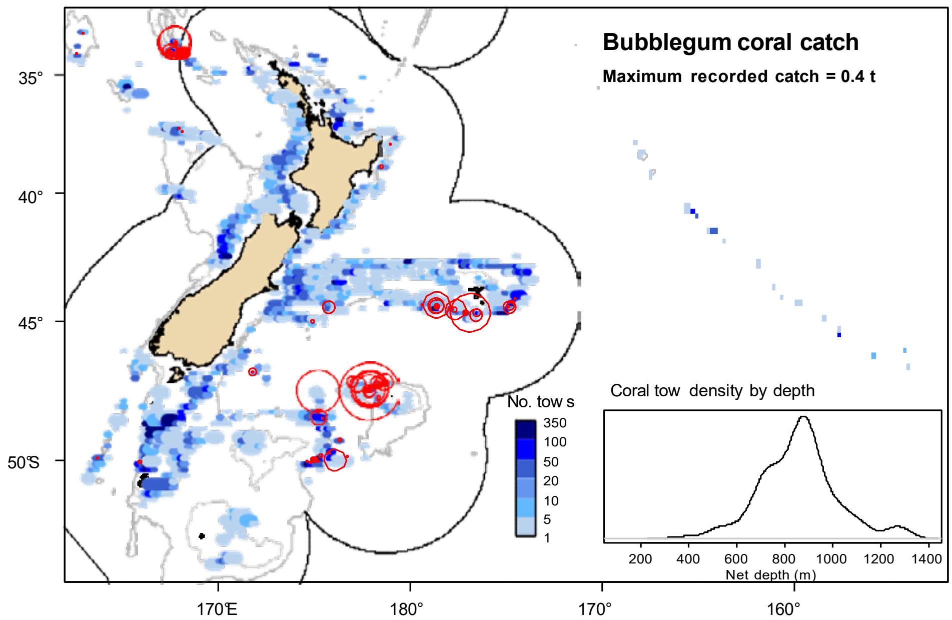

Figure 9. Distribution of observed tow effort (by 0.2° latitude x 0.2° longitude cells) and the bubblegum coral tow catch weights (t) (red circles: size is proportional to the maximum recorded catch), based on the reported start locations, for 2007–08 to 2009–10. The inset shows the depth distribution of observed tows with bubblegum coral catch.

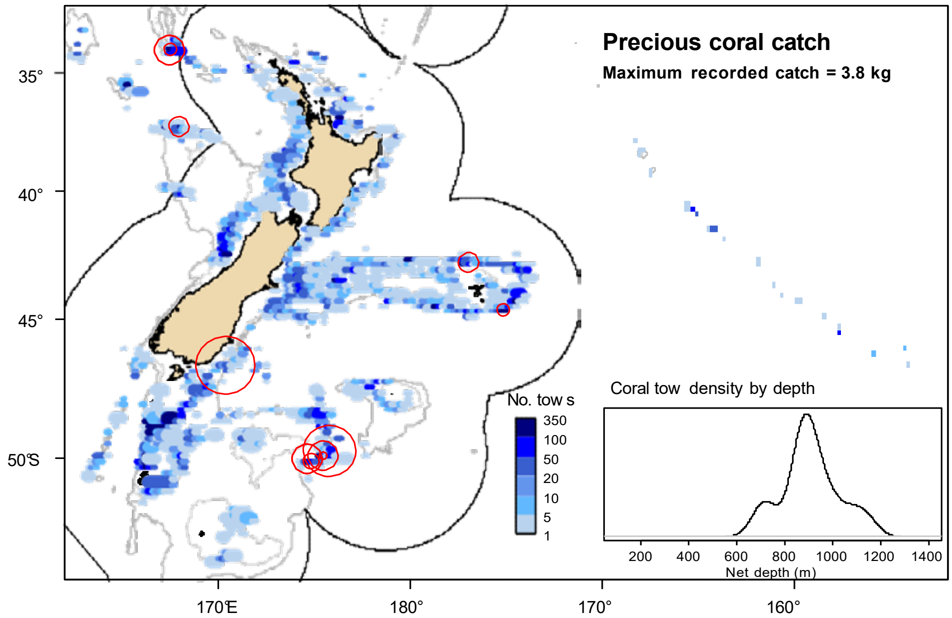

Figure 10. Distribution of observed tow effort (by 0.2° latitude x 0.2° longitude cells) and the precious coral tow catch weights (t) (red circles: size is proportional to the maximum recorded catch), based on the reported start locations, for 2007–08 to 2009–10. The inset shows the depth distribution of observed tows with precious coral catch.

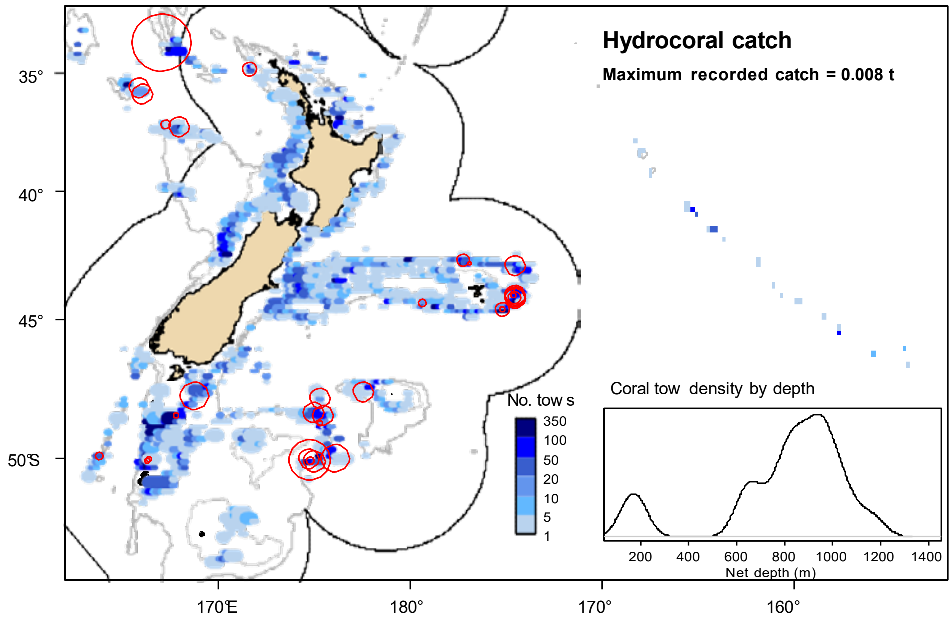

Figure 11. Distribution of observed tow effort (by 0.2° latitude x 0.2° longitude cells) and the hydrocoral tow catch weights (t) (red circles: size is proportional to the maximum recorded catch), based on the reported start locations, for 2007–08 to 2009–10. The inset shows the depth distribution of observed tows with hydrocoral catch.

A range of statistical modelling methods to predict habitat suitability and species distributions in unsampled regions have been developed in recent years, many of which take advantage of the processing power of modern computers and machine learning algorithms. In New Zealand such models have been used to predict the distribution of fish and benthic invertebrate taxa over broad regions of the Exclusive Economic Zone (EEZ) and beyond into the wider Pacific. A specific project was developed in 2012-15, aimed (i) to produce such models for VMEs in the area adjacent to New Zealand's EEZ[372] (SPRFMO area), and (ii) to evaluate their effectiveness for potential management and conservation scenarios. Utilising predictions of future marine climatic conditions from Earth System Models, these modelling tools were also applied to help identify potential future refuges for deep-sea corals and to help identify areas of risk from ongoing interactions with commercial fishing gear (Anderson *et al.,* 2015)[373]. Other models have focussed on smaller areas of interest, using camera surveys and fine-scale environmental data sets derived from multibeam echo-sounder surveys to predict species distributions across the variable terrain of individual seamounts (e.g., Rowden *et al.,* 2017[374]). The more recent studies combined predictions from two or three methods into ensemble models in order to provide averaged estimates from models using disparate methodologies. Precision of the outputs was often estimated, typically using bootstrap resampling techniques.

The predictive habitat modelling studies for marine benthic invertebrates were commissioned by several New Zealand government agencies and most have focused on protected corals (Rowden *et al.,* 2014[375]; Baird *et al.,* 2013[376]; Tracey *et al.,* 2011[377]) and vulnerable marine ecosystem (VME) indicator taxa (Anderson *et al.*, 2016a[378], 2016b[379]; Georgian *et al.*, 2019[380]), with only one published study producing models for individual species/genera across a wide range of taxonomic groups (Compton *et al.,* 2013)[381]. Examples of the methods applied include boosted regression trees (BRT); maximum entropy (MaxEnt); random forest (RF), and generalised additive models (GAM).

5.5 – Impact mitigation and protection measures

Protection of the benthos within the EEZ is not specifically focussed on protecting VMEs but protecting the benthic environment generally, however, the types of habitats protected by the criteria (for example seamounts and hydrothermal vents) are associated with VME taxa and habitats. BPAs are not specifically recognised as a

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[372] https://www.un.org/depts/los/bfw/New%20Zealand_2022.pdf

[373] Anderson, O.; Mikaloff Fletcher, S.; Bostock, H. 2015. Development of models for predicting future distributions of protected coral species in the New Zealand region. NIWA Client Report to Department of Conservation No. WLG2015-65. 28 p.

[374] Rowden, A.; Anderson, O.F.; Georgian, S.E.; Bowden, D.A.; Clark, M.R.; Pallentin, A.; Miller, A. (2017). High-resolution Habitat Suitability Models for the Conservation and Management of Vulnerable Marine Ecosystems on the Louisville Seamount Chain, South Pacific Ocean. Frontiers in Marine Science 4. 1–19.

[375] Rowden, A.; Leduc, D.; Torres, L.; Bowden, D.; Hart, A.; Chin, C.; Davey, N.; Nodder, S.D.; Pallentin, A.; Mackay, K.A.; Northcote, L.; Sturman, J. 2014. Benthic epifauna communities of the central Chatham Rise crest. NIWA Client Report to Chatham Rock Phosphate Ltd. No. WLG2014-9. 116 p.

[376] Baird, S.J., Tracey D., Mormede, S., Clark, M. 2013. The distribution of protected corals in New Zealand waters. Research report for the Department of Conservation. Available for download from http://www.doc.govt.nz/publications/conservation/marine-and-coastal/conservationservices-programme/csp-reports/distribution-of-protected-corals/

[377] Tracey, D.; Rowden, A.; Mackay, K.; Compton, T. 2011. Habitat-forming cold-water corals show affinity for seamounts in the New Zealand region. Marine Ecology Progress Series, 430: 1–22.

[378] Anderson, O.; Guinotte, J.; Rowden, A.; Clark, M.; Mormede, S.; Davies, A.; Bowden, D. 2016a. Field validation of habitat suitability models for vulnerable marine ecosystems in the South Pacific Ocean: Implications for the use of broad-scale models in fisheries management. Ocean & Coastal Management, 120: 110-126. <http://dx.doi.org/10.1016/j.ocecoaman.2015.11.025>.

[379] Anderson, O.; Guinotte, J.; Rowden, A.; Tracey, D.; Mackay, K.; Clark, M. 2016b. Habitat suitability models for predicting the occurrence of vulnerable marine ecosystems in the seas around New Zealand. Deep-Sea Research Part I-Oceanographic Research Papers, 115: 265-292. <http://dx.doi.org/10.1016/j.dsr.2016.07.006>.

[380] Georgian, S.E.; Anderson, O.F.; Rowden, A.A. 2019. Ensemble habitat suitability modelling of vulnerable marine ecosystem indicator taxa to inform deep-sea fisheries management in the South Pacific Ocean. Fisheries Research 211: 256–274.

[381] Compton, T.; Bowden, D.; Pitcher, R.; Hewitt, J.; Ellis, N. 2013. Biophysical patterns in benthic assemblage composition across contrasting continental margins off New Zealand. Journal of Biogeography, 40(1): 75-89. <http://dx.doi.org/10.1111/j.1365-2699.2012.02761.x

fisheries management tool in New Zealand but rather are for the protection of a representative range of benthic biodiversity within the EEZ[382].

New Zealand has one of the largest national networks for protected areas with 32% of its EEZ (1.2 million square kilometres) closed to bottom trawling and dredging. BPAs are closed to bottom-fishing, and strict rules are in place for off-bottom fishing activities. Mid-water trawling can only occur if two government observers are onboard and if an electronic net monitoring system is onboard to record prevent trawl gear does not impact the seabed. Fishing with off-bottom gear is prohibited within 100 m of the seabed and fines are issued if trawl gear exceeds this depth (MPI, 2020)[383]. The majority of BPAs are in areas which are too deep to trawl and only 16% of the BPA are in areas with trawlable depths (Leathwick *et al.,* 2008)[384], however, with the large spatial extent of the BPAs, 16% still provides a significant level of protection.

Encounter thresholds are not used within the EEZ as adverse effects are more likely to be avoided by restricting bottom fishing to specific areas outside of large BPAs (Helson *et al.,* 2010)[385]. New Zealand do implement encounter thresholds and move-on rules within the SPRFMO Convention Area.

Many deep-water fisheries have a requirement that a proportion of fishing effort be observed. Fisheries New Zealand considers that 30% is a suitable target but that in some cases the target can be higher or lower than 30% (New Zealand Government, 2019)[386].

One of the most well-known tools is the MPA, where fishing is significantly restricted, or not allowed, which serves to protect representative areas that are unique or rare, or serve an important function for supporting marine life.

Statutory Management Mechanisms Legislated spatial protection Marine reserves and marine protected areas in the Territorial Sea New Zealand has a range of marine protected areas in place within the Territorial Sea, some of which provide protection of coral species. Corals are identified as one potential component of biogenic habitats, to be represented within a network of marine protected areas (Department of Conservation and Ministry of Fisheries, 2011) [387]. As at September 2019, there are 44 marine reserves implemented under the Marine Reserves Act 1971 and 19 "Type 2" marine protected areas implemented under other legislation (Figure 12). Marine reserves provide the highest level of protection by prohibiting activities that may involve the take or disturbance of marine life. Type 2 MPAs are managed areas that meet a defined protection standard under New Zealand's MPA Policy (Department of Conservation and Ministry of Fisheries 2005[388]; Ministry of Fisheries and Department of Conservation 2008). These protected areas range in latitudinal extent from the subtropical Kermadec Islands Marine Reserve in the north, to subantarctic Moutere Ihupuku/ Campbell Island Marine Reserve in the south. A wide range of other spatial restrictions apply that provide protection against some but not all of the disturbance agents specified in the marine protected areas protection standard. While some of these protected areas and other spatial closures are relatively small and confined to

[382] Walmsley, S; Pack, K; Roberts, C; and Blyth-Skyrme, R (2021). Vulnerable Marine Ecosystems and Fishery Move-on-Rules - Best Practice Review. Published by the Marine Stewardship Council [www.msc.org]. 134 pp

[383] MPI, 2020. Benthic protected areas. Available at: https://www.mpi.govt.nz/fishing-aquaculture/sustainable-fisheries/protected-areas/benthic-protection-areas/.

[384] Leathwick, J., Moilanen, A., Francis, M., Elith, J., Taylor, P., Julian, K., Hastie, T. & Duffy, C. 2008. Novel methods for the design and evaluation of marine protected areas in offshore waters. Conservation Letters. 1(2). p.91-102.

[385] Helson, J., Leslie, S., Clement, G., Wells, R. & Wood, R. 2010. Private rights, public benefits: Industry-driven seabed protection. Marine Policy. 34(3). p.557-566.

[386] New Zealand Government, 2019. Annual Operational Plan for Deepwater Fisheries 2019/20. Fisheries New Zealand Technical Paper No: 2019/05. Available at https://www.mpi.govt.nz/dmsdocument/36804/direct.

[387] http://www.mpi.govt.nz/news-resources/publications.aspx

[388] Marine Protected Areas: Policy and implementation plan. 2005. Published by Department of Conservation and Ministry of Fisheries

nearshore habitats, some are large and extend across habitats within the Territorial Sea and likely include at least some species of protected corals. For example, the spatial closure in Spirits Bay implemented under the Fisheries Act 1996 contains at least 29 species of corals and gorgonians (Cryer *et al.,* 2000)[389].

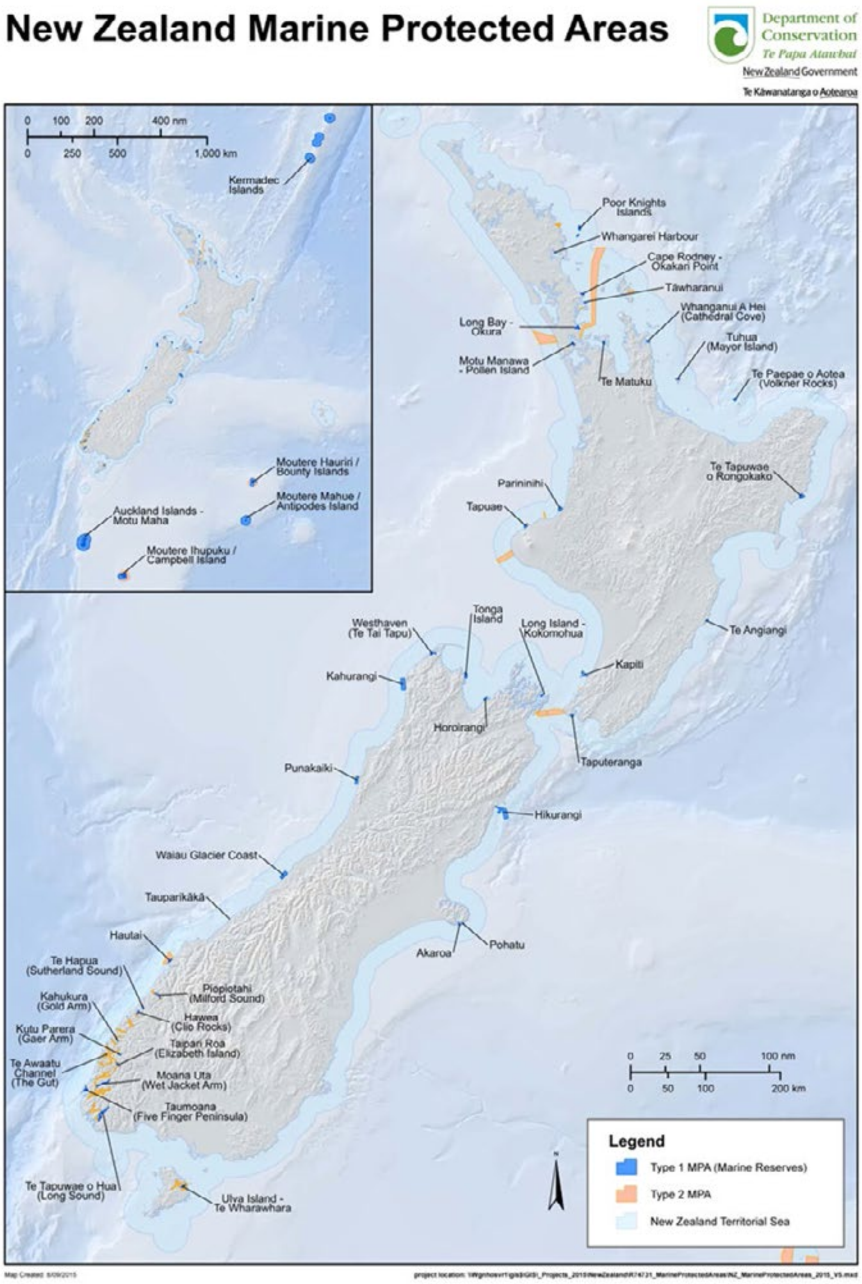

Figure 12. New Zealand Marine Protected Areas.

Spatial protection in the Exclusive Economic Zone

Marine reserves cannot be established outside the Territorial Sea under the Marine Reserves Act 1971. Current spatial measures to protect corals from the effects of

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[389] Cryer, M.; O'Shea, S.; Gordon, D.; Kelly, M.; Drury, J.; Morrison, M.; Hill, A.; Saunders, H.; Shankar, U.; Wilkinson, M.; Foster, G. 2000. Distribution and structure of benthic invertebrate communities between North Cape and Cape Reinga. Final Research Report for Ministry of Fisheries Research Project ENV9805 Objectives 1-4: 1-154.

fishing in New Zealand's Exclusive Economic Zone (EEZ, from 12 to 200 nautical miles from the coast) have been put in place using the Fisheries Act 1996.

In 2001 the Government prohibited trawling in 17 seamounts distributed throughout the EEZ. Within these areas all trawling methods are prohibited; there is no provision for midwater trawling. In 2007, in response to a fishing industry proposal, the Government closed an additional 17 areas (Benthic Protection Areas, BPAs) within the EEZ to dredging and placed tight restrictions on trawling in those areas. The purpose of the BPAs and seamount closures (Figure 13) was to protect benthic (seafloor) biodiversity. The BPAs cover between 3 and 86% of oceanic environment classes (as defined by the 20-class New Zealand Marine Environment Classification; Snelder *et al*., 2005)[390]. While the BPAs were not focussed specifically on corals, the BPAs and Seamount Closures together cover 28% of known underwater topographic features in the EEZ, 52% of known seamounts with an elevation of >1000 m, and 88% of known active hydrothermal vents (Helson *et al*., 2010)[391]. Currently these are the only deepwater protected areas that have been established in the EEZ.

[390] T. Snelder,J. Leathwick,K. Dey,M. Weatherhead,G. Fenwick,M. Francis,R. Gorman,J. Grieve,M. Hadfield,J. Hewitt,T. Hume,K. Richardson,A. Rowden,M. Uddstrom,M. Wild,J. Zeldis. 2005. Marine Environment Classification. Environmental Science. https://environment.govt.nz/sites/default/files/marine-environment-classification.

[391] Helson, J., Leslie, S., Clement, G., Wells, R., and Wood, R. 2010. Private rights, public benefits: Industry-driven seabed protection. Marine Policy. 34:557-566.

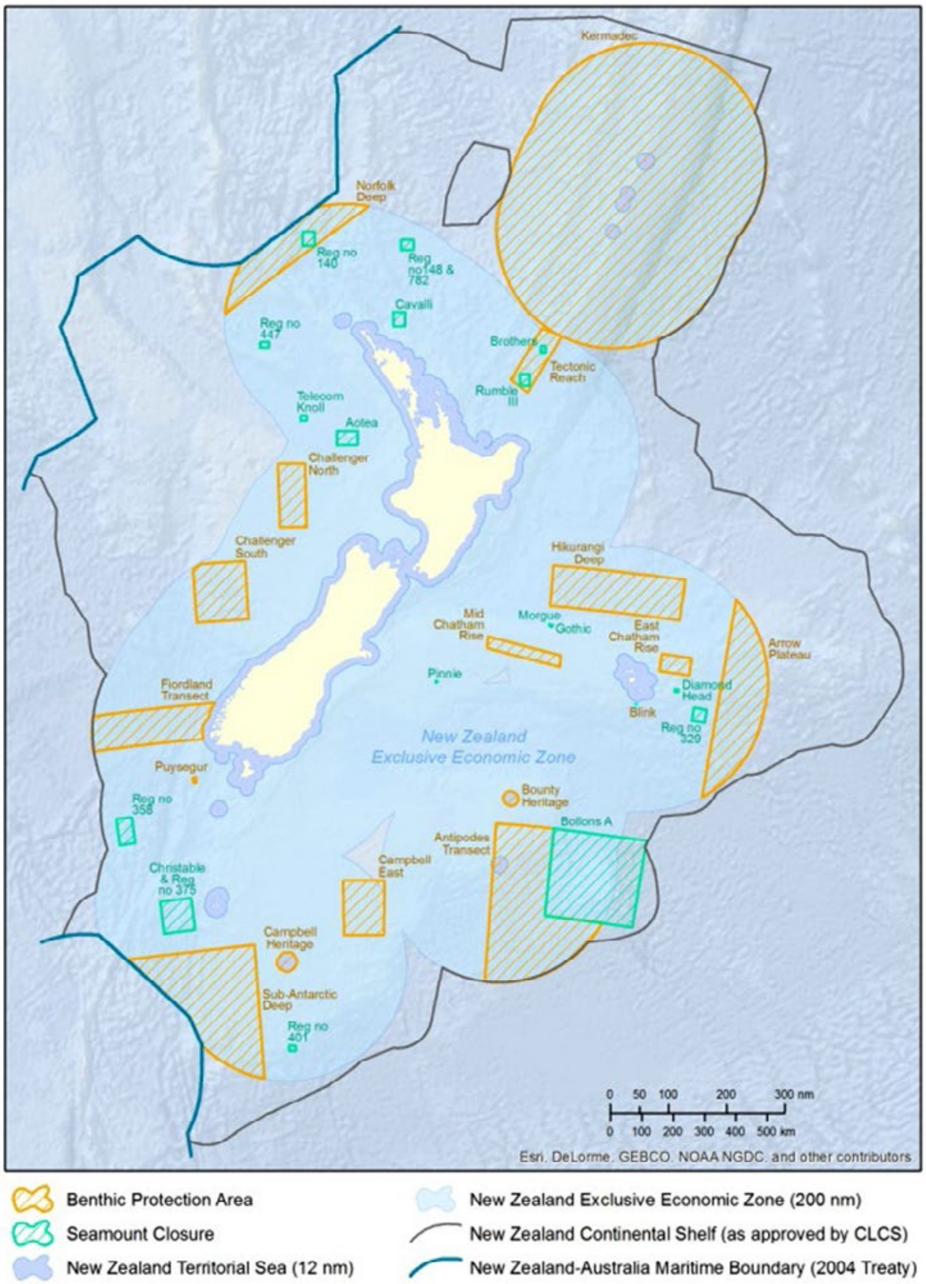

Figure 13. Map of New Zealand's exclusive economic zone with Benthic Protection Area (BPA) and Seamount Closure

5.6 – Monitoring of VME impacts

The Fisheries New Zealand closely monitors bottom trawling as part of a comprehensive fisheries management regime. Controls on bottom trawling include closed areas and regular monitoring of where fishing vessels have fished, and the type and quantity of marine species, such as corals and sponges, which are caught.
For over a decade, Government Fisheries Observers (referred to as observers throughout) placed aboard fishing vessels have also been documenting fishery impacts as the occurrence of non-target species ('bycatch') in commercial catch. Observer documentation includes sampling protected coral bycatch and depositing voucher specimens within the NIWA Invertebrate Collection (NIC). Observer digital images and voucher material are examined by taxonomists and other expert identifiers. This identified bycatch component has been used as an estimate of

fisheries impacts, both in terms of biomass (e.g., Anderson & Clark 2003)[392] and biodiversity (e.g., Blom *et al.,* 2009)[393].

The Conservation Services Programme (CSP) monitors the impact of commercial fishing on protected species, studies species populations and looks at ways to mitigate bycatch. Protected marine species include all marine mammals and reptiles; sea birds (except black backed gulls); seven species of fish; all black corals, gorgonian corals, stony corals and hydrocorals.

The Department of Conservation and National Institute of Water and Atmospheric Research carries out benthic surveys[394] to evaluate the diversity of benthic marine areas, including Benthic Protection Areas and Seamount Closures, using two gear types, NIWA's Deep Towed Imaging System (DTIS) and sled/beam trawl.

[392] Anderson, O., Clark, M.R. (2003) Analysis of bycatch in the fishery for orange roughy, *Hoplostethus atlanticus*, on the South Tasman Rise. Marine and Freshwater Research, 54: 643–652.
[393] Blom, W., Webber, R., Schultz, T. (2009) Invertebrate bycatch from bottom trawls in the New Zealand EEZ. Tuhinga, 20: 33-40.
[394] Within the ocean survey 20/20 programme, the Department of Conservation, NIWA and the Ministry of Fisheries carried out benthic surveys to characterise the seabed habitat.

List of Acronyms

ACE	Annual Catch Entitlement
ALC	Automatic Location Communicator
AOP	Annual Operational Plan
ARR	Annual Review Report
BPAs	Benthic Protection Areas
BRT	Boosted regression trees
CBD	Convention on Biological Diversity
CCAMLR	The Convention on the Conservation of Antarctic Marine Living
CSP	Conservation Services Programme
DOC	Departament of Conservation
DTIS	Deep Towed Imaging System
DWG	Deepwater Group
EDW	Enterprise Data Warehouse
EEZ	Exclusive Economic Zone
FMAs	Fishery Management Areas
FNZ	Fisheries New Zealand
GAM	Generalised Additive Models
GPR	Geospatial Position Reporting
HSS	Harverst Strategy Standard
ITQ	Individual Transferable Quota
MaxEnt	Maximum Entropy
MBES	Multi-beam Echosounder
MCS	Marine Conservation Services
MfE	Ministry for Environment
MoU	Memorandum of Understanding
MPAs	Marine Protected Areas
MPI	Ministry for Primary Industries
NABIS	National Aquatic Biodiversity Information System
NIC	NIWA Invertebrate Collection
NIWA	National Institute of Water and Atmospheric Research
NZTCS	New Zealand Threat Classification System
QMA	Quota Management Areas
QMS	Quota Management System
RF	Random Forest
RFMOs	Regional Fisheries Management Organisations
SDGs	Sustainable Development Goals
SPRFMO	South Pacific Regional Fisheries Management Organisation
TAC	Total Allowable Catch
TACC	Total Allowable Commercial Catch
TCEPRs	Trawl Catch Effort and Processing Returns
TCERs	Trawl Catch Effort Returns
TS	Territorial Sea
UNCLOS	United Nations Convention on the Law of the Sea
UNFSA	United Nations Fish Stocks Agreement
UTC	Coordinated Universal Time
VME	Vulnerable Marine Ecosystem
VMS	Vessel Monitoring System

VTU	Vessel Track Unit
WCPFC	Western and Central Pacific Fisheries Commission

ANNEX 2

Individual Review Tables by Country[1]

CONTENTS

For each country, the following six key topics were considered:

1. *Data availability and governance framework.*

2. *Description of sensitive species and habitats.*

3. *Assessment of bottom fishing impacts.*

4. *Mapping of sensitive species and habitats.*

5. *Impact mitigation and protection measures.*

6. *Monitoring of VME impacts.*

[1] The tables show, for each country, a summary of the rationale for the scoring used for the assessment of the key topics, the main gaps, comments and sources of information.

CASE STUDY 1 – UNITED ESTATES OF AMERICA (USA)

1.1 - Data availability and governance frameworks					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
1.1.1	Are there governance frameworks and specific government departments related to DSF/activities other than fishing (research, monitoring, management and enforcement)?	Fully	3	The Magnuson–Stevens Fishery Conservation and Management Act (MSFCMA) is the primary law that governs marine fisheries management, including the protection of sensitive habitats. Fisheries management is based on science, Fishery Management Plans (FMPs) developed by Regional Fisheries Management Councils (RFMCs), and enforcement. NOAA Fisheries is the office responsible for the stewardship of the living marine resources and their habitats (including deep-sea coral and sponges). NOAA manages marine fisheries in federal waters (EEZ). Coastal states are in charge of inshore fisheries. The Bureau of Ocean Energy Management (BOEM) have the mission to manage development of outer continental shelf energy (i.e. oil and gas, renewable energy) and mineral resources in an environmentally and economically responsible way (including the impacts on deep-sea coral and sponges). The High Seas Fishing Compliance Act (HSFCA) was adopted to implement the *FAO Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas*.	https://www.fisheries.noaa.gov/insight/understanding-fisheries-management-united-states https://www.fisheries.noaa.gov/topic/laws-policies#magnuson-stevens-act https://www.fisherycouncils.org https://www.boem.gov https://www.fisheries.noaa.gov/permit/high-seas-fishing-permits Wallace, R. and Fletcher, K. (2001) Understanding Fisheries Management: A Manual for understanding the Federal Fisheries Management Process, Including Analysis of the 1996 Sustainable Fisheries Act. 2nd ed. University, MS: Mississippi-Alabama Sea Grant Consortium.
1.1.2	Are data on catches, landings and bycatch (including VMEs/sensitive species and habitats) routinely collected and assessed?	Fully	3	The main source of data for fisheries management are (i) NOAA research surveys, NOAA fishery observers and at-sea monitors, and fisheries landings collected by NOAA for each year in all states. Fisheries observers obtain first-hand data on interactions with protected resources, contributing to understand the distribution of deep-sea corals and sponges. Moreover, data from the Deep Sea Coral Research and Technology Program (DSCRTP) supports resource management in fisheries and other sectors. NOAA Fisheries assesses and predicts the status of fish stocks, sets catch limits, ensures compliance with fisheries regulations, and reduces bycatch using the MSFCMA as a guide.	https://www.fisheries.noaa.gov/national/science-data/research-surveys https://www.fisheries.noaa.gov/topic/fishery-observers https://www.fisheries.noaa.gov/national/sustainable-fisheries/commercial-fisheries-landings https://www.fisheries.noaa.gov/international/bycatch/national-bycatch-reduction-strategy NOAA (2021) *Deep Sea Coral Research and Technology Program*. 2020 Report to Congress
1.1.3	Are VMS data routinely recorded, stored and assessed and is a bottom fishing footprint available?	Mostly (in progress)	2.5	A VMS program is primarily used to monitor the location and movement of more than 4,000 commercial fishing vessels in the EEZ and treaty areas, focused on enforcement and compliance issues. *Gap: Except for the Northeast region, no available footprint information for other U.S. regions was found.*	https://www.fisheries.noaa.gov/topic/enforcement#vessel-monitoring https://northeastoceandata.org
1.1.4	Does the government departments related to DSF/activities other than fishing have a website?	Fully	3	Most of departments, agencies and RFMCs have good and user-friendly websites. Data portals (e.g. NOAA Deep-Sea Coral & Sponge Data Portal), and online tools to display maps (e.g. Deep-Sea Coral & Sponge Map Portal, Essential Fish Habitat mapper, etc.) are also available.	https://www.fisheries.noaa.gov https://deepseacoraldata.noaa.gov/ https://www.boem.gov https://www.usgs.gov https://www.fisherycouncils.org http://www.habitat.noaa.gov/protection/efh/habitatmapper.html
1.1.5			2.5		See above

	Are reports and other types of information and data on DSF/VMEs/sensitive species and habitats publicly available?	Mostly (in progress)		A wide range of information, reports, papers, data and maps are publicly available from the official websites, data portals and online tools. A variety of reports are routinely published, including reports summarizing the state of deep-sea coral and sponge ecosystems in the U.S. waters. *Gap: Certain type of data/reports are difficult to obtain (e.g. bottom footprint maps).*	https://spo.nmfs.noaa.gov/sites/default/files/OHC4_v2.pdf
1.2 - Description of sensitive species and habitats					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
1.2.1	Are biodiversity indicators available?	Mostly (in progress)	2.5	Abundance and diversity estimates are available for both corals and sponges in several deep-sea areas (e.g. Pacific region: NOAA CAPSTONE project)	https://www.un.org/depts/los/bfw/United-States__2022.pdf https://www.frontiersin.org/articles/10.3389/fmars.2019.00480/full
1.2.2	Has a definition of VME concept or an alternative concept (e.g. sensitive species and habitats) been agreed?	Mostly/Fully	2.5	The VME terminology is not usually used in the U.S. jurisdiction. Generally, the VME concept is mentioned in the context of the fishing activities conducted in international waters (the High Seas Fishing Compliance Act includes requirements to protect VMEs). Sensitive (i.e. vulnerable) benthic habitats within U.S. EEZ (equivalent to VMEs in areas beyond national jurisdiction) are included under the FMPs developed by the RFMCs. *Gaps: Regarding identification of sensitive habitats, there is no criterion similar to the FAO criterion "structural complexity".*	https://www.un.org/depts/los/bfw/United-States__2022.pdf https://www.fisheries.noaa.gov/permit/high-seas-fishing-permits
1.2.3	Are there VME species/VME features lists available?	Mostly/Fully	2.5	A comprehensive list of known deep-sea corals in the U.S. EEZ, specific regional deep-sea coral species lists and an Atlas of Large Submarine Canyons of the U.S. outer continental shelf (including information on the sensitive habitats that they contain) are available. *Gap: No lists of other VME species/VME features was found.*	https://deepseacoraldata.noaa.gov/library/2017-state-of-deep-sea-corals-report https://deepseacoraldata.noaa.gov/library/2020-regional-deep-sea-coral-species-list/ https://www.boem.gov/environment/large-submarine-canyons-atlas
1.2.4	Have VMEs/sensitive species and habitats been identified and described?	Mostly (in progress)	2.5	According to the FMPs developed by the RFMCs, for each federal managed fishery, Essential Fish Habitats (EFH) are identified, described and mapped to define the areas (waters and substrate) necessary for the spawning, breeding, feeding, and growth to maturity of target fish species. FMPs also requires the identification of Habitat Areas of Particular Concern (HAPC), that meet one or more of these criteria: Ecological function, sensitive to human degradation, stressed by development, considered rare. Designating Seamounts, canyons, corals and associated habitats as HAPCs helps identify these areas as important to protect and manage regarding human impacts.	https://static1.squarespace.com/static/511cdc7fe4b00307a2628ac6/t/573a073937013bed07239025/1463421108737/Regional-HAPC-Report_WEB.pdf
1.3 - Assessment of bottom fishing impacts					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
1.3.1	Are bottom fisheries formally assessed?	Mostly (in progress)	2.5	NOAA Fisheries manages ~500 fish stocks (pelagic and bottom fisheries) in federal waters. However, they only have data and resources to assess ~200 stocks each year. Stock assessment prioritization allows NOAA to work with regional partners to decide which stocks are assessed each year. Currently, only one U.S. vessel is authorized to conduct bottom fisheries in NAFO waters (NAFO assess formally their bottom fisheries), and no U.S. vessels are authorized to conduct bottom fisheries in areas beyond national jurisdiction (ABJN) outside of RFMOs.	https://www.fisheries.noaa.gov/stock-assessment-prioritization https://www.st.nmfs.noaa.gov/stocksmart?app=homepage https://www.un.org/depts/los/bfw/United-States__2022.pdf
1.3.2	Has a bottom fishing footprint been defined?	Mostly or partially in progress	2	Detailed maps of bottom fishing footprint for the Northeast region are publicly available. *Gap: No information for other regions or a general fishing footprint map for the U.S. bottom fisheries was found.*	https://northeastoceandata.org

1.3.3	Are routine fishery independent surveys or other relevant surveys conducted to assess impacts?	Mostly/Fully	2.5	A Strategic Plan for Deep-Sea Coral and Sponge Ecosystems was designed with the aim to improve: (i) exploration and research (e.g. locate the ecosystems and understand the extent and degree of impact caused by fishing and other human activities), (ii) conservation and management, and (iii) international cooperation (e.g. increase international research, etc.). In the case of Alaska and the U.S. West coast, the most comprehensive picture of deep-sea coral and sponge presence comes from bycatch in annual scientific trawl surveys conducted by NOAA. Some trawl surveys have now been complemented by towed/drift camera surveys. The DSCRTP complements the federal research program focused on deep ocean exploration (NOAA Ocean Exploration - OER), working closely with the RFMCs and sponsoring field research programs.	https://www.coris.noaa.gov/activities/deepsea_coral/dsc_strategicplan.pdf https://spo.nmfs.noaa.gov/sites/default/files/OHC4_v2.pdf https://oceanexplorer.noaa.gov/about/welcome.html
1.3.4	Are observer programmes implemented?	Fully	3	There are observer programmes implemented by NOAA to collect data from U.S. commercial fishing. Fishery observers are important for deep-sea coral and sponge monitoring, particularly in Alaska and the U.S. West coast (information on coral bycatch in commercial fisheries).	https://www.fisheries.noaa.gov/topic/fishery-observers https://www.fisheries.noaa.gov/resource/map/map-us-observer-program-locations
1.3.5	Are there methods described and conducted for assessing Significant Adverse Impacts on VMEs/sensitive species and habitats?	Fully	3	The approach adopted in the U.S. to address bottom fishing impacts within national jurisdiction, is focused on the identification, designation and protection of sensitive fish habitats, rather than assessing the significant adverse impacts of bottom fisheries on VMEs, as the VME terminology is not usually used in the U.S. jurisdiction (see question 2.2). In this regard, the RFMCs are required to designate EFHs and take steps to minimize the impacts of fishing to the extent practicable. This includes the description of threats from human activities.	https://www.fisheries.noaa.gov/national/habitat-conservation/essential-fish-habitat https://static1.squarespace.com/static/511cdc7fe4b00307a2628ac6/t/573a073937013bed07239025/1463421108737/Regional-HAPC-Report_WEB.pdf http://www.habitat.noaa.gov/protection/efh/habitatmapper.html
1.4 - Mapping of sensitive species and habitats					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
1.4.1	Are routine fishery independent surveys or other relevant surveys to sample VMEs indicators/sensitive species and habitats?	Mostly/Fully	2.5	The National Database for Deep-Sea Corals and Sponges displays known deep-sea coral and sponge locations submitted by researchers located across the U.S. (and internationally). In terms of number of records, the principal sampling method are Remote Operated Vehicles (ROV), following by submersibles and trawls. NOAA fishery surveys (particularly trawl data) and NOAA observers (bycatch data from commercial fisheries) are also important to sample deep-sea coral and sponges, particularly in Alaska and the U.S. West coast. Moreover, the DSCRTP complements the OER, working closely with the RFMCs and sponsoring a variety of field research programs and surveys.	https://deepseacoraldata.noaa.gov/ https://oceanexplorer.noaa.gov/about/welcome.html
1.4.2	Are scientific observer programs implemented to sample VME indicator species?	Mostly (in progress)	2.5	NOAA fishery observers in the commercial groundfish fisheries, particularly in Alaska and the U.S. West coast, collect data on bycatch of deep-sea corals and sponges. *Gap: No information on importance of observer programs for VMEs sampling in other regions was found.*	https://www.fisheries.noaa.gov/topic/fishery-observers
1.4.3	Have habitat suitability models/species distribution models been developed to map VMEs/sensitive species and habitats?	Mostly (in progress)	2.5	Predictive habitat modeling (PHM) methods are used to target areas for field sampling efforts and to help inform RFMCs management actions designed to protect deep-sea coral habitats (boundaries of closed areas, EFHs, and HAPCs). PHM also helped guide BOEM-funded field surveys of canyons in the Mid-Atlantic region. Spatial predictive modeling has been also used in several NOAA collaborative research projects in the Gulf of Mexico, West coast, and Atlantic coast. Predictive habitat suitability models allow some extrapolation of the data stored in the National Database for Deep-Sea Corals and Sponges to unsurveyed areas.	https://spo.nmfs.noaa.gov/sites/default/files/OHC4_v2.pdf https://coastalscience.noaa.gov/project/characterizing-spatial-distributions-of-deep-sea-corals-and-hardbottom-habitats-in-the-u-s-southeast-atlantic/ https://www.ncei.noaa.gov/maps/deep-sea-corals/mapSites.htm.
1.4.4		Fully	3		https://oceanexplorer.noaa.gov/about/welcome.html

	Have the VMEs/sensitive species and habitats been mapped?			The OER is the only U.S. federal program dedicated to exploring the deep ocean. This program mapped and explored a variety of sensitive habitats and features along the U.S. (e.g. canyons, seamounts, coral communities, seeps, vents and volcanoes). The NOAA Deep-Sea Coral Data Portal includes a digital map displaying more than 500,000 records and predictive habitat suitability models (coral and sponges). The NOAA EFH mapper provides an interactive platform for viewing data and spatial boundaries of EHFs and HAPCs (sensitive habitats). The DSCRTP sponsored field research programs (e.g. the Deep-Sea Coral and Sponge Initiatives) in several regions, that have been supplemented by targeted projects to map deep-sea coral distributions. Updated maps of deep-sea coral and sponge by U.S. region are included in the last DSCRTP report.	https://www.ncei.noaa.gov/maps/deep-sea-corals/mapSites.htm. https://www.habitat.noaa.gov/apps/efhmapper/?dlg=dialog_17 https://deepseacoraldata.noaa.gov/browse-studies#b_start=0 NOAA (2021) *Deep Sea Coral Research and Technology Program*. 2020 Report to Congress. Appendices
1.5 - Impact mitigation and protection measures					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
1.5.1	Are there any VME encounter rules/thresholds which the bottom fisheries use?	Mostly or partially in progress	2	The approach adopted in the U.S. to address bottom fishing impacts within national jurisdiction, is focused on the identification, designation and protection of sensitive fish habitats, rather than use of VME encounter rules/thresholds. Regarding ABJN, according to the available information, the U.S. currently has no vessels participating in bottom fisheries managed by other RFMOs than NAFO (NAFO has specific VME encounter rules/thresholds), and no U.S. vessels are authorized to conduct bottom fisheries in ABJN outside of RFMOs. *Gap: No information on VME encounter rules/thresholds regarding domestic bottom fisheries was found.*	https://www.un.org/depts/los/bfw/United-States__2022.pdf
1.5.2	Are there any VME bottom fishery closures or MPA in place?	Mostly (in progress)	2.5	There are several deep-water coral and sponge closures in place (implemented directly through coral-specific FMPs, or indirectly through FMPs for other managed species) and several Habitat Protection Areas (e.g. Seamounts). Deep-sea coral habitats are also protected for its own sake, even if its benefit to managed fish species is not known. In addition, there are other protection mechanisms available to RFMCs, such as federally managed National Marine Sanctuaries, U.S. Fish and Wildlife Refuges, and Marine National Monuments, that can provide protection for deep-sea coral and sponge habitats. Moreover, several federal and state Marine Protected Areas (MPAs), have been established. *Gap: The above-mentioned measures provide important protections. However, some documented vulnerable areas still remain unprotected from bottom fishing impacts and relatively high levels of coral bycatch are reported in certain regions.*	https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=ba469d2d7fef4885b2f9076a2f969dcc https://deepseacoraldata.noaa.gov/ https://sanctuaries.noaa.gov https://marineprotectedareas.noaa.gov/dataanalysis/mpainventory/ Coleman, H., Hourigan, T., Eaton, R.; McGuinnand, R. and Dornback, M. (2020) History of Deep-Sea Coral Protection in U.S. Waters. Deep Sea Coral Research and Technology Program. https://deepseacoraldata.noaa.gov/2020-dsc-report-to-congress/
1.5.3	Are there any BFIAs/ bottom fishery exploratory protocols required?	Mostly or partially in progress	2	The approach adopted in the U.S. to address bottom fishing impacts within national jurisdiction, is focused on the identification, designation and protection of sensitive fish habitats, rather than use of BFIAs/ bottom fishery exploratory protocols. Regarding ABJN, according to the available information, the U.S. currently has no vessels participating in bottom fisheries managed by other RFMOs than NAFO (NAFO has specific bottom fishery exploratory protocols), and no U.S. vessels are authorized to conduct bottom fisheries in ABJN outside of RFMOs. *Gap: No information on BFIAs/bottom fishery exploratory protocols regarding domestic bottom fisheries was found.*	https://www.un.org/depts/los/bfw/United-States__2022.pdf
1.5.4	Are there any bottom gear restrictions/depth	Mostly (in progress)	2.5	There are a range of mitigation and protection measures in place within the different RFMCs regions: Bottom-contact gears are prohibited within HAPCs (e.g. North Pacific region); Depth restrictions were	https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=ba469d2d7fef4885b2f9076a2f969dcc

	restrictions/ freezing of the historical footprint adopted as mitigation and protection measure?			implemented to protect seafloor features (canyons, banks, and seamounts) and to prevent bottom trawling in areas not historically fished (e.g. Pacific region); The trawling footprint was frozen, which limited trawling to areas used recently, and prohibited new areas from being developed (e.g. Bering Sea).	
1.5.5	Are there any VMEs impact mitigation and protection measure adopted regarding activities other than fishing.	Mostly (in progress)	2.5	The NOAA DSCRTP supports resource management not only in fisheries but also in other sectors. As each sector requires knowledge of deep-sea coral locations to mitigate damage to vulnerable habitats, managers in the U.S. have used information from the DSCRTP to make informed decisions about protected area boundaries. NOAA Fisheries and the RCFMs have the ability to provide recommendations to Federal or State agencies concerning proposed human activities that may affect the habitat of a fishery resource under their authority NOAA Fisheries provides information to help the BOEM make informed decisions about offshore wind energy development and operations. Moreover, some RCFMs have developed a series of policies on activities other than fishing (e.g. oil and gas, submarine cables, renewable energy, etc.).	https://www.boem.gov/ https://www.mafmc.org/northeast-offshore-wind;https://www.mafmc.org/actions/offshore-energy
1.6 - Monitoring of VMEs impacts					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
1.6.1	Are VMEs/sensitive species and habitats routinely monitored in bottom fisheries?	Fully	3	In terms of fishery management, EFH must be included in the FMPs. NOAA Fisheries works with RFMCs and uses the best available scientific information to identify, describe, map and monitor EFH. The RFMCs uses this information to pinpoint and protect sensitive habitats. Moreover, every two years, NOAA submits biennial reports to the U.S. Congress summarizing the results of the DSCRTP (e.g. identification, monitoring and protection of deep-sea corals).	https://deepseacoraldata.noaa.gov/2020-dsc-report-to-congress/
1.6.2	Are activities other than fishing considered in the long-term monitoring of VMEs/sensitive species and habitats?	Mostly (in progress)	2.5	The BOEM's Environmental Studies Program develops, funds, and manages scientific research specifically to inform policy decisions on the development of energy and mineral resources on the U.S. Outer Continental Shelf (OCS). BOEM works together with NOAA and other partners on VME research with the aim to collect baseline information on benthic ecosystems to inform and support environmental risk assessments, environmental impact statements, and other decision documents related to the offshore energy and mineral developments. In addition, the MarineCadastre.gov, an integrated marine information system developed by BOEM and NOAA, provides public access to data and tools for marine spatial planning. Data obtained from MarineCadastre.gov allowed the assessment of areas potentially impacted by offshore drilling (e.g. EFH).	https://www.boem.gov/ https://marinecadastre.gov/
1.6.3	Are there any plans for the long-term monitoring of VMEs/sensitive species and habitats (including activities other than fishing)?	Fully	3	The DSCRTP was stablished following the 2006 MSFCMA Reauthorization, which tasked NOAA with submitting, in consultation with the RFMCs, *"biennial reports to Congress and the public on steps taken by the Secretary to identify, monitor, and protect deep sea coral areas, including summaries of the results of mapping, research and data collection performed under the program"*. DSCRTP updated biennial reports were submitted in 2008, 2010, 2012, 2014, 2016, 2018 and 2020. No impediments for the long-term monitoring were found.	NOAA (2008) Report to Congress on the Implementation of the *Deep Sea Coral Research and Technology Program*. https://deepseacoraldata.noaa.gov/sitemap

CASE STUDY 2 – CANADA

2.1 - Data availability and governance frameworks					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
2.1.1	Are there governance frameworks and specific government departments related to DSF/activities other than fishing (research, monitoring, management and enforcement)?	Fully	3	The Fisheries Act and the Oceans Act outline the requirements for sustainable fisheries and marine protected areas respectively. Fisheries and Oceans Canada (DFO) is the federal institution responsible for management of both domestic and international commercial fisheries (including DSF). DFO includes a Science Branch that provides information to the Oceans Management Branch to help fisheries management. DFO enforces the Fisheries Act and other regulations and legislation. The Canadian Coast Guard (CCG) operates under the DFO. DFO also works closely with a number of RFMOs (e.g. NAFO and NPFC). In 2012 the Royal Society of Canada (RSC) assessed the challenges faced in achieving sustainable fisheries. This led to the strengthening of the Fisheries Act to rebuild depleted fisheries and the Oceans Act that outlined the means to create a network of MPAs. The 2002 Canadian Oceans Strategy outlined initiatives encouraging cooperation between different sectors (fisheries, offshore oil and gas, shipping, etc.).	https://www.dfo-mpo.gc.ca/about-notre-sujet/organisation-eng.htm https://www.dfo-mpo.gc.ca/about-notre-sujet/organisation-eng.htm https://www.dfo-mpo.gc.ca/acts-lois/regulations-reglements-eng.htm https://waves-vagues.dfo-mpo.gc.ca/Library/264675.pdf
2.1.2	Are data on catches, landings and bycatch (including VMEs/sensitive species and habitats) routinely collected and assessed?	Fully	3	Fishery dependent data are collected through self-reporting by fishers, at-sea observers, dockside monitoring and at-sea electronic monitoring systems and the requirements for data collection can be found on the DFO site. They are used primarily to conduct stock assessments, provide scientific advice and to track in general the health of Canada's fish stocks. Data are available through the Government Open Data Portal and also through the RFMOs (NAFO and NPFC).	https://www.dfo-mpo.gc.ca/science/publications/index-eng.htm
2.1.3	Are VMS data routinely recorded, stored and assessed and is a bottom fishing footprint available?	Mostly (in progress)	2.5	DFO's National Vessel Monitoring System (VMS) manage the Canadian VMS and store the data and stored in a centralized database. As well as for compliance purposes, VMS data can be used for scientific purposes that support departmental activities as well as aid Canada's participation in RFMOs (e.g. NAFO). *Gap: Bottom footprint maps/fishing effort distribution maps are available only for certain regions (e.g. Maritimes, Scotian Shelf).*	https://www.dfo-mpo.gc.ca/fisheries-peches/sdc-cps/vessel-monitoring-surveillance-navire/index-eng.html https://publications.gc.ca/site/archivee-archived.html?url=https://publications.gc.ca/collections/collection_2019/mpo-dfo/Fs97-6-3293-eng.pdf
2.1.4	Does the government departments related to DSF/activities other than fishing have a website?	Mostly (in progress)	2.5	Most of departments and agencies have websites. Online tools to display maps are also available. *Gap: DFO website/online maps could be more user friendly.*	https://www.dfo-mpo.gc.ca https://open.canada.ca/en/maps https://www.canada.ca/en/impact-assessment-agency.html https://www.cnlopb.ca/
2.1.5	Are reports and other types of information and data on DSF/VMEs/sensitive species and habitats publicly available?	Mostly/Fully	2.5	A wide range of information, reports, papers, data and maps are publicly available from the official websites, including some spatial information of oil and gas activities. Some data are available through Open Data Portals. Science advice is provided through the Canadian Science Advisory Secretariat (CSAS) and published in Science Advisory Reports, Research Documents or Science Responses (e.g. stock status, fishing pressure,	https://www.isdm-gdsi.gc.ca/csas-sccs/applications/Publications/index-eng.asp https://open.canada.ca/data/en/organization/dfo-mpo?res_type=dataset&page=2 https://open.canada.ca/en/open-data?_ga=1.34965857.1546288596.1392327917 https://www.dfo-mpo.gc.ca/science/publications/reports-rapports-eng.html

				ecosystem and environmental conditions, habitat, status, options for management measures, etc.). *Gap: Certain type of data/reports are difficult to obtain (e.g. bottom footprint maps, monitoring of the impacts on VMEs from offshore oil and gas activities/mitigation measures, etc.).*	https://www.dfo-mpo.gc.ca/science/publications/index-eng.htm https://open.canada.ca/en/maps
2.2 - Description of sensitive species and habitats					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
2.2.1	Are biodiversity indicators available?	Mostly (in progress)	2.5	Many studies have provided species richness and diversity estimates of VME taxa in Canadian waters.	DFO. 2010. Occurrence, Susceptibility to Fishing, and Ecological Function of Corals, Sponges, and Hydrothermal Vents in Canadian Waters. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/041; Knudby, A., Lirette, C., Kenchington, E., and Murillo, F.J. 2013. Species Distribution Models of Black Corals, Large Gorgonian Corals, and Sea Pens in the NAFO Regulatory Area. NAFO SCR Doc 13/78, Ser. No N6276. 17 p. Knudby, A., Kenchington, E., and Murillo, F.J. 2013. Modelling the Distribution of Geodia Sponges and Sponge Grounds in the Northwest Atlantic. PLoS One 8, e82306. doi:10.1371/journal.pone.0082306. Kenchington, E., Lirette, C., Cogswell, A., Archambault, D., Archambault, P., Benoît, H., Bernier, D., Brodie, B., Fuller, S., Gilkinson, K., Lévesque, M., Power, D., Siferd, T., Treble, M., and Wareham, V. 2010. Delineating Coral and Sponge Concentrations in the Biogeographic Regions of the East Coast of Canada Using Spatial Analyses. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/041. vi + 202 p. Kenchington, E., Murillo, F.J., Lirette, C., Sacau, M., Koen-Alonso, M., Kenny, A., Ollerhead, N., Wareham, V., and Beazley, L. 2014. Kernel Density Surface Modelling as a Means to Identify Significant Concentrations of Vulnerable Marine Ecosystem Indicators. PLoS ONE 10(1): e0117752. doi:10.1371/journal.pone.0117752. Chu, Jackson W.F., et al. 2019. Modelling the environmental niche space and distributions of cold-water corals and sponges in the Canadian northeast Pacific Ocean. Deep Sea Research Part I: Oceanographic Research Papers151: 103063.
2.2.2	Has a definition of VME concept or an alternative concept (e.g. sensitive species and habitats) been agreed?	Fully	3	No specific definitions for VMEs are provided by DFO, they refer to cold water corals and sponges. Nevertheless, according to DFO, the concepts of Significant Benthic Areas (SiBAs) and VME are equivalent and the functional groups used to define SiBAs and VMEs are also consistent. With respect to cold-water corals and/or sponges, a SiBA is a regional habitat that contains sponges, large and small gorgonians and/or sea pens as a dominant and defining feature. These habitats are structurally complex, characterized by higher diversities and/or different benthic communities, and provide a platform for ecosystem functions/processes closely linked to these characteristics.	DFO. 2017. Guidance on the level of protection of significant areas of coldwater corals and sponge-dominated communities in Newfoundland and Labrador waters. DFO Can. Sci. Advis. Sec. Sci. Resp. 2017/030. DFO. 2017. Delineation of Significant Areas of Coldwater Corals and Sponge-Dominated Communities in Canada's Atlantic and Eastern Arctic Marine Waters and their Overlap with Fishing Activity. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2017/007.
2.2.3	Are there VME species/VME features lists available?	Mostly or partially in progress	2	Canada does not recognize VMEs as such within its waters but instead cold-water corals and sponges. *Gap: Lists of corals and sponges are available, but no specific lists of VME species/VME features were found.*	

2.2.4	Have VMEs/sensitive species and habitats been identified and described?	Mostly (in progress)	2.5	Different types of VMEs were identified in Canadian waters as well as in the RFMOs which operate DSFs in waters to the east and west of Canada (NAFO and NPFC).	
2.3 - Assessment of bottom fishing impacts					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
2.3.1	Are bottom fisheries formally assessed?	Mostly (in progress)	2.5	DFO is responsible for fisheries science and fisheries management in Canada. Fisheries management decisions are informed using the Data to Decision process which is made up of four steps: Data collection, Stock assessment, Science advice, and management decisions.	https://www.isdm-gdsi.gc.ca/csas-sccs/applications/Publications/index-eng.asp https://www.dfo-mpo.gc.ca/science/species-especes/fisheries-halieutiques/about-sur/index-eng.html
2.3.2	Has a bottom fishing footprint been defined?	Mostly or partially in progress	2	Detailed maps of bottom fishing footprint/maps of fishing effort distribution for some regions (e.g. Maritimes, Scotian Shelf) are publicly available. *Gap: No information for other regions or a general fishing footprint map for the Canadian bottom fisheries was found.*	-
2.3.3	Are routine fishery independent surveys or other relevant surveys conducted to assess impacts?	Mostly (in progress)	2.5	In the eastern coast of Canada, annual research vessel trawl surveys provided distribution and diversity data to underpin the Coral and Sponge Conservation Strategy . Trawl data was used to delineate concentrations of sea pens, gorgonian corals and sponges applying the NAFO methodology as well as to predict VMEs distributions. Moreover, there successful examples about international collaboration between Canada and NAFO contracting parties to address the study and protection of VMEs within the NAFO Regulatory Area (e.g. collection of ecosystem data through the NEREIDA programme lead by Spain with contribution from Canada, UK and Russia).	DFO, 2015. Coral & Sponge Conservation Strategy for Eastern Canada 2015. https://www.dfo-mpo.gc.ca/oceans/publications/cs-ce/index-eng.html, Accessed 10th Jun 2019. https://www.nafo.int/About-us/International-Cooperation
2.3.4	Are observer programmes implemented?	Fully	3	The At-Sea Observer Program provides independent third-party verification of fish harvesting activities. Observers are assigned to fishing vessels operating in the offshore, inshore and near-shore areas.	
2.3.5	Are there methods described and conducted for assessing Significant Adverse Impacts on VMEs/sensitive species and habitats?	Fully	3	An Ecological Risk Assessment Framework (ERAF) for corals and sponges was developed by the DFO, under the Sensitive Benthic Areas (SeBAs) policy. This is a process for identifying both the level of risk associated with fishing activity and the actual impacts of different types of fishing activity. It provides guidance on how to conduct a risk assessment for sponges and corals based on determining the risk on exposure to fishing. This is then used to provide management advice to avoid Serious or Irreversible Harm (SIH) to cold water coral and sponge communities. The notion of SIH used by DFO is analogous to Significant Adverse Impact (SAI).	DFO, 2013. Ecological risk assessment framework (ERAF) for cold-water corals and sponge dominated communities. Sustainable Fisheries Framework (SFF): Policy to manage the impacts of fishing on Sensitive Benthic Areas.
2.4 - Mapping of sensitive species and habitats					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
2.4.1	Are routine fishery independent surveys or other relevant surveys to sample VMEs indicators/sensitive species and habitats?	Mostly (in progress)	2.5	Data on corals and sponges in Eastern Canada has primarily been collected opportunistically from three main data sources: (i) annual DFO multispecies research vessel surveys; (ii) fisheries observer data, collected onboard commercial fishing vessels operating within Canadian waters; and the northern shrimp survey (DFO and industry collaboration).Non-intrusive data techniques are also employed including multibeam sonar, video footage and drop cameras, acoustic sub-bottom profiling and dedicated ROV deployments.	https://www.dfo-mpo.gc.ca/oceans/publications/cs-ce/index-eng.html DFO, 2015. Coral & Sponge Conservation Strategy for Eastern Canada 2015. https://www.dfo-mpo.gc.ca/oceans/publications/cs-ce/index-eng.html, Accessed 10th Jun 2019. Baker, K.D., Wareham, V.E., Snelgrove, P.V.R., Haedrick, R.l., Fifield, D.A., Edinger, E.N., and Gilkinson, K.D. 2012. Distributional patterns of deep sea coral

					assemblages in three submarine canyons off Newfoundland, Canada. Marine Ecology Progress Series, 445: 235-249.
2.4.2	Are scientific observer programs implemented to sample VME indicator species?	Mostly (in progress)	2.5	Canada operates an at sea observer programme funded through the industry who since 2013 have assumed the full costs of the programme. Observers monitor fishing activities, collect scientific data and monitor industry compliance. They do not specifically collect VME data, except when operating within an RFMO, but will collect data on benthic bycatch.	
2.4.3	Have habitat suitability models/species distribution models been developed to map VMEs/sensitive species and habitats?	Mostly (in progress)	2.5	Some studies have developed predictive modelling tools to map VMEs.	Knudby, A., Lirette, C., Kenchington, E., and Murillo, F.J. 2013. Species Distribution Models of Black Corals, Large Gorgonian Corals, and Sea Pens in the NAFO Regulatory Area. NAFO SCR Doc 13/78, Ser. No N6276. 17 p. Chu, Jackson W.F., et al. 2019. Modelling the environmental niche space and distributions of cold-water corals and sponges in the Canadian northeast Pacific Ocean. Deep Sea Research Part I: Oceanographic Research Papers151: 103063. Kenchington, E., Beazley, L., Lirette, C., Murillo, F.J., Guijarro, J., Wareham, V., Gilkinson, K., Koen-Alonso, M., Benoît, H., Bourdages, H., Sainte-Marie, B., Treble, M. & Siferd, T. (2016) Delineation of coral and sponge significant benthic areas in eastern Canada using kernel density analyses and species distribution models. Canadian Science Advisory Secretariat. Research Document 2016/093. Available at: https://waves-vagues.dfo-mpo.gc.ca/Library/40577806.pdf. DFO. 2010. Occurrence, Susceptibility to Fishing, and Ecological Function of Corals, Sponges, and Hydrothermal Vents in Canadian Waters. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/041.
2.4.4	Have the VMEs/sensitive species and habitats been mapped?	Mostly (in progress)	2.5	DFO, in collaboration with university, NGO and industry partners began collecting information on corals and sponges in 1998 to map out their distributions in the Maritimes (four-year research plan 2000-2003, funded by the Environmental Research Fund).Maps of the location of significant concentrations of corals and sponges on the east coast of Canada , were produced by the DFO through quantitative analyses of research vessel trawl survey data, supplemented with other data sources where available. Sponge reef areas of the Pacific Region are available, derived from sponge data mapped by Natural Resources Canada (NRCan) and DFO.	https://www.dfo-mpo.gc.ca/csas-sccs/Publications/ResDocs-DocRech/2016/2016_093-eng.html https://open.canada.ca/data/en/dataset/8ba7bced-b63f-462a-a8a1-7c7c8a7bcfa4 https://waves-vagues.dfo-mpo.gc.ca/Library/40577806.pdf.
2.5 - Impact mitigation and protection measures					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
2.5.1	Are there any VME encounter rules/thresholds which the bottom fisheries use?	Mostly or partially in progress	2	Encounter thresholds and move-on rules were voluntarily adopted in two domestic fisheries for compliance with MSC certification. VME encounter rules are in place in the NAFO and NPFC areas. In addition, encounter thresholds and move-on rules were voluntarily adopted in two domestic fisheries for compliance with MSC certification.	Walmsley, S., Pack, K., Roberts, C., and Blyth-Skyrme, R. (2021). Vulnerable Marine Ecosystems and Fishery Move-on-Rules - Best Practice Review. Published by the Marine Stewardship Council [www.msc.org]. 134 pp
2.5.2			2	There are 34 marine refuges in place and 18 MPAs within the Canadian EEZ. DFO have a policy in place for identifying and managing the impacts from fishing on SeBAs. *Gap:*	https://www.dfo-mpo.gc.ca/oceans/oecm-amcepz/refuges/index-eng.html https://www.dfo-mpo.gc.ca/oceans/conservation/areas-zones/index-eng.html

	Are there any VME bottom fishery closures or MPA in place?	Mostly or partially in progress		*With the exception of Vazella pourtalesi in a small area of the Scotian shelf, sponges are not currently protected by Canadian closures within NAFO Divisions 3LNO. This means a lower level of protection in domestic waters, compared to the greater protection that exists in international waters (NAFO Regulatory Area).*	DFO, 2019. Evaluation of Existing Frameworks and Recommendations for Identifying Significant Benthic Areas in the Pacific Region. DFO Can. Sci. Advis. Sec. Sci. Resp. 2019/028 NAFO WG-ESA 2022
2.5.3	Are there any BFIAs/ bottom fishery exploratory protocols required?	Mostly (in progress)	2.5	Within the Canadian EEZ exploratory fisheries are managed through the Emerging Fisheries Policy developed in 1996. This lays out the requirements that must be met and the procedures that should be followed for any new fishery and applies to all new fisheries undertaken in marine or freshwater areas.	DFO, 2001. New Emerging Fisheries Policy. https://www.dfo-mpo.gc.ca/reports-rapports/regs/efp-pnp-eng.htm
2.5.4	Are there any bottom gear restrictions/depth restrictions/ freezing of the historical footprint adopted as mitigation and protection measure?	Mostly (in progress)	2.5	Gear restrictions or modifications are recommended as part of the ERAF process, where the risk is considered Moderate or High	DFO, 2013. Ecological risk assessment framework (ERAF) for cold-water corals and sponge dominated communities. Sustainable Fisheries Framework (SFF): Policy to manage the impacts of fishing on Sensitive Benthic Areas.
2.5.5	Are there any VMEs impact mitigation and protection measure adopted regarding activities other than fishing.	Mostly or partially in progress	2	The offshore drilling industry is subject to impact assessments, all proposed works are evaluated by the Fish and Habitat Protection Program (FFHPP) of the DFO. *Gap: It is worth to note that there are offshore oil and gas activities (regulated by Canada), which appear to have significant spatial overlap with NAFO bottom fisheries, NAFO closures and VMEs, and have the potential to impact fisheries resources and the ecosystems. These activities have increased in recent years, including drilling activities on closed areas established by NAFO to protect VMEs.*	NAFO, 2022. Report of the Scientific Council Meeting. 03 -16 June 2022 Halifax, Nova Scotia, Canada. NAFO SCS Doc. 22/18. Serial No. N7322. Northwest Atlantic Fisheries Organization. 241 pp.
2.6 - Monitoring of VMEs impacts					
Questions					
2.6.1	Are VMEs/sensitive species and habitats routinely monitored in bottom fisheries?	Fully	3	Monitoring of VMEs (SiBAs) is ongoing and with regards to fisheries the impacts are monitored through the ERAF process. Remote monitoring tools are used for monitoring deep sea hydrothermal vents. Other information from visual surveys have been used to gather information on seamounts off eastern Canada. Data are also available in some areas from trawl surveys. Within the RFMOs (NAFO and NPFC) data on VME are routinely collected by research vessels/observers.	
2.6.2	Are activities other than fishing considered in the long-term monitoring of VMEs/sensitive species and habitats?	Mostly or partially in progress	2	There are currently measures in place related to exploratory drilling programs in the Newfoundland and Labrador region. *Gap: Information on the assessment of the potential impacts of oil and gas activities in the high seas (e.g. NAFO Area), monitoring and mitigation measures is scarce or difficult to obtain.*	NAFO, 2022. Report of the Scientific Council Meeting. 03 -16 June 2022 Halifax, Nova Scotia, Canada. NAFO SCS Doc. 22/18. Serial No. N7322. Northwest Atlantic Fisheries Organization. 241 pp.

2.6.3	Are there any plans for the long-term monitoring of VMEs/sensitive species and habitats (including activities other than fishing)?	Mostly (in progress)	2.5	There is a monitoring program in place for all the 14 designating MPAs with fisheries independent surveys being conducted on a regular basis. Monitoring of VMEs (SiBAs) is ongoing through the ERAF process. NAFO has a plan to monitor VMEs using data from groundfish surveys. *Gap: Information on monitoring plans of impacts on VMEs from offshore oil and gas activities is scarce or difficult to obtain, particularly in the high seas (e.g. NAFO Area).*	NAFO, 2022. Report of the Scientific Council Meeting. 03 -16 June 2022 Halifax, Nova Scotia, Canada. NAFO SCS Doc. 22/18. Serial No. N7322. Northwest Atlantic Fisheries Organization. 241 pp.

CASE STUDY 3 – ARGENTINA

3.1 - Data availability and governance frameworks					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
3.1.1	Are there governance frameworks and specific government departments related to DSF/activities other than fishing (research, monitoring, management and enforcement)?	Fully	3	The Federal Fisheries Law establishes the Undersecretariat of Fisheries and Aquaculture under the Ministry of Agriculture, Livestock and Fisheries (MAGYP) as the competent body for the application of the LFP and creates the Federal Fisheries Council (CFP) to regulate fishing activity based on the conservation of resources, sustainable fishing and the ecosystem protection. The LFP covers research, conservation and management and a fishing regime. The Provinces have jurisdiction in the territorial sea adjacent to their coasts up to 12 nm, while the remaining areas within the EEZ are under federal jurisdiction. The CFP is advised by technical committees for the different fisheries, with the participation of the National Institute for Fisheries Research and Development (INIDEP) and the provinces. INIDEP, is a decentralized state agency in charge of fisheries resources rational exploitation, analyzing environmental and economic factors and of developing new technologies. Argentina has ratified several international treaties related to the conservation and sustainable use of benthic marine resources. In addition, the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET) is the main organization dedicated to the promotion of marine research. Regarding activities other than fishing, the competent environmental authorities are the Ministry of Environment and Sustainable Development, responsible for processing the Environmental Assessment and issuing the Environmental Impact Statements of the oil and gas projects, and the Secretariat of Energy, in charge of controlling and supervising compliance with the Environmental Impact Statement and its corresponding Environmental Management Plan. The "Pampa azul" is an interministerial initiative that articulates scientific research, technological development and innovation actions to provide scientific bases for national ocean policies (e.g. strengthening of national sovereignty over the sea, strengthening of sea industries, economic development of maritime regions, conservation, sustainability and MPAs).	https://cfp.gob.ar/wp-content/uploads/2017/09/LeyPesca.pdf https://www.argentina.gob.ar/inidep www.conicet.gov.ar Gaitán, E. (2020). Legislación e instrumentos de manejo existentes para la protección de los fondos marinos en la plataforma Continental Argentina. *Marine and Fishery Sciences*, 33(2): 247-263. doi: 10.47193/mafis.3322020301104.
3.1.2	Are data on catches, landings and bycatch (including VMEs/sensitive species and habitats) routinely collected and assessed?	Mostly (in progress)	2.5	The LFP establishes as primary sources of information for the administration of fishery resources, the landing declarations (fishing reports), the landing reports (drawn up by an inspector on the quay) and the satellite monitoring of the fleet. Research surveys are the most important source of information available to INIDEP for advising on the sustainability of fishery resources and obtaining data on the abundance of target species, size structure, reproductive status and bycatch. With regards to the high seas, Spain (IEO), under the ATLANTIS project, conducted a series of surveys (between	https://www.inidep.edu.ar/images/adjuntos/memoria2020-comprimido.pdf http://www.ieo.es/documents/10640/31690/Temas+de+Oceanograf%C3%ADa+06+-.pdf/9f7d8404-4682-498d-b0a7-1ab4c2357aa0

				2007-2010) to identify VMEs and possible interactions with fisheries in international waters in the Southwest Atlantic. Positions of all organisms considered vulnerable were mapped. *Gap: No information on importance of benthic invertebrate data in other fisheries than scallops and prawn was found.*	Portela, J., Acosta, J., Cristobo, J., Muñoz, A., Parra, S., Ibarrola, T., Del Río, J.L., Vilela, R., Ríos, P., Blanco, R., Almón, B., Tel, E., Besada, V., Viñas, L., Polonio, V., Barba, M. & Marín, P. 2012. Management Strategies to Limit the Impact of Bottom Trawling on VMEs in the High Seas of the SW Atlantic. En: Cruzado, A. (Ed.). Marine Ecosystem. InTech: 199-228.
3.1.3	Are VMS data routinely recorded, stored and assessed and is a bottom fishing footprint available?	Mostly (in progress)	2.5	VMS has been in force since 2005 to date. The fishing vessel positioning system obliges all fishing vessels, with the exception of the artisanal fleet. The VMS allows the position of the various vessels, their course and speed of displacement to be known. The shipowner is obliged to contract a satellite communication service that allows the SSPyA, the Argentine Naval Prefecture, the Argentine Navy, the INIDEP and the provinces with a maritime coastline to access the data. The VMS System makes it possible to visualise the position of fishing vessels operating in real time, classified by fishing gear, through the website of the Ministry of Agriculture, Livestock and Fisheries. The VMS has been used mainly for control and surveillance. It is now also used to map (i) the landings of the various fleets and (ii) the activity in the areas available for oil exploration. *Gap: A general map of the Argentine historic fishery footprint was not found. There is very little information on fishing effort in the high seas of the Patagonian Shelf.*	https://www.argentina.gob.ar/normativa/nacional/disposici%C3%B3n-2-2003-87371 https://www.magyp.gob.ar/sitio/areas/pesca_maritima/monitoreo/ https://www.magyp.gob.ar/sitio/areas/pesca_maritima/informes/pesquerias/index.php
3.1.4	Does the government departments related to DSF/activities other than fishing have a website?	Mostly (in progress)	2.5	MAGYP, CFP, INIDEP and CONICET have websites regarding fisheries and marine research. In addition, there are some institutional repositories (e.g. INIDEP, CONICET) as well as public online tools to display maps (e.g. Ministry of Economy website: location of offshore oil and gas activities; Ministry of Agriculture, Livestock and Fisheries website: Maps of fishing activity). *Gap: Websites/online maps could be more user friendly.*	https://cfp.gob.a https://www.argentina.gob.ar/inidep www.conicet.gov.ar https://www.argentina.gob.ar/economia/energia/hidrocarburos/mapas-del-sector-de-hidrocarburos https://www.magyp.gob.ar/sitio/areas/pesca_maritima/monitoreo/
3.1.5	Are reports and other types of information and data on DSF/VMEs/sensitive species and habitats publicly available?	Partially in progress	2	From 2022 onwards, INIDEP started to publish survey reports, official technical reports, research reports, etc. on its website. These are assessment reports with abundance estimates, population dynamics, status of the fisheries as well as analyses of the different fisheries. Moreover, there are reports regarding Benthic communities in regions of fishing interest in Argentina. Current INIDEP publications comprise two periodical series: Marine and Fishery Sciences and INIDEP Technical Report. CONICET website offers an institutional repository on marine research (e.g. oceanography marine geology and marine biodiversity). Some information and maps (including spatial information on fishing activities and offshore oil and gas activities) are publicly available from official website/online tools. *Gap: A general map of the Argentine historic fishery footprint was not found; Specific data and information on the assessment of the potential impacts of oil and gas activities on fisheries and ecosystems as well as mitigation measures are difficult to obtain; Specific data on VMEs is scarce or difficult to obtain.*	https://www.inidep.edu.ar/solicitud-de-informes-catalogo.html https://ri.conicet.gov.ar/discover?filtertype=subjectClassification&filter_relational_operator=authority&filter=178 https://www.argentina.gob.ar/economia/energia/exploracion-costa-afuera

3.2 - Description of sensitive species and habitats					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
3.2.1	Are biodiversity indicators available?	No evidence	0	No available information was found.	
3.2.2	Has a definition of VME concept or an alternative concept (e.g. sensitive species and habitats) been agreed?	Partially in progress	2	According to a INIDEP report (Allega *et al.*, 2020), certain groups of benthic invertebrates (e.g. sponges, cnidarians, tunicates, brachiopods) are called indicator taxa (IT) and stand out for their ecological role and susceptibility to natural or anthropogenic changes. When biomasses greater than 10 kg 1,200 m-2 are detected in these groups, the habitats are included in the so-called VMEs. *Gap: No other specific definition of VME concept was found.*	Allega, L., Braverman, M.S., Cabreira, A.G., Campodónico, S., Colonello, J.H. *et al.* (2020) Estado del conocimiento biológico pesquero de los principales recursos vivos y su ambiente, con relación a la exploración hidrocarburífera en la Zona Económica Exclusiva Argentina y adyacencias. Mar del Plata Instituto Nacional de Investigación y Desarrollo INIDEP. 119p.
3.2.3	Are there VME species/VME features lists available?	Partially in progress	2	Inventories of benthic species, including corals and sponges, are available for several areas. *Gap: No specific lists of VME indicator species/features were found.*	
3.2.4	Have VMEs/sensitive species and habitats been identified and described?	Mostly (in progress)	2.5	In the Patagonian shelf, cnidarians and sponges were identified. Both the outer continental margin and the continental slope contain deep submarine canyons with presence of VMEs. The inventory of benthic species in several MPAs is available. The map of corals recorded on the Argentine continental shelf indicating the regions where high densities have been recorded (corresponding to VMEs) is available in Allega et al. (2020). VMEs were identified in the high seas (up to 1500 m deep) based on surveys carried out by Spain. In addition, in the Antarctic area VMEs were identified based on Argentinean research surveys.	Allega, L., Braverman, M.S., Cabreira, A.G., Campodónico, S., Colonello, J.H. et al. (2020) Estado del conocimiento biológico pesquero de los principales recursos vivos y su ambiente, con relación a la exploración hidrocarburífera en la Zona Económica Exclusiva Argentina y adyacencias. Mar del Plata Instituto Nacional de Investigación y Desarrollo INIDEP. 119p. del Rio, J.; Acosta, J.; Cristobo, J.; Portela, J.; Al, E. Estudio de Los Ecosistemas Marinos Vulnerables en Aguas Internacionales del Atlántico Sudoccidental; Instituto Español de Oceanografía: Madrid, Spain, 2012
3.3 - Assessment of bottom fishing impacts					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
3.3.1	Are bottom fisheries formally assessed?	Mostly (in progress)	2.5	The Fish Fisheries and Invertebrate Fisheries and Marine Environment Directorates (INIDEP) are responsible for carrying out research activities on the main fishery resources related to demersal fisheries, pelagic fisheries and marine invertebrates. One of the objectives of this activities is to establish annually the potential of the fishery resources of the Argentinean Sea and to generate the scientific, technical and economic bases advisable for their exploitation and sustainable management; all these objectives will apply to common hake, shrimp, Argentinean squid, Patagonian toothfish, Patagonian toothfish, Patagonian toothfish, Patagonian toothfish, corvina, whiting, sea bream, cartilaginous fish (sharks and rays), anchovy, mackerel, scallops and spider crab.	https://www.argentina.gob.ar/inidep/investigacion-cientifica
3.3.2	Has a bottom fishing footprint been defined?	Partially in progress	2	VMS has been used primarily for control and surveillance. It is now also used for mapping (i) fleet landings and (ii) fishing activity in oil exploration areas. VMS System makes it possible to visualise a map with the positions of fishing vessels operating in	del Rio, J.; Acosta, J.; Cristobo, J.; Portela, J.; Al, E. Estudio de Los Ecosistemas Marinos Vulnerables en Aguas Internacionales del Atlántico Sudoccidental; Instituto Español de Oceanografía: Madrid, Spain, 2012

				real time, classified by fishing gear, through the website of the Ministry of Agriculture, Livestock and Fisheries (graphical representation of the status of fishing vessels reporting to the Argentine VMS System). In addition, the Spanish fishery footprint on the high seas of the SW Atlantic is available (Observers data: 1989-2010). *Gap: A general map of the Argentine historic fishery footprint was not found. Available information about fishing fleets operating in the high seas is scarce and with very limited access (the principal source of information comes mainly from the data provided by the Spanish fleet).*	https://www.magyp.gob.ar/sitio/areas/pesca_maritima/monitoreo/
3.3.3	Are routine fishery independent surveys or other relevant surveys conducted to assess impacts?	Partially in progress	2	INIDEP carried out research surveys for advising on the sustainability of fishery resources and obtaining data on bycatch. Information on Antarctic benthic organisms was obtained from research surveys jointly organized by INIDEP and the Argentine Antarctic Institute. Information on oceanographic surveys carried out by Argentina since 2013 are available from the Pampa Azul website. Spain carried out a series of surveys within the Argentine continental slope up to 1500 m depth to identify VMEs in international waters.	Schejter, l., Rimondino, C., Chiesa, I., Díaz de Astarloa, J.M., Doti, B., Elías, R., Escolar, M., Genzano, G., López-Gappa, J., Tatián, M., Zelaya, D.G., Cristobo, J., Pérez, C.D., Cordeiro, R.T. & Bremec, C.S. 2016 a. Namuncurá MPA: an oceanic hot spot of benthic biodiversity at Burdwood bank, Argentina. Pol. Biol., 39: 2373-2386. Schejter, L., Escolar, M., Marecos, A. & Bremec, C. 2014. Asociaciones faunísticas en las unidades de manejo del recurso “vieira patagónica” en el frente de talud durante el período 1998-2009. Inf. Invest. INIDEP Nº 13/2014, 29 pp. del Rio, J.; Acosta, J.; Cristobo, J.; Portela, J.; Al, E. Estudio de Los Ecosistemas Marinos Vulnerables en Aguas Internacionales del Atlántico Sudoccidental; Instituto Español de Oceanografía: Madrid, Spain, 2012 www.conicet.gov.ar https://www.argentina.gob.ar/inidep
3.3.4	Are observer programmes implemented?	Fully	3	The National Programme of Observers on board the commercial fleet has the general objective of covering the activity of fishing vessels, in order to obtain information and biological data on target species, discards and bycatch of chondrichthyans, seabirds and marine mammals. Some observer programmes (e.g. scallop and prawn fisheries) also sampled benthic fauna.	https://www.argentina.gob.ar/inidep/Programa-Adquisici%C3%B3n-de-Informaci%C3%B3n-Biol%C3%B3gico-Pesquera-y-Ambiental
3.3.5	Are there methods described and conducted for assessing Significant Adverse Impacts on VMEs/sensitive species and habitats?	No evidence	0	No available information was found.	-
3.4 - Mapping of sensitive species and habitats					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
3.4.1	Are routine fishery independent surveys or other relevant surveys to sample VMEs indicators/sensitive species and habitats?	Mostly (in progress)	2.5	INIDEP carried out routine research surveys (e.g. scallop assessment surveys) wich include the sampling of benthic communities. Information on Antarctic benthic organisms was obtained from research surveys jointly organized by INIDEP and the Argentine Antarctic Institute. During the Antarctic campaigns onducted aboard the CONICET research vessel, studies of the benthic community were conducted. Spain	https://www.argentina.gob.ar/inidep www.conicet.gov.ar

				carried out a series of surveys within the Argentine continental slope up to 1500 m depth to identify VMEs in international waters.	
3.4.2	Are scientific observer programs implemented to sample VME indicator species?	Partially in progress	2.5	Some observer programmes (e.g. scallop and prawn fisheries) sampled benthic fauna. *Gap: No information on importance of observer programs for VMEs sampling in other fisheries was found.*	Escolar M., Diez, M., Hernández, D., Marecos, Á., Campodónico, S., Bremec, C. (2009). Captura incidental de invertebrados en bancos de pesca de vieira patagónica: un caso de estudio con datos obtenidos por el Programa Observadores a Bordo. Revista de biología marina y oceanografía. 44. 369-377.
3.4.3	Have habitat suitability models/species distribution models been developed to map VMEs/sensitive species and habitats?	No evidence	0	No available information was found.	
3.4.4	Have the VMEs/sensitive species and habitats been mapped?	Partially in progress	2	The map of corals recorded on the Argentine continental shelf indicating the regions where high densities have been recorded (corresponding to VMEs) is available in Allega *et al.* (2020). In addition, the map of VMEs identified in the high seas (up to 1500 m deep) is available based on surveys carried out by Spain. *Gap: Regarding EEZ, no maps of other VMEs than corals were found.*	del Rio, J.; Acosta, J.; Cristobo, J.; Portela, J.; Al, E. Estudio de Los Ecosistemas Marinos Vulnerables en Aguas Internacionales del Atlántico Sudoccidental; Instituto Español de Oceanografía: Madrid, Spain, 2012 del Rio, J.; Acosta, J.; Cristobo, J.; Portela, J.; Al, E. Estudio de Los Ecosistemas Marinos Vulnerables en Aguas Internacionales del Atlántico Sudoccidental; Instituto Español de Oceanografía: Madrid, Spain, 2012
3.5 - Impact mitigation and protection measures					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
3.5.1	Are there any VME encounter rules/thresholds which the bottom fisheries use?	No evidence	0	No available information was found.	
3.5.2	Are there any VME bottom fishery closures or MPA in place?	Mostly (in progress)	2.5	Within the EZZ, there are closed areas, restricted effort areas with partial protection, and several MPAs. The closed areas are conceptually assimilable to MPAs, and should therefore be considered within the framework of Argentina's Marine Protected Areas System (148,000 km2, or a total of 42% of the areas under the control of Argentina). A Bill on the implementation of a strict Benthic MPA in the high seas is currently in discussion ("Agujero Azul Benthic MPA"). This MPA will not affect the water column.	Gaitán, E. (2020). Legislación e instrumentos de manejo existentes para la protección de los fondos marinos en la plataforma Continental Argentina. Marine and Fishery Sciences, 33(2): 247-263. doi: 10.47193/mafis.3322020301104.
3.5.3	Are there any BFIAs/ bottom fishery exploratory protocols required?	No evidence	0	No available information was found.	-
3.5.4	Are there any bottom gear restrictions/depth	Mostly (in progress)	2.5	There are several bottom gear restrictions/depth restrictions/season restrictions. The main purpose of these measures is to protect juvenile and spawning fish.	https://www.argentina.gob.ar/inidep/areas-de-veda

	restrictions/ freezing of the historical footprint adopted as mitigation and protection measure?				
3.5.5	Are there any VMEs impact mitigation and protection measure adopted regarding activities other than fishing.	Partially in progress	2	The competent environmental authorities are the Ministry of Environment and Sustainable Development, responsible for processing the Environmental Assessment and issuing the Environmental Impact Statements of the oil and gas projects, and the Secretariat of Energy, in charge of controlling and supervising compliance with the Environmental Impact Statement and its corresponding Environmental Management Plan. *Gap: No available information on impact mitigation and protection measure adopted was found.*	https://www.argentina.gob.ar/economia/energia/exploracion-costa-afuera/turismo-ambiente-y-pesca
3.6 - Monitoring of VMEs impacts					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
3.6.1	Are VMEs/sensitive species and habitats routinely monitored in bottom fisheries?	Partially in progress	2	Some observer programmes (e.g. scallop commercial fishery) and research surveys (e.g. scallop assessments surveys) routinely sampled benthic fauna. *Gap: Information on routine monitoring of VMEs was only found for certain fisheries/areas.*	Escolar M., Diez, M., Hernández, D., Marecos, Á., Campodónico, S., Bremec, C. (2009). Captura incidental de invertebrados en bancos de pesca de vieira patagónica: un caso de estudio con datos obtenidos por el Programa Observadores a Bordo. Revista de biología marina y oceanografía. 44. 369-377.
3.6.2	Are activities other than fishing considered in the long-term monitoring of VMEs/sensitive species and habitats?	Partially in progress	2	The competent environmental authorities are the Ministry of Environment and Sustainable Development, responsible for processing the *Environmental Assessment* and issuing the *Environmental Impact Statements* of the oil and gas projects, and the Secretariat of Energy, in charge of controlling and supervising compliance with the *Environmental Impact Statement* and its corresponding *Environmental Management Plan*. In 50 years of oil and gas activity there has been no proven report of damage to marine fauna, nor any spill that has generated irreparable damage to the coasts. *Gap: No available information on long term monitoring of VMEs was found.*	https://www.argentina.gob.ar/economia/energia/exploracion-costa-afuera/turismo-ambiente-y-pesca
3.6.3	Are there any plans for the long-term monitoring of VMEs/sensitive species and habitats (including activities other than fishing)?	Partially in progress	2	Some observer programmes (e.g. scallop commercial fishery) and research surveys (e.g. scallop assessments surveys) routinely sampled benthic fauna. The recent "Pampa Azul" Initiative has several objectives related to long-term monitoring of benthic communities: (i) Characterize and evaluate the conservation status of biodiversity and ecosystems in priority geographic areas; (ii) Identify and characterize the distribution of VMEs in the Argentinean Sea; (iii) Identify those habitats essential for the life cycles of species of priority conservation interest; and (iv) Design a national system of indicators for monitoring biodiversity and socio-ecological systems. *Gap: No information on importance of VMEs monitoring in other fisheries /areas were found.*	https://www.argentina.gob.ar/inidep/Programa-Adquisici%C3%B3n-de-Informaci%C3%B3n-Biol%C3%B3gico-Pesquera-y-Ambiental https://www.pampazul.gob.ar/redes-de-observacion/

CASE STUDY 4 – AUSTRALIA

4.1 - Data availability and governance frameworks					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
4.1.1	Are there governance frameworks and specific government departments related to DSF/activities other than fishing (research, monitoring, management and enforcement)?	Fully	3	The Australian Fisheries Management Authority (AFMA) is the Australian Government agency responsible for the efficient and sustainable management of Commonwealth fish resources on behalf of the Australian community. It was established as a statutory authority in 1992 and is governed by the Fisheries Administration Act 1991 to manage Australia's Commonwealth fisheries and apply the provisions of the Fisheries Management Act 1991 (Fisheries Management Act). AFMA comprises the AFMA Commission (the Commission), the Chief Executive Officer (CEO), and 152 staff.	https://www.afma.gov.au/
4.1.2	Are data on catches, landings and bycatch (including VMEs/sensitive species and habitats) routinely collected and assessed?	Mostly/Fully	2.5	Ecological risk assessments and regular reporting is mandatory for Australian Commonwealth Fisheries. Every year a Fishery status report is published summarizing the performance of approximately 22 fisheries, covering 96 stocks, on their biological, economic and environmental status. Ecological risk assessments are conducted to inform AFMA using an ecological risk management (ERM) framework. Since 2018, fisheries are now obliged to report how they will address any impacts identified in risk assessment, particularly if this includes any impacts towards commercial, bycatch and threatened, endangered and protected species.	https://www.agriculture.gov.au/abares/research-topics/fisheries/fishery-status
4.1.3	Are VMS data routinely recorded, stored and assessed and is a bottom fishing footprint available?	Mostly or partially in progress	2	Australian high-seas fishing permits require the implementation of vessel monitoring systems (VMS), as well as all fishing vessels operating within the Convention Area of RFMOs. As a Contracting party to CCAMLR, under CMM 10-04, all fishing vessel must be equipped with an Automatic location communicator (ALC). For all fisheries, data should be transmitted every hour to the Fisheries Monitoring Centre (FMC). VMS data is securely stored by the Secretariat in electronic data processing facilities with limited access granted via a flexible user identification and password mechanism. Fishing by Australian vessels is restricted to areas previously fished during the historical reference period of 2002-06 in the SPRFMO area, as defined by the SPRFMO CMM for the Management of Bottom Fishing in the SPRFMO Convention Area (CMM 03-2017). In the SIOFA area, fishing by Australian vessels is restricted to areas previously fished during the historical reference period of 1999-2009, as defined by the SIOFA CMM for the Interim Management of Bottom Fishing in the SIOFA Agreement Area (CMM 2017/01). The inclusion of a restrictive fishing footprint aims to prevent significant adverse impacts to vulnerable marine ecosystems (VMEs). Australian operators in the SIOFA area have agreed to further restrict fishing areas beyond the footprint reference period to exclude fishing in areas voluntarily closed by industry members of the Southern Indian Ocean Deepsea Fishers Association.	https://www.afma.gov.au/fisheries-services/vessel-monitoring https://www.dcceew.gov.au/sites/default/files/env/consultations/1bfa775f-38b9-4a54-b2ef-b8a400fcb618/files/high-seas-permits-reassessment-january-2018.pdf

4.1.4	Does the government departments related to DSF/activities other than fishing have a website?	Fully	3	Most of departments and agencies and RFMCs have websites.	https://www.afma.gov.au/sustainability-environment/petroleum-industry-consultation https://www.nopsema.gov.au/ https://www.afma.gov.au/
4.1.5	Are reports and other types of information and data on DSF/VMEs/sensitive species and habitats publicly available?	Mostly/Fully	2.5	Under the MoU between AFMA and the Department of Climate Change, Energy, the Environment and Water (DCCEEW), AFMA provides a quarterly summary of logbook reports on interactions with protected species in AFMA-managed fisheries to DCCEEW on behalf of fishers. Under CMM 2019/01, all Bottom Fishing Impact Assessment Standard (BFIA) must be updated and submitted to the SIOFA Scientific Committee if any fishing activities have changed or new fisheries/fishing areas are being proposed. All BFIA must follow the SIOFA Bottom Fishing Impact Assessment Standard (BFIAS). Under CMM 2020/01, The Scientific Committee must also be notified of any new data, such as stock status or where VMEs are known or likely to occur. In 2011, Australia completed a BFIA to determine whether individual bottom-fishing activities would have an SAI on VMEs in the SPRFMO Convention Area with similar conclusions to the SIOFA BFIA. In 2020, Australia and New Zealand updated their BFIA. BFIAs seek to be consistent with FAO guidelines and are available in SIOFA and SPRFMO websites.	https://www.afma.gov.au/sites/g/files/net5531/f/uploads/2010/06/mou.pdf https://www.afma.gov.au/sustainability-environment/protected-species-management/protected-species-interaction-reports https://www.sprfmo.int/assets/Fisheries/Science/SPRFMO-Bottom-Fishery-Impact-Assessment-Standard-2019.pdf http://www.sprfmo.int/assets/2020-SC8/SC8-DW07-rev-1-Cumulative-Bottom-Fishery-Impact-Assessment-for-Australia-and-New-Zealand.pdf
4.2 - Description of sensitive species and habitats					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
4.2.1	Are biodiversity indicators available?	Mostly or partially in progress	2	Within waters under national jurisdiction, with the exception of Heard and McDonald Islands (HIMI), there are no defined VME indicator species and data on the types and distributions of benthic habitat are generally scarce. Within each of the RFMOs in which it operates, Australia uses the VME indicator species adopted by the RFMO and used by all members. Australian vessels use the same scoring system adopted by New Zealand for eight primary taxa and two habitat indicators which has since been adopted by SPRFMO in 2019 and is currently in force under CMM 03-2020. This list includes sponges, stony corals, black corals, seapens, hydrocorals, etc. SIOFA uses the same list of VME Taxa as CCAMLR. *Gaps: Within waters under national jurisdiction, except of Heard and McDonald Islands (HIMI), there are no defined VME indicator species. Benthic data is generally scarce.*	CMM 03-2020 CMM 2020/01
4.2.2	Has a definition of VME concept or an alternative concept (e.g. sensitive species and habitats) been agreed?	Mostly or partially in progress	2	With the exception of HIMI, which uses the CCAMLR definition, there is no definition of a VME within waters under national jurisdiction. Under CCAMLR CM 22-06, VMEs include seamounts, hydrothermal vents, cold water corals and sponge fields. In the SPRFMO Convention Area, the definition of VME is the same as the FAO description, as stated under paragraph 3 of SPRFMO CMM 03-2022, "the term 'vulnerable marine ecosystem' (VME) means a marine ecosystem that has the characteristics referred to in paragraph 42 and elaborated in the Annex of the FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas." *Gap: No VMEs definition within waters under national jurisdiction, except of Heard and McDonald Islands (HIMI).*	CM 22-06 CMM 03-2022

4.2.3	Are there VME species/VME features lists available?	Mostly/Fully	2.5	In 2009 New Zealand developed a list of 10 VME indicator taxa that could be used by observers to detect encounters with VMEs in the SPRFMO Convention Area (Parker et al., 2009). This was updated to 15 VME taxa which are listed under Annex 5 of CMM 03-2022 and therefore apply to all SPRFMO Members. This list includes species such as sponges, coral, sea pens, anemones, hydrozoans, bryozoans and starfish. In 2009, a CCAMLR VME taxa workshop developed a comprehensive list of 22 indicator species for observers, fishers and biologists to use as a quick on-deck guide to classify VME taxa caught as bycatch. SIOFA have developed a list of VME indicator Taxa (Annex 1 of CMM 2020_01) and a guide for use by observers, these are same as those used by CCAMLR.	Parker, S.J., Penney, A.J. and Clark, M.R., 2009. Detection criteria for managing trawl impacts on vulnerable marine ecosystems in high seas fisheries of the South Pacific Ocean. Marine Ecology Progress Series, 397, pp.309-317. https://www.sprfmo.int/measures/ https://www.ccamlr.org/en/system/files/VME-guide.pdf
4.2.4	Have VMEs/sensitive species and habitats been identified and described?	Mostly/Fully	2.5	With the exception of Heard and McDonald Islands (HIMI), there are no VMEs defined within waters under national jurisdiction. The Ecological Risk Assessment for Effect of Fishing (ERAEF) for the Western Deep-Water Trawl Fishery (WDWTF) did identify bryozoan rich substrates between 120 meters and 300 meters, raising the concern that they may be impacted by trawling (Wayte et al., 2007). Within the Evaluated Area of the SPRFMO Convention Area, the distribution of VME indicator taxa has been mapped between depths of 200m and 3000m (Georgian et al., 2019). In the CCAMLR waters, all currently-identified VMEs, confirmed by research-vessel surveys, occur in relatively shallow water within a depth range of 42 to 695m. *Gap: No VMEs defined within waters under national jurisdiction, except of Heard and McDonald Islands (HIMI).*	Wayte, S., Dowdney, J., Williams, A. Fuller, M., Bulman, C., Sporcic, M., Smith, A. (2007) Ecological Risk Assessment for the Effects of Fishing: Report for the Western Deepwater Trawl Fishery. Report for the Australian Fisheries Management Authority, Canberra. Georgian, S.E., Anderson, O.F., Rowden, A.A. (2019). Ensemble habitat suitability modelling of vulnerable marine ecosystem indicator taxa to inform deep-sea fisheries management in the South Pacific Ocean. Fisheries Research 211:256-274.
4.3 - Assessment of bottom fishing impacts					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
4.3.1	Are bottom fisheries formally assessed?	Fully	3	Nine fisheries are managed solely by the Australian Fisheries Management Authority (AFMA) on behalf of the Australian Government. Seven fisheries are managed jointly by AFMA and regional or international partners (such as Western and Central Pacific Fisheries Commission, Commission for the Conservation of Antarctic Marine Living Resources, etc).	https://www.afma.gov.au/fisheries
4.3.2	Has a bottom fishing footprint been defined?	Mostly or partially in progress	2	See above (section 4.1.3) Australia's fishing footprint (1999-2009) within the SIOFA Area Australia's fishing footprint (2002-2006) within the SPRFMO Area Additionally, trawl footprints have been mapped and reported for bioregions at the sub regional scale under the Integrated Marine and Coastal Regionalisation of Australia (IMCRA). The effort data were taken between 2007 and 2012 and converted into a common scale of swept area per km2 which allowed a quantification of the footprint for all demersal trawling as a percentage of each bioregion.	Woodhams, J, Stobutzki, I, Noriega, R & Roach, J 2012, Sustainability of harvest levels by Australian flagged vessels in the high seas areas of the South Pacific Ocean and South Indian Ocean, ABARES report to client prepared for the Australian Fisheries Management Authority, Canberra, November 2012. https://soe.environment.gov.au/theme/marine-environment/topic/2016/commercial-and-recreational-fishing.
4.3.3	Are routine fishery independent surveys or other relevant surveys conducted to assess impacts?	Mostly/Fully	2.5	The Commonwealth Scientific and Industrial Research Organisation (CSIRO), undertakes research on the impacts of fishing on the seabed ecosystem. A full list of surveys can be found in Appendix 2 of Pitcher et al., (2018).	https://www.csiro.au/en/research/animals/Fisheries/Sustainable-trawling https://www.frdc.com.au/sites/default/files/products/2016-039-DLD.pdf -

4.3.4	Are observer programmes implemented?	Fully	3	The Australian Fisheries Management Authority (AFMA) recruits and trains the observers with scientific background or experience in the fishing industry or other maritime industries and must demonstrate skills in collecting biological data at sea, fisheries research methodologies and collection of associated scientific data. Australian high-seas fishing permits require the implementation of vessel monitoring systems, mandatory 100% observer coverage on all trawl vessels and a minimum of 10% observer coverage per vessel on all non-trawl vessels.	https://www.afma.gov.au/fisheries-services/observer-services
4.3.5	Are there methods described and conducted for assessing Significant Adverse Impacts on VMEs/sensitive species and habitats?	Mostly (in progress)	2.5	Within waters under national jurisdiction there is no definition of an SAI, however risk assessments are undertaken using the methodology outlined in the Ecological Risk Assessment for the Effects of Fishing (ERAEF). Within the RFMOs and CCAMLR, Australia follow the definitions as prescribed by the RFMO. *Gap: No SAI definition within waters under national jurisdiction*	http://www.afma.gov.au/environment/eco based/eras/docs/methodology.pdf. Hobday, A.J., Smith, A.D.M., Stobutzki, I.C., Bulman, C., Daley, R., Dambacher, J.M., Deng, R.A., Dowdney, J., Fuller, M., Furlani, D., Griffiths, S.P., Johnson, D., Kenyon, R., Knuckey, I.A., Ling, S.D., Pitcher, R., Sainsbury, K.J., Sporocic, M., Smith, T., Walker, T.I., Wayte, S.E., Webb, H., Williams, A., Wise, B.S., Zhou, S., (2011). Ecological risk assessment for the effects of fishing. Fish. Res., doi:10.1016/j.fishres. 2011.01.013. http://www.csiro.au/science/fisheries-ecological-riskassessment.html
4.4 - Mapping of sensitive species and habitats					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
4.4.1	Are routine fishery independent surveys or other relevant surveys to sample VMEs indicators/sensitive species and habitats?	Fully	3	Yes, surveys are undertaken by CSIRO and other agencies, aiming to: i) quantify trawl impacts on different seabed biota; ii) monitoring of recovery rates; iii) study of trawl bycatch; iv) mapping of regional distributions of seabed habitats & biota; v) simulation modelling of trawl fisheries; vi) building of comprehensive national databases of seabed biota distributions and trawl fishing effort across Australia; vii) quantify and map of trawl footprints; viii) mapping of national seabed assemblages and regional seabed invertebrate communities to quantify exposure of seabed biodiversity to bottom trawling and protection in reserves & fishery closures and; ix) development of quantitative models for risk assessment of trawling, including simpler methods that can be used in data-limited situations.	https://www.csiro.au/en/research/animals/Fisheries/Sustainable-trawling
4.4.2	Are scientific observer programs implemented to sample VME indicator species?	Fully	3	Yes, scientific observers are required to collect biological data including length frequencies and catch composition of target species, and by-catch monitoring. The observer is also involved with the process of determining if by-catch of VME taxa exceeds the trigger limits (currently > 50 kg of coral and sponges). On return from a voyage, the observer is required to present a report to AFMA and the collected data is entered in to the AFMA observer database.	https://www.afma.gov.au/sites/default/files/uploads/2014/02/bottom_fishery_impact_assessment_sprfmo.pdf
4.4.3	Have habitat suitability models/species distribution models been developed to	Mostly or partially in progress	2	Within the SPRFMO Convention Area, there is very little information regarding the biomass, depth and location of VME indicator taxa. Therefore, habitat suitability models (HSM) are used to predict the niche and distribution of species based on limited data. *Gap: VME limited and sparse information*	http://www.sprfmo.int/assets/02-SC10/Meeting-Papers/SC10-DW05-Further-development-of-VME-indicator-taxa-distribution-models-NZ.pdf

	map VMEs/sensitive species and habitats?				
4.4.4	Have the VMEs/sensitive species and habitats been mapped?	Partially in progress	2	Mazor et al., (2017) used a combination of survey data and predictive modelling to map the distribution of seabed invertebrates (benthos) in nine regions around Australia. The distributions were modelled and predicted using Random Forests (RF), an ensemble of decision trees with binary splits. Within the SPRFMO Convention Area, the distribution of VME indicator taxa has been mapped between depths of 200m and 3000m (Georgian et al., 2019). Australian fishing effort with SIOFA has been low, with only one longline vessel participating in 2020 (SC-06-14). No surveys have been undertaken by Australia in this area. Within areas of national jurisdiction, with the exception of HIMI, there are no VME areas defined. *Gap: Lack of quantitative data available to accurately map VMEs*	Mazor TK, Pitcher CR, Ellis N, et al. Trawl exposure and protection of seabed fauna at large spatial scales. Divers Distrib. 2017;23:1280–1291. https://doi.org/10.1111/ddi.12622 Georgian, S.E., Anderson, O.F., Rowden, A.A. (2019). Ensemble habitat suitability modelling of vulnerable marine ecosystem indicator taxa to inform deep-sea fisheries management in the South Pacific Ocean. Fisheries Research 211:256-274.
4.5 - Impact mitigation and protection measures					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
4.5.1	Are there any VME encounter rules/thresholds which the bottom fisheries use?	Mostly or partially in progress	2	There are no VME encounter rules within waters under national jurisdiction, there are areas that are closed to trawling to protect benthos. SPRFMO, SIOFA and CCAMLR adopted encounter´s thresholds. *Gap: No VME encounter rules within waters under national jurisdiction*	CMM 03-2021 Annex 6A
4.5.2	Are there any VME bottom fishery closures or MPA in place?	Mostly (in progress)	2.5	Within waters under national jurisdiction, there are areas that are closed to trawling to protect benthos (including marine reserves and fishery closures). In the CCAMLR region, all currently-identified VMEs, confirmed by research-vessel surveys, occur in relatively shallow water within a depth rage od 42 to 695m. These VMEs are protected by designating Risk Areas, closed to bottom fishing. SPRFMO: None. SIOFA: benthic protection areas are not closed to demersal longline. *Gap: No VME bottom fishery closures/MPA in place for SPRFMO or SIOFA*	Mazor TK, Pitcher CR, Ellis N, et al. Trawl exposure and protection of seabed fauna at large spatial scales. Divers Distrib. 2017;23:1280–1291. https://doi.org/10.1111/ddi.12622 http://www.fao.org/3/i5952e/i5952e.pdf
4.5.3	Are there any BFIAs/ bottom fishery exploratory protocols required?	Mostly/Fully	2.5	Australia have conducted Bottom Fishing Impact Assessments (BFIAs) for their fishing activity within CCAMLR, SIOFA and SPRFMO. Within the Australian EEZ, Ecological Risk Assessment (ERAs) have been undertaken for all the major fisheries. The Australian Government are currently reviewing their exploratory fisheries policy (AFMA 2020) and the draft guidelines are undergoing a public consultation	https://www.sprfmo.int/assets/Fisheries/Science/SPRFMO-Bottom-Fishery-Impact-Assessment-Standard-2019.pdf http://www.sprfmo.int/assets/2020-SC8/SC8-DW07-rev-1-Cumulative-Bottom-Fishery-Impact-Assessment-for-Australia-and-New-Zealand.pdf https://research.csiro.au/cor/research-domains/fisheries-domestic/ecological-risk-assessment/ Wayte, S., Dowdney, J., Williams, A. Fuller, M., Bulman, C., Sporcic, M., Smith, A. (2007) Ecological Risk Assessment for the Effects of Fishing: Report for the Western Deepwater Trawl Fishery. Report for the Australian Fisheries Management Authority, Canberra.
4.5.4	Are there any bottom gear restrictions/depth restrictions/ freezing of the historical footprint adopted	Mostly/Fully	2.5	The Management guidelines the various domestic fisheries that take place within the EEZ are laid out in the various management plans. Although not related to benthic impacts, the North West Slope Trawl Fishery and Western Deepwater Trawl Fishery place a restriction on mesh size and require 100% observer coverage on any fisheries taking place shallower than 200m (AFMA 2012).	https://www.afma.gov.au/fisheries

	as mitigation and protection measure?			The Southern and Eastern Scalefish and Shark Fishery (SESSF) operates a number of different fishing gears for deep water species. Within this fishery there are a three trawl exclusion zones that have been put in place to protect benthic habitats. The Macquarie Island Toothfish Fishery (MITF) is an MSC certified fishery operating off the Australian offshore territory of Macquarie Island. Its management plan was last updated in 2016 (AFMA 2016). There are gear limitations in place for trawl fishing (although this no longer operates, only longlines are used) and not all are related exclusively to protection of the benthos.	
4.5.5	Are there any VMEs impact mitigation and protection measure adopted regarding activities other than fishing.	Mostly or partially in progress	2	There are no guidelines specific to VMEs, all companies wishing to undertake offshore energy activities must submit an environmental plan under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Environment Regulations) which include an assessment on the impacts to the ecosystem and are assessed by National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA.)	https://www.nopsema.gov.au/offshore-industry/environmental-management/assessment-process
4.1.6 - Monitoring of VMEs impacts					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
4.6.1	Are VMEs/sensitive species and habitats routinely monitored in bottom fisheries?	Partially in progress	2	Within Australia's area of jurisdiction, with the exception of HIMI, there is no routine monitoring of VMEs, although benthic surveys are undertaken on an ad-hoc basis by CSIRO and other organisations. Within HIMI, Australia conducted annual surveys using camera systems as part of an eight-year monitoring programme to monitor the vulnerability of benthic habitats to impact by demersal gears (Welsford et al., 2014). *Gap: Within Australia's area of jurisdiction, with the exception of HIMI, there is no routine monitoring of VMEs*	Welsford, D,C. et al., (2014) Demersal fishing interactions with marine benthos in the Australian EEZ of the Southern Ocean: An assessment of the vulnerability of benthic habitats to impact by demersal gears. The Department of the Environment, Australian Antarctic Division and the Fisheries Research and Development Corporation. Final Report FRDC Project 2006/042.
4.6.2	Are activities other than fishing considered in the long-term monitoring of VMEs/sensitive species and habitats?	Partially in progress	2	Environmental plans must be submitted and reviewed by NOPSEMA prior to any offshore activities taking place, however these do not include long term monitoring plans. None outlined within areas of national jurisdiction specific to VMEs. Impacts to the benthic habitat in general are monitored through surveys. Monitoring of VMEs within RFMOs is still under development.	https://www.nopsema.gov.au/sites/default/files/documents/2021-03/A339814.pdf
4.6.3	Are there any plans for the long-term monitoring of VMEs/sensitive species and habitats (including activities other than fishing)?	Partially in progress	2	See above (section 4.6.2)	https://www.nopsema.gov.au/sites/default/files/documents/2021-03/A339814.pdf

CASE STUDY 5 – NEW ZEALAND

5.1 - Data availability and governance frameworks					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
5.1.1		Fully	3		www.mpi.govt.nz/fishing-aquaculture

	Are there governance frameworks and specific government departments related to DSF/activities other than fishing (research, monitoring, management and enforcement)?			Direct fisheries management is the responsibility of Fisheries New Zealand (FNZ), and the wider context of fisheries sustainability is a significant part of their work, in collaboration with the Department of Conservation and the Ministry for the Environment. Regional councils also have the ability to strongly influence the marine environment both through control of land-based activities and by management of the marine space itself (within the territorial sea, 0-12 nautical miles offshore). There are many other regulators of activities in the marine environment covering issues like health and safety, oil and gas licensing, marine transport and discussion and participation in international agreements around ocean governance and fisheries management: Ministry of Foreign Affairs and Trade; Ministry of Business, Innovation and Employment; petroleum and Minerals); Environmental Protection Authority; Ministry of Transport Maritime New Zealand; National Maritime Coordination Centre and many other ministries that have adjacent or supporting roles.	www.mpi.govt.nz/legal/legislation-standards-and-reviews/fisheries-legislation/maps-of-nz-fisheries/
5.1.2	Are data on catches, landings and bycatch (including VMEs/sensitive species and habitats) routinely collected and assessed?	Fully	3	The online fishing data portal launched in 2020, allows public access to spatial data relating to the commercial fishing regulations. Updated data sets include coordinates for fisheries management areas, general statistical areas, and quota management areas. The management of New Zealand's commercial deep-water fisheries is a collaborative arrangement between Fisheries New Zealand (representing the Crown and its statutory obligations to the public) and the commercial fishing industry, represented by Deepwater Group (DWG). The management of deep-water fisheries encompasses all target stocks, bycatch stocks, and the environmental effects of fishing. All deep-water species in the quota management system (QMS) have been categorised into two tiers according to their commercial value and volume of catch. Tier 1 fisheries are high volume and/or high value fisheries and are typically targeted. They deliver significant export revenue, which is reflected in the high quota value associated with these species. Tier 2 fisheries are typically less commercially valuable, comprise bycatch fisheries, or are only targeted periodically throughout the year.	www.mpi.govt.nz/legal/legislation-standards-and-reviews/fisheries-legislation/maps-of-nz-fisheries/
5.1.3	Are VMS data routinely recorded, stored and assessed and is a bottom fishing footprint available?	Fully	3	In 1993, New Zealand, enacted the Fisheries (Satellite Vessel Monitoring) Regulations 1993, whereby it was required that by 1 April 1994 an Automatic location communicator (ALC) should be installed and carried on board the vessels. Regulation 8 of the Fisheries (Satellite Vessel Monitoring) Regulations 1993 defines the different categories of offences relating to VMS. The data collected on the Trawl Catch Effort Returns (TCER) and Trawl Catch Effort and Processing Returns (TCEPR) forms are used to generate annual trawl footprints that represent the area of the seafloor contacted by trawl gear. Assessment of the annual trawl footprint is a monitoring requirement for Deepwater Fisheries Management Objective 7: Manage deep-water and middle-depth fisheries to avoid, remedy or mitigate the impacts of deep-water fisheries on the benthic habitat (Ministry for Primary Industries 2017). Maps of New Zealand fisheries, including commercial fishing, customary fisheries, and marine protected areas are publicly available from the National Aquatic Biodiversity Information System (NABIS) fishery mapping tool	www.mpi.govt.nz/legal/legislation-standards-and-reviews/fisheries-legislation/maps-of-nz-fisheries/ Section 2.1.2.1, Ministry of Agriculture and Fisheries, Vessel Monitoring Systems, Circular One on Certification Requirements for Inmarsat-C Automatic Location Communicators (December 1993); Fisheries (Satellite Vessel Monitoring) Regulations 1993; Ministry for Primary Industries (2017). National Fisheries Plan for Deepwater and Middle-depth Fisheries – Part 1A. MPI Discussion Paper No: 2017/26. Prepared for public consultation by the Deepwater Fisheries team. 37 p.

5.1.4	Does the government departments related to DSF/activities other than fishing have a website?	Fully	3	The Ministry for Primary Industries (MPI) has a website related to the management of New Zealand's deep-water and middle-depth fisheries under the National deep-water fisheries plan. It includes, plans for specific fisheries, deep-water fish stocks, and how the effects of deep-water fishing on the environment are managed. Ministry of Business, Innovation and Employment is responsible for health and safety in the marine environment. This includes managing permits and licences for oil, gas and minerals (via New Zealand Petroleum and Minerals).	https://www.mpi.govt.nz/fishing-aquaculture/fisheries-management/deepwater-fisheries/ https://www.mbie.govt.nz/cross-government-functions/regulatory-stewardship/regulatory-systems/petroleum-and-minerals-regulatory-system/
5.1.5	Are reports and other types of information and data on DSF/VMEs/sensitive species and habitats publicly available?	Fully	3	Fisheries New Zealand (FNZ) works with the Department of Conservation (DOC) to detect trends in the number of protected species that are captured by commercial fishing, making a scientific assessment and deciding how to manage the impacts. Every 3 months, FNZ release information gathered from the daily self-reports from commercial fishers. These reports inform about their catches – the species, the fishing methods they are using, and where they are fishing and about accidental catches of marine mammals (like seals and dolphins), seabirds, reptiles, protected fish, and corals, sponges, and bryozoans. Research on the impacts of fisheries on protected and non-target species, as well as the marine environment, especially benthic (sea floor) organisms and communities is undertaken by National Institute of Water and Atmospheric Research (NIWA).	https://niwa.co.nz/fisheries/programmes/fisheries-environmental-impacts
5.2 - Description of sensitive species and habitats					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
5.2.1	Are biodiversity indicators available?	Mostly/Fully	2.5	The Department of Conservation held an expert workshop to assess New Zealand's marine invertebrates using the New Zealand Threat Classification System (NZTCS) criteria (Townsend et al., 2008), updating a previous listing process from 2009 (Freeman et al., 2009). The 2010 amendment of Schedule 7A of the Wildlife Act 1953 protects most corals in New Zealand waters, which are comprised of four main groups: stony corals (all species in the Order Scleractinia), black corals (all species in the Order Antipatharia), gorgonian corals (most species in the Order Alcyonacea), and some hydrocorals (all species in the Family Stylasteridae).	https://niwa.co.nz/sites/niwa.co.nz/files/Deepsea-corals-NZ-2019-NIWA-SciTechSeries-84.pdf Townsend, A.J.; de Lange, P.J.; Duffy, C.A.J.; Miskelly, C.M.; Molloy, J.; Norton, D.A. 2008: New Zealand Threat Classification System manual. Department of Conservation, Wellington, New Zealand. 35 p;DJ Freeman, BA Marshall, ST Ahyong, SR Wing and RA Hitchmough. 2010. Conservation status of New Zealand marine invertebrates, 2009, New Zealand Journal of Marine and Freshwater Research, 44:3, 129-148.
5.2.2	Has a definition of VME concept or an alternative concept (e.g. sensitive species and habitats) been agreed?	Fully	3	A marine ecosystem is classified as 'vulnerable' based on the characteristics that it possesses, such as uniqueness or rarity; functional significance of the habitat; fragility; life-history traits of component species that make recovery difficult; and structural complexity. Examples are seamounts and deep-water coral forests.	https://fs.fish.govt.nz/Page.aspx?pk=77&tk=316
5.2.3	Are there VME species/VME features lists available?	Mostly/Fully	2.5	The list of VME indicator taxa is included in Annexes 5 and 6 of CMM 03-2020. This list has previously been assessed against the Food and Agriculture Organisation of the United Nations (FAO) VME criteria. There is a report (Clark et al., 2022) that documents	https://www.sprfmo.int/assets/Fisheries/Conservation-and-Management-Measures/2020-CMMs/CMM-03-2020-Bottom-Fishing-31Mar20.pdf

				an update on information for Underwater Topographic Features (UTFs) in the New Zealand region. Underwater topographic features (UTFs) are seamounts, knolls, and hills defined as features with greater than 100 m elevation from the surrounding seafloor. They are classified as vulnerable marine ecosystems as they can host fragile and slow-growing benthic communities.	Clark, M.R.; Wood, B.; Mackay, K.; Anderson, O.F.; Hart, A.; Rickard, G.; Rowden, A.A. (2022); Underwater Topographic Features in the New Zealand region: development of an updated; 'SEAMOUNT' database and information on the extent and intensity of deep-sea trawl fisheries on them; New Zealand Aquatic Environment and Biodiversity Report No. 291. 28 p.
5.2.4	Have VMEs/sensitive species and habitats been identified and described?	Mostly/Fully	2.5	The Exclusive Economic Zone (EEZ) and Continental Shelf (Environmental Effects—Permitted Activities) Regulations 2013, provide for the management of the environmental effects of permitted activities in the EEZ if they occur in areas of sensitive marine benthic environments; Schedule 6 of these regulations includes a list of indicators of the existence of sensitive environments. Many reviews were done for the list providing description, distribution, and definition of the sensitive marine benthic habitats, including stony coral thickets or reefs	https://www.legislation.govt.nz/regulation/public/2013/0283/20.0/DLM5270660.html Rowden, A.; Clark, M. (2008). Benthic biodiversity of seven seamounts on the southern end of the Kermadec volcanic arc, northeast New Zealand. New Zealand Aquatic Environment and Biodiversity Report No. 62. 31 p; MacDiarmid, A.; Bowden, D.; Cummings, V.; Morrison, M.; Jones, E.; Kelly, M.; Neil, H.; Nelson, W.; Rowden, A. (2013). Sensitive marine benthic habitats defined. NIWA Client Report WLG2013-18. 72 p. Anderson, T.; Morrison, Mark.; MacDiarmid, A.; D'Archino, R.; Nelson, W.; Tracey, D.; Clark, M.; Gordon, D.; Read, G.; Morrisey, D.; Kettles, H.; Wood, A.; Anderson, O.; Smith, A.; Page, M.; Paul-Burke, K.; Schnabel, K.; Wadhwa, S. (2018). Review of New Zealand's Key Biogenic Habitats. NIWA client report prepared for the Ministry for the Environment Project MFE18301. 184 p. https://www.mpi.govt.nz/dms-document/15604-database-documentation-seamount
5.3 - Assessment of bottom fishing impacts					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
5.3.1	Are bottom fisheries formally assessed?	Fully	3	New Zealand has conducted impact assessments of all bottom fishing activities by New Zealand vessels in the CCAMLR and SPRFMO Convention Areas, in accordance with 119(a) of resolution 64/72 and 129(a) of resolution 66/68. Both SPRFMO and CCAMLR impact assessments are available on their respective websites.	
5.3.2	Has a bottom fishing footprint been defined?	Mostly/Fully	2.5	In 2019, the trawl footprint was 81,054 square kilometres (km2). The total area trawled from 1990 to 2019 is 460,627km2. This is about: 11% of the total area within the boundary of New Zealand's EEZ and territorial seas; 33% of the area that can be fished (which is down to depths of 1,600 metres).	https://www.mpi.govt.nz/fishing-aquaculture/sustainable-fisheries/strengthening-fisheries-management/bottom-trawling/
5.3.3	Are routine fishery independent surveys or other relevant surveys conducted to assess impacts?	Mostly/Fully	2.5	The National Institute of Water and Atmospheric Research (NIWA) has a programme that consists of research on the impacts of fisheries on protected and non-target species, as well as the marine environment, especially benthic (sea floor) organisms and communities. This research on the impacts on the marine environment is largely funded through fishing industry levies, and the industry plays a key role in the prioritisation and evaluation of this research. NIWA has run the Ministry of Fisheries-funded Chatham Rise survey using R.V. Tangaroa every year since 1992. The main aim of the surveys is to estimate the abundance of hoki and other commercially important species (such as hake and ling), but during the 20 consecutive surveys NIWA scientists have also been able to	https://niwa.co.nz/fisheries/programmes/fisheries-environmental-impacts https://niwa.co.nz/fisheries/research-projects/20-years-of-fish-surveys

				study other aspects of deep-water biodiversity on the Chatham Rise, including fish distribution, abundance, and ecology.	
5.3.4	Are observer programmes implemented?	Fully	3	New Zealand has had an observer programme in place since 1986, operating as a unit within the New Zealand Ministry for Primary Industries (MPI). New Zealand observers collect a wide range of data to inform scientific analyses including both target stock assessments and quantification of bycatch, monitoring of compliance with requirements including seabird mitigation measures, and the collection of more general biological information.	https://www.sprfmo.int/assets/2021-SC9/SC9-Doc15-rev1-New-Zealand-Annual-Report.pdf
5.3.5	Are there methods described and conducted for assessing Significant Adverse Impacts on VMEs/sensitive species and habitats?	Mostly/Fully	2.5	New Zealand is actively engaged in developing, improving and implementing measures to sustainably manage deep-sea fish stocks and prevent significant adverse impacts from bottom fishing on vulnerable marine ecosystems (VMEs), both in its own exclusive economic zone and on the high seas. Since 2020, New Zealand has continued to advocate for, and implement, improved measures adopted by CCAMLR to prevent significant adverse impacts on VMEs in the CCAMLR Convention Area, including supporting proposals by other member states to establish further MPAs in the Convention Area. Moreover, continued a comprehensive research programme and engaged in SPRMFO processes to ensure management measures in SPRFMO are effective in preventing significant adverse impacts on VMEs.	https://www.un.org/Depts/los/bfw/New%20Zealand_2022.pdf
5.4 - Mapping of sensitive species and habitats					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
5.4.1	Are routine fishery independent surveys or other relevant surveys to sample VMEs indicators/sensitive species and habitats?	Mostly/Fully	2.5	NIWA monitors and analyses the impact of commercial fishing activity on species that aren't targeted by fishing (bycatch). This monitoring and analysis comprise: i) Other fish species; ii) invertebrates, such as protected corals and; iii) Seabirds, including modelling how fishing practices affects their population.	https://niwa.co.nz/fisheries/programmes/fisheries-environmental-impacts
5.4.2	Are scientific observer programs implemented to sample VME indicator species?	Fully	3	Since 2007, as part of the requirements of the Department of Conservation (DOC) Marine Conservation Services (MCS) Conservation Services Programme (CSP), observers have recorded and collected samples of any coral taxa that (1) are protected, (2) that strongly resemble protected coral fauna, or (3) that have been proposed for protection. Observers photograph coral specimens at sea and all samples, or a sub-sample of the colony, are returned to NIWA (frozen) for identification and curation. Corals are identified to the lowest possible taxonomic level and resulting data are entered into the Ministry of Fisheries (MFish) Centralised Observer Database (cod) that is maintained by NIWA.	https://deepwatergroup.org/wp-content/uploads/2013/08/Tracey-et-al.-2011-Identification-of-Protected-Corals.pdf
5.4.3		Mostly/Fully	2.5		https://www.un.org/depts/los/bfw/New%20Zealand_2022.pdf

	Have habitat suitability models/species distribution models been developed to map VMEs/sensitive species and habitats?			Statistical modelling methods to predict habitat suitability and species distributions in unsampled regions have been developed in recent years, many of which take advantage of the processing power of modern computers and machine learning algorithms. In New Zealand such models have been used to predict the distribution of fish and benthic invertebrate taxa over broad regions of the Exclusive Economic Zone (EEZ) and beyond into the wider Pacific.	Anderson, O.; Mikaloff Fletcher, S.; Bostock, H. 2015. Development of models for predicting future distributions of protected coral spe¬cies in the New Zealand region. NIWA Client Report to Department of Conservation No. WLG2015-65. 28 p.; Rowden, A.; Anderson, O.F.; Georgian, S.E.; Bowden, D.A.; Clark, M.R.; Pallentin, A.; Miller, A. (2017). High-resolution Habitat Suitability Models for the Conservation and Management of Vulnerable Marine Ecosystems on the Louisville Seamount Chain, South Pacific Ocean. Frontiers in Marine Science 4. 1–19.
5.4.4	Have the VMEs/sensitive species and habitats been mapped?	Mostly or partially in progress	2	Tracey et al., (2011) described the spatial distribution of the coral bycatch from observed fishing operations during 2007–08 to 2009–10, and thus identify areas where protected corals may be at risk from fishing activities. Information on seamount features (seamounts, knolls, hills, pinnacles) specifically have been compiled since 1999 when new research became focused on assessing the diversity and ecology of seamount benthic macroinvertebrate fauna. The "seamount database" presents a synopsis of the physical characteristics of seamounts within the New Zealand region. There are highly detailed maps of New Zealand's seabed available on NIWA's website. These maps show ridges, volcanoes, plateaus, canyons and seamounts. Distributional gaps in sampling and hence knowledge of the species composition in some areas is still poor, and especially so for depths greater than 2000 m. *Gap: Knowledge of the species composition in some areas is still poor.*	https://niwa.co.nz/news/download-the-seabed Tracey, D.; Baird, S.J.; Sanders, B.M.; Smith, M.H. 2011. Distribution of protected corals in relation to fishing effort and assessment of accuracy of observer identification. NIWA Client Report No: WLG2011-33 prepared for Department of Conservation, Wellington. 74 p.
5.5 - Impact mitigation and protection measures					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
5.5.1	Are there any VME encounter rules/thresholds which the bottom fisheries use?	Mostly or partially in progress	2	Encounter thresholds are not used within the EEZ as adverse effects are more likely to be avoided by restricting bottom fishing to specific areas outside of large BPAs Research to inform the development of the measure included analysis of historical VME bycatch weights in bottom trawl operations to develop appropriate thresholds to identify encounters with potential VMEs. CCAMLR has adopted a VME encounter measure (CM 22-07) which is described in New Zealand's 2009 report. SPRFMO's bottom fishing measure (CMM 03-2022) includes a VME encounter protocol. If there is an encounter, the area of the encounter is immediately closed to all bottom fishing. Information on any encounters is submitted to the SPRMFO Secretariat immediately. CMM 03 will be reviewed in 2023. *Gap: Encounter thresholds are not used within the EEZ.*	Helson, J., Leslie, S., Clement, G., Wells, R. & Wood, R. 2010. Private rights, public benefits: Industry-driven seabed protection. Marine Policy. 34(3). p.557-566. https://www.un.org/Depts/los/bfw/New%20Zealand_2022.pdf https://www.mpi.govt.nz/dmsdocument/4158-report-by-new-zealand-on-actions-taken-pursuant-to-operative-paragraphs-80-and-83-87 https://www.sprfmo.int/assets/Fisheries/Conservation-and-Management-Measures/2022-CMMs/CMM-03-2022-Bottom-Fishing-7Mar22.pdf
5.5.2	Are there any VME bottom fishery closures or MPA in place?	Mostly/Fully	2.5	In 2001 the Government prohibited trawling in 17 seamounts distributed throughout the EEZ. Within these areas all trawling methods are prohibited; there is no provision for midwater trawling. In 2007, in response to a fishing industry proposal, the Government closed an additional 17 areas (Benthic Protection Areas, BPAs) within the EEZ to dredging and placed tight restrictions on trawling in those areas. The purpose of the BPAs and seamount closures was to protect benthic (seafloor) biodiversity.	T. Snelder,J. Leathwick,K. Dey,M. Weatherhead,G. Fenwick,M. Francis,R. Gorman,J. Grieve,M. Hadfield,J. Hewitt,T. Hume,K. Richardson,A. Rowden,M. Uddstrom,M. Wild,J. Zeldis. 2005. Marine Environment Classification. Environmental Science. https://environment.govt.nz/sites/default/files/marine-environment-classification

5.5.3	Are there any BFIAs/ bottom fishery exploratory protocols required?	Mostly/Fully	2.5	New Zealand has conducted impact assessments of all bottom fishing activities by New Zealand vessels in the CCAMLR and SPRFMO Convention Areas, in accordance with 119(a) of resolution 64/72 and 129(a) of resolution 66/68. Both SPRFMO (CMM 03-2022) and CCAMLR (CCAMLR CM 22-06) impact assessments are available on their respective websites. The adoption of the first interim SPRFMO Bottom Fishery Impact Assessment Standard (BFIAS) was in 2011. They are carried out as a priority before authorising bottom fishing activities, and to ensure that CMMs are based on and updated on the basis of the best available scientific information, noting in particular the need to improve effective implementation of thresholds and move on rules.	http://www.sprfmo.int/assets/Fisheries/Science/SPRFMO-Bottom-Fishery-Impact-Assessment-Standard-2019.pdf
5.5.4	Are there any bottom gear restrictions/depth restrictions/ freezing of the historical footprint adopted as mitigation and protection measure?	Mostly/Fully	2.5	Around 30% of New Zealand's exclusive economic zone (EEZ) is closed to bottom trawling. Trawling of all types is prohibited in about 21% of the territorial sea (the area within 12 nautical miles of the coast). The effects of bottom trawling are managed through: i) closing certain areas to trawling; ii) limiting which sized vessels can fish in an area. The catch limits imposed under the Quota Management System also act to limit the amount of trawling that occurs in New Zealand waters. Some closures to trawling were put in place to limit the effects of fishing on the seafloor environment, like seamount closures and benthic protection areas.	https://www.mpi.govt.nz/fishing-aquaculture/sustainable-fisheries/strengthening-fisheries-management/bottom-trawling/
5.5.5	Are there any VMEs impact mitigation and protection measure adopted regarding activities other than fishing.	Mostly/Fully	2.5	Oil and gas development in New Zealand is regulated by a series of separate agencies, each with different responsibilities and areas of expertise. New Zealand participates in the work of the International Seabed Authority (ISA) as a member of the Assembly and as an observer on the Council. It is not a sponsoring State of seabed mining in the Area. Important steps need to be taken before mining can occur in order for VMEs to be protected from significant adverse impacts. To this end New Zealand is actively engaged in negotiations to develop exploitation regulations, standards and guidelines (known as the 'Mining Code') at the ISA.	https://www.nzpam.govt.nz/how-we-regulate/regulatory-environment/petroleum-regulators/ https://www.un.org/depts/los/bfw/New%20Zealand_2022.pdf
5.6 - Monitoring of VMEs impacts					
Questions		*Status*	*Score*	*Country justification and comments*	*Data sources*
5.6.1	Are VMEs/sensitive species and habitats routinely monitored in bottom fisheries?	Mostly/Fully	2.5	The Fisheries New Zealand closely monitors bottom trawling as part of a comprehensive fisheries management regime. Controls on bottom trawling include closed areas and regular monitoring of where fishing vessels have fished, and the type and quantity of marine species, such as corals and sponges, which are caught. Government Fisheries Observers placed aboard fishing vessels have also been documenting fishery impacts as the occurrence of non-target species ('bycatch') in commercial catch.	https://www.mpi.govt.nz/dmsdocument/3575-Protecting-New-Zealands-Seabed-from-the-Impacts-of-Bottom-Trawling
5.6.2	Are activities other than fishing considered in the long-term monitoring of VMEs/sensitive species and habitats?	Mostly/Fully	2.5	Monitoring is undertaken by reviewing information that is routinely provided from offshore operators to meet their consent and regulatory requirements. The Environmental Protection Authority (EPA) also use their powers under the EEZ Act to undertake inspections, periodically visiting onshore offices and heading offshore to visit structures and ships working in the EEZ. EPA takes a risk-based approach to determine the level of planned monitoring, and this is outlined in the EEZ Compliance and Enforcement Programme. EPA reviews plan regularly to re-evaluate risks and identify priority areas, where extra focus may be warranted.	https://www.epa.govt.nz/

5.6.3	Are there any plans for the long-term monitoring of VMEs/sensitive species and habitats (including activities other than fishing)?	Mostly/Fully	2.5	See above (section 5.6.2)	https://www.epa.govt.nz/

ANNEX 3

D1 Review of the implementation of the FAO Guidelines in the high seas (Task 2)

Acronyms

ABJN	Areas Beyond National Jurisdiction
BBJN	Biological diversity in marine areas beyond national jurisdiction
BTMAs	Bottom Trawl Management Areas (SPRFMO)
CBD	Convention on Biological Diversity
CCAMLR	The Convention for the Conservation of Antarctic Marine Living
CECAF	Fishery Committee for the Eastern Central Atlantic
CM	Conservation Measure
CEM	NAFO CEM
CMM	Conservation and management measure
CPCs	Contracting parties and cooperating non-contracting parties
DSCC	Deep Sea Conservation Coalition
DSF	Deep-sea fisheries
EAF	Ecosystem Approach to Fisheries
eDNA	Environmental DNA (Deoxyribonucleic acid)
FAO	Food and Agriculture Organization of the United Nations
GFCM	General Fisheries Commission for the Mediterranean
GSAs	Geographical subareas (GFCM)
IPOA-IUU	International Plan of Action to Prevent, Deter, and Eliminate Illegal, Unreported and Unregulated Fishing
KDE	Kernel Density Estimate
MCA	Multi-criteria assessment
MCS	Monitor, Control and Surveillance
MoP	Meeting of the Parties (SIOFA)
MoU	Memorandum of Understanding
NAFO	The Northwest Atlantic Fisheries Organisation
NEAFC	The Northeast Atlantic Fisheries Commission
NGO	Non- governmental Organization
NPFC	The North Pacific Fisheries Commission
RFBs	Regional Fisheries Bodies
RFMO	Regional Fisheries Management Organization
SAI	Significant Adverse Impact
SEAFO	The Southeast Atlantic Fisheries Organization
SDM	Species Distribution Model
SIOFA	The South Indian Ocean Fisheries Agreement
SPRFMO	The South Pacific Regional Fisheries Management Organization
UNCLOS	United Nations Convention on the Law of the Sea
UNFSA	United Nations Fish Stocks Agreement
UNGA	United Nations General Assembly
VME	Vulnerable Marine Ecosystem
WECAFC	Western Central Atlantic Fishery Commission
WGMHM	ICES Working Group on Marine Habitat Mapping
WTO	World Trade Organization

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1. Introduction

1.1 Task description

The aim of this task was to conduct a critical review of FAO 2008 DSF guidelines and to compile and develop best practices and recommendations on key aspects related to the conservation of VMEs and management of DSF in the high seas. It was especially important to identify the best available scientific knowledge and practices, but also any specific concerns raised in academic literature or by civil society that have emerged since the development of the guidelines in this task.

The scope of this task was limited to DSFs in the high seas in the following RFMOs/RFBs/Fishing areas:

- The Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR)
- The General Fisheries Council for the Mediterranean (GFCM)
- The Northwest Atlantic Fisheries Organisation (NAFO)
- The Northeast Atlantic Fisheries Commission (NEAFC)
- The Southeast Atlantic Fisheries Organisation (SEAFO)
- The South Indian Ocean Fisheries Agreement (SIOFA)
- The South Pacific Regional Fisheries Management Organisation (SPRFMO)
- Fishery Committee for the Eastern Central Atlantic (CECAF)
- Western Central Atlantic Fishery Commission (WECAFC)
- FAO Area 41 (SW Atlantic)

In particular, the review was carried out considering two sub-tasks:

Sub-task 2.1 – Review the 2008 DSF FAO guidelines

This task focused on reviewing the implementation of the DSF provisions in the high seas (FAO, 2009). This first step of this review focused on accessing the available information from DSFs in the considered RFMOs/Fishing areas, regarding the following aspects:

- Characteristics of the DSF
- Definitions and interpretation of key concepts (e.g., VMEs and SAIs)
- Criteria/guidelines used for assessing SAIs,
- Identification and assessment of VMEs, VME indicator species and threshold levels
- Characteristics of implemented data collection programs (e.g., type of data, resolution of the data, etc.) and reporting systems

- Frameworks and measures to prevent SAI including identification of areas known or likely to contain VMEs, and monitoring, control and surveillance frameworks in place
- Reported issues or challenges regarding the implementation of measures related to the FAO Guidelines

This information can be found in Annex I. Once the information for each of the DSFs was gathered, a critical assessment was carried out in order to identify the strengths and the weaknesses in each case, the context in which these methodologies have been implemented.

Sub-task 2.2 – Compilation of best practices

The objective of this sub-task was compiling and developing best practices and recommendations on key aspects related to the conservation of VMEs and management of DSF in the high seas. The topics and subtopics that were considered were:

- Criteria for identification of existing and potential VMEs;
- VMEs indicator taxa (species: deep sea and shallow waters);
- Approaches and methods for the identification and mapping of VMEs;
- Monitoring of VMEs;
- Assessment all of the six FAO (2009) criteria for SAI assessment for different gears and development of bottom fishing impact assessments:
    - The intensity or severity of the impact at the specific site being affected.
    - The spatial extent of the impact relative to the availability of the habitat type affected.
    - The sensitivity/vulnerability of the ecosystem to the impact.
    - The ability of an ecosystem to recover from harm, and the rate of such recovery.
    - the extent to which ecosystem functions may be altered by the impact; and
    - the timing and duration of the impact relative to the period in which a species needs the habitat during one or more of its lifehistory stages.
- Minimization of fisheries impacts (e.g., avoidance and impact mitigation approaches such as, encounter protocols and move-on rules).

Virtual Workshop

A virtual workshop was carried out on February 28th 2022 with the objective of bringing together a group of relevant experts and improve the outcomes of the work carried out by the partners in Task 2. The consortium prepared a brief document containing a compilation of the main issues and good practices regarding VMEs conservation in deep sea fisheries in the high seas (Annex II). This document was presented and discussed, and the main outputs of this workshop were included in this deliverable. This workshop is referred to throughout this document as “the Workshop”.

1.2 Background

Deep-sea fisheries operate globally throughout the world's oceans, chiefly targeting stocks on the upper and mid-continental slope and offshore seamounts. Major commercial fisheries occur, or have occurred, for species such as orange roughy, oreos, cardinalfish, grenadiers and alfonsino. Fishing in the deep sea not only harvests target species but can also cause unintended environmental harm, mostly from operating heavy bottom trawls and, to a lesser extent, bottom longlines. Bottom trawling over hard seabed (common on seamounts) routinely removes most of the benthic fauna (Clark et al., 2016).

The FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas (FAO, 2009) were developed for fisheries exploiting deep-sea fish stocks, in a targeted or incidental manner, in areas beyond national jurisdiction (ABNJ), including fisheries with the potential to have significant adverse impacts on vulnerable marine ecosystems (VMEs). The role of the Guidelines is to provide tools, including guidance on their application, to facilitate and encourage the efforts of States and RFMOs towards sustainable use of marine living resources exploited by deep-sea fisheries, the prevention of significant adverse impacts on deep-sea VMEs and the protection of marine biodiversity that these ecosystems contain. These Guidelines are the non-binding standard reference for the management of DSF at the present. The scope of the Guidelines covers the areas beyond national jurisdiction, but they may also be applied to the national jurisdictions of coastal states. The Guidelines were developed with a view to assisting states and RFMOs with the implementation of the United Nations General Assembly (UNGA) Resolution 61/105 of 2006, concerning responsible DSF in the marine ecosystems of the high seas.

According to the FAO Guidelines, States and RFMOs should:

- Adopt and implement measures in accordance to the precautionary approach and ecosystem approach to fisheries,
- Develop and adopt fishery management plans for specific DSFs
- Identify areas where VMEs are known or are likely to occur and the locations of fisheries in relation to those areas (i.e., fisheries 'footprint')
- Conduct assessments to establish if deep-sea fishing is likely to produce significant adverse impacts.
- Develop data collection and research programs
- Use science-based management approaches
- Develop and use selective and cost-efficient fishing methods

- Implement and enforce conservation and management measures through monitoring, control and surveillance (e.g., vessel authorizations and records of fishing vessels, catch and effort data reporting, transshipment monitoring, VMS, inspection schemes, Port State Monitoring, compliance evaluation)
- Adopt measures to address IUU
- Ensure transparency and public dissemination of information and enable participation of stakeholders
- RFMOs should develop mechanisms of cooperation and coordination among themselves

The FAO Guidelines provide a description of **key concepts**, such as:

> **Characteristics of species exploited by DSF** (e.g., maturation at relatively old age, slow growth, long life expectancies, low natural mortality rates, intermittent recruitment of successful year classes and spawning that may not occur every year). These resources have low productivity and once depleted, their recovery is expected to be long and not assured.
>
> **Vulnerable marine ecosystems (VMEs)**. Vulnerability is related to the likelihood that a population, community, or habitat will experience substantial alteration from short term or chronic disturbance, and the likelihood that it would recover and in what time frame. These are in turn, related to the characteristics of the ecosystems themselves, especially biological and structural aspects. VME features may be physically or functionally fragile. The most vulnerable ecosystems are those that are both easily disturbed and very slow to recover, or may never recover.
>
> **Significant adverse impacts (SAIs)** are those that compromise ecosystem integrity, i.e., ecosystem structure or function in a manner that: i) impairs the ability of affected populations to replace themselves; (ii) degrades the long-term natural productivity of habitats; or (iii) causes, on more than a temporary basis, significant loss of species richness, habitat or community types. Impacts should be evaluated individually or in combination and cumulatively.

The FAO Guidelines establish six factors that should be considered when determining the scale and significance of an impact (e.g., intensity or severity, spatial extent, sensitivity/vulnerability of the ecosystem, ability of an ecosystem to recover, alteration of ecosystem functions, timing and duration). It also defines temporary impacts as those that are limited in duration and allow the ecosystem to recover over an acceptable period of time (5-20 years).

A marine ecosystem shall be classified as vulnerable based on the characteristics it possesses. To identify VME and assess SAIs, the FAO Guidelines establish five **criteria**:

1) **Uniqueness** or **rarity** – an area or ecosystem that is unique or that contains rare species whose loss could be not compensated for by similar areas or ecosystems (e.g., habitats with endemic species, nurseries or discrete feeding, breeding and spawning areas).
2) **Functional significance of the habitat** – areas that are necessary for the survival, function reproduction or recovery of fish stocks or of rare, threatened and endangered species).
3) **Fragility**. Ecosystems that are highly susceptible of degradation by anthropogenic activities
4) **Life history traits** of component species that make recovery difficult (e.g., slow growth, late maturation, low or unpredictable recruitment, long life expectancy)
5) **Structural complexity** – an ecosystem that is characterized by complex physical structures created by significant concentrations of biotic and abiotic features.

The FAO Guidelines provide examples of possible VMEs (but no definitions), such as:

- potentially **vulnerable species groups, communities** and **habitats**: Cold-water corals and hydroids that form reefs and coral forests, sponge dominated communities, cold seep and hydrothermal vent communities, etc.)
- **topographical, hydrophysical** or **geological features**: submerged edges and slopes, summits and flanks of seamounts, canyons and trenches, cold seeps and hydrothermal vents.

As mentioned above, RFMOs should establish conservation and management measures to protect VMEs. The most important requirements are:

- RFMOs should **close areas where VMEs have been designated, or are known or likely to occur** (based on research surveys or modelling, for example) to prevent SAIs on VMEs and ensure long term conservation of deep-sea fish stocks.

- States and RFMOs should establish **encounter protocols** (including a definition of what constitutes an encounter) to determine how vessels should respond to encounters in the course of fishing operations.

The FAO Guidelines provides a list of other general measures to achieve long-term conservation and sustainable use of deep-sea fish stocks, ensure adequate protection and prevent SAIs, for example:

- Effort controls and/or catch controls
- Temporal and spatial restrictions or closures
- Changes in gear design, such as reduction of contact between fishing gear and the seabed, use of bycatch reduction devices or other technical measures.

In recent years, there have been several actions focused on improving the implementation of the Guidelines (e.g., the FAO Project "Support to the Implementation of the International Guidelines on the Management of Deep-sea Fisheries in the High Seas (GCP/GLO/323/NOR)" or the FAO-GEF ABJN Deep Seas Project). Yet, one of the current challenges for the implementation of the FAO guidelines is the fact that some parts of those could be understood and interpreted in different ways, or that there was not enough scientific knowledge to guide their operationalization.

Geographical areas, fisheries and relevant RFMOs/RFBs.

Under the UNCLOS, States are obliged to cooperate with each other, through Regional or Sub-regional Fisheries Management Organizations (RFMOs), in the conservation and management of living resources in the areas of the high seas , although this is not always the case as in the South West Atlantic (FAO Area 41). FAO recognizes 61 Regional Fisheries Bodies (RFBs), which have varying mandates and functions (e.g., advisory, coordination, management). According to the FAO, those RFBs which have a management mandate are considered RFMOs (Figure 1).

Participants in RFMOs (or arrangements) include not only the bordering coastal States, but also third countries that are involved in fishing in a given high seas area or those with a real interest in the fisheries concerned. European countries, in turn, are represented in numerous RFMOs by the European Commission. Almost all commercially relevant fish species are covered by the RFMOs (World Ocean Review, 2021). Thus, the primary competence and responsibility of RFMOs is to manage fisheries in their Convention Areas, typically achieved through legally-binding conservation and management measures (CMMs). The ecosystem approach to fisheries (EAF) is being applied (with various levels of effective implementation) by management bodies responsible for deep-sea fisheries (Fletcher, 2020). The main purpose of applying EAF is to ensure the conservation and sustainable use of all ecological, social and economic systems related to the fishery, not just the targeted species. This means that all ecological 'assets', including all target stocks and other species belonging to the same ecosystem or associated with or dependent on the target stocks, habitats, ecosystems relevant to the fishery and the issues/impacts generated by the fishery that may be affecting these assets should be considered (Fletcher, 2020).

Figure 1. Overview of relevant RFMOS, RFBs and Fishing Areas. Source: FAO, 2016.

2. Critical assessment of the implementation of FAO Guidelines in the high seas

2.1 Definitions and interpretation of key concepts

The great majority of RFMOs/RFBs refer to the concept of VME established in the FAO Guidelines. The most notable exception is CCAMLR, that only includes seamounts, hydrothermal vents cold water corals and sponge fields in its definition of VMEs, although it has defined many of its VMEs considering a variety of VME taxa (e.g., sea pens, stalked crinoids and pterobranchs) included in its CCAMLR VME Taxa Classification Guide (https://www.ccamlr.org/en/system/files/VME-guide.pdf).

From a practical point of view, however, the definition of what constitutes a VME must be further developed to create operational definitions, in order to consistently identify VMEs. The lack of operational definitions in many of the RFMOs/RFB is one of the main issues that have been identified in this review. For example, operational definitions have been established in NAFO (2013) and by ICES (2020a)—relevant for NEAFC. Although they are not incorporated in their adopted conservation measures, they are used by the scientific bodies that provide advice to these RFMOs. Here are some examples of the operational definitions used by NAFO, to define “VMEs” and “Significant concentrations of VME Indicators”:

- “Vulnerable Marine Ecosystem (VME)”. Under the structure-forming criterion, it is a regional habitat that contains VME indicator species at or above significant concentration levels. These habitats are structurally complex, characterized by higher diversities and/or different benthic communities, and provide a platform for ecosystem functions/processes closely linked to these characteristics. The spatial scale of these habitats is larger than the footprint of a higher concentration observation. This means that habitats not only include the area where a dense aggregation of VME organisms are observed, but also include other areas where smaller aggregations of VME organisms are present. NAFO has used quantitative methods to objectively define areas that contain VME indicator species at or above significant concentration levels. These areas are not simply defined by the individual tows above the threshold value but also all of the smaller catches within the delimited polygon. These smaller catches may represent recruitment or smaller species in the VME indicator group. These larger areas are the ‘VMEs proper’ unless post-hoc considerations suggest otherwise. VMEs occur throughout the NRA and their spatial arrangement may be important to recruitment processes and to overall ecosystem

- "Higher concentration observations of VME indicator species" (a.k.a. "Significant concentrations"). These are specific locations where there are individual records of VME indicator species at densities at or above a threshold value that, for that specific VME indicator species, is associated with the formation of highly aggregated groups of that species. These higher concentration locations have been the basis for the delineation of the polygons referred as "Areas of higher sponge and coral concentrations" in NAFO CEM Article 16.5, which are closed to bottom fishing activities.

Something similar happens with the definitions of VME topographical, hydrophysical or geological features or elements. The FAO Guidelines provide examples of elements, for example, submerged edges and slopes, summits and flanks of seamounts, canyons and trenches, hydrothermal vents and cold seeps. However, the Guidelines do not include precise definitions for those elements. In a practical sense, the ICES Working Group on Marine Habitat Mapping—WGMHM (ICES, 2020b) has noted that many of the VME elements lack:

- exact definitions for using them as a tool for considering the distribution of VMEs,
- rule-sets to derive/delineate these elements (except for the 'Steep flanks 6.4°' element used in NAFO) and
- peer-review studies demonstrating the explicit link between VME elements and VME habitats or indicators.

The ICES WGMHM (2020b) has recently reviewed existing definitions, and developed working definitions for the analysis, for the VME elements such as isolated seamounts; steep-slopes and peaks on mid-ocean ridges; knolls; canyons; steep flanks >6.4° and hydrothermal vents. In addition, they have identified other geomorphological features which might have merit as VME Elements, namely: guyots (isolated or groups of seamounts with a smooth, flat top); escarpments (elongated, linear, steep slopes separating gently sloping sectors of the seafloor in non-shelf areas); and glacial troughs (elongated troughs formed by shelf valleys at high latitudes incised by glacial erosion during the Pleistocene). NAFO has also interpreted the features listed in the FAO Guidelines to produce operational definitions. This is something that could be carried out in other RFMOs to improve the identification of VME. To this respect, ICES WGMHM proposes that the following steps be taken to validate and standardize the use of VME elements (ICES, 2020b) and this can be considered in the different RFMOs/RFBs:

- Link VME elements to an existing geomorphological glossary so that definitions remain standardized between studies.
- If the geomorphological glossary does not provide specific instructions on how to derive the feature of interest, a rule-set must be written so that VME elements are consistently delineated and transferable between areas.
- The relationship between VME elements and VME habitat and indicator species should be proven and quantified. Once quantified, it can be used to weight the use of different elements in order of effectiveness. This report starts this validation process but further work will be needed to extend this analysis (as well as update it when new VME observations are reported).

On a more general matter, some experts have recently pointed out that there has been some confusion between the concepts of "community" (e.g., dense aggregations of VME indicators) and the concept of "ecosystem" (which is a broader concept, for example, that may include different populations, communities of several kinds and habitats, that are nested and interact at a functional level) (Watling and Auster, 2021). Many times, when referring to VME, people are really talking about vulnerable marine communities, which can be in fact, part of the larger ecosystem. In this context, they suggest for example, the seamount ecosystem may extend over multiple seamounts in a biogeographic area, harboring a variety of communities and habitats, and that it is this larger ecosystem that needs to be protected to avoid disruptions of its functioning. Watling and Auster (2021) also point out that the concept of VME indicator species has been conflated with the ecosystem itself so that when some authors speak of VMEs they are simultaneously speaking of the presence of indicator species but also, by inference, evaluating the presence of a vulnerable ecosystem. In their opinion, the problem is that sometimes, the occasional presence (i.e., sparse distribution) of indicator species is interpreted to mean that we are not in an VME. However, they stress that indicator species are meant to represent all of the other species that cannot be considered or sampled in the ecosystems, which means that we cannot exclude being in a VME just because VME indicators are distributed sparsely.

This last issue was discussed during the Workshop, where it was pointed out that some of the confusion or misunderstanding may have arisen from the scale at which one is looking at VMEs. That spatial scale is very much influenced through the lens in which VMEs are evaluated. From the perspective of marine nature conservation, the scale for protecting seascapes is much broader and more all-encompassing in terms of very wide variety of habitats that are interconnected (which may be part of different ecosystems), supporting different populations of benthic organisms that are interacting amongst each other, and some of those will necessarily occur in certain locations at higher densities. However, this does not seem to be the perspective taken in the Guidelines, where the intention is to ensure that RFMOs are moving towards more sustainable fishing at an ecosystem level, and implementing ecosystem approach to fisheries management. This is in line with the concept of SAIs, as defined in the Guidelines, which not only refers to the spatial extent of the impact but it places that spatial extent in the context of available habitat, and this is quite important, because what it implies is that within RFMOs the objective is not to protect under closure measures all VMEs, but to ensure sufficient VMEs are protected and significant adverse impacts are avoided. In the case of NAFO, this has been the interpretation of the Guidelines, and based on that, NAFO has set the protection level to be at 60% (see NAFO 2021b, p. 60), based on VME organisms' biomass rather than abundance. However, some concerns were raised about the 60% level of protection used in NAFO, because it is not clear how this 60% percent should be applied, for example, would this 60% of protected biomass include only specific VME taxonomic groups or all VME indicator taxa in the bioregion? Therefore, it is necessary to discuss this issue further in order to establish acceptable thresholds of protection level for VMEs, as it may not be realistic to be able to protect 100% of VMEs.

There are also societal issues and broader biodiversity considerations as well that that need to be consider in the definition of VMEs, and they will continue to play together with the fisheries interests in terms of the overall debate at the international level on VME protection and biodiversity protection. For example, a study in Norway showed that people value cold water coral due to its role as habitat for fish not only because fish provides food (and generate income) for them, but also because they care about the existence of fish. That is, people do care for cold water coral per se, and especially if it constitutes an important habitat for fish. Also, they are willing to accept that commercial fishing and the oil industry are adversely affected by cold water coral protection (Foley et al. 2010). In addition to that, VMEs (such as cold water coral reefs) offer different services that are of value to society. Below is a list of the main ecosystem services that have been identified for VMEs (Foley et al. 2010; Armstrong et al 2014; Weinnig et al., 2020):

- **Supporting services**. Biotic supporting services refer to the functional values associated with biodiversity and the role of VMEs as an essential fish habitat in supporting specific fisheries. Cold-water coral communities are an essential component of healthy deep-sea ecosystems and function by contributing to nutrient and carbon cycling, and providing heterogeneous biogenic habitats, feeding grounds, and nurseries for many fishes and invertebrates

- **Provisioning services**. At present, there is very limited direct use of VME indicator species, with fragments of cold water coral traded as jewellery or decorations being the only example. Potential future direct use may however include chemical compounds for industrial and pharmaceutical applications. VMEs are thought to offer new opportunities for pharmaceutical, engineering, medical and food research. For example, the coral species *Sarcodictyon roseum* is being used in clinical trials for the cure of various strains of cancer and bamboo corals are being used for bone grafting.
- **Regulating services**. Some types of VMEs, such as cold water coral reefs may sequester CO2 and thus remove CO2 from the atmosphere. In this light, national policy for the protection of CWC could also potentially be used in a similar vein to afforestation thereby alleviating climate change.
- **Cultural services**. Cultural services are the non-material benefits people obtain from habitats and ecosystems through recreation, aesthetic enjoyment, inspiration and awe. There are an increasing number of books and documentaries discussing deep-sea ecosystems and habitats which allow people to see and appreciate them.

So overall, there is an increasing awareness that human welfare crucially depends on ecosystem services beyond our daily experiences, which renders information about these unfamiliar and inconspicuous goods and services highly important. Further protection of cold-water corals (and other deep sea species) is regarded as a benefit for which people have a positive and significant willingness-to-pay (Aanesen et al. 2015).

Summary of main issues regarding definitions and interpretation of key concepts

- Lack of operational definitions.
- Some experts consider that there is a confusion between the concepts of “community” (e.g., dense aggregations of VME indicators) and the concept of “ecosystem” (i.e., Watling and Auster, 2021).
- There is a need to discuss and establish acceptable thresholds of protection level for VMEs, as it may not be realistic to be able to protect 100% of VMEs.

- Societal issues and broader biodiversity (e.g., BBJN) considerations as well need to be considered in the definition of VMEs.

2.2 VME indicator species

In general, RFMOS/RFBs have elaborated lists of regional VME indicator taxa following the criteria established in the FAO Guidelines. These lists have included them in their conservation measures to protect VMEs. Some RFMOs/RFBs include a wide variety of taxa, that include corals (gorgonians, hydrocorals, stony corals, black corals), sponges, bryozoans, sea lilies, anemones, etc. (CCAMLR, NAFO, NEAFC, SPRFMO). Others however, have only included in their measures a few taxa, for example, GFCM has included only 15 species of cnidarians and NPFC only include 4 groups of corals, but neither has other types of organisms, such as sponges or bryozoans. In most RFMOs, the lists of VME indicators are being revised as new information becomes available. For example, in the last years, SPRFMO has been frequently revising its list of indicator taxa practically every year (SPRFMO, 2019, SPRFMO, 2020 and SPRFMO, 2021c).

In most cases, individual criteria are used to evaluate possible VME indicator taxa, however, improvements for the evaluation of VME indicator taxa are being investigated. For example, in SPRFMO (2021c), the authors argue that there is value in evaluating multiple combinations of the FAO's VME criteria. They have used different combinations of criteria, such as fragility plus recovery, which provides the most basic assessment of whether a VME indicator taxa is likely to suggest the presence of a VME, combining as it does the two criteria central to the concept of a VME. Additional combinations of the VME criteria provide insights into: (i) those taxa that may be vulnerable because their loss in one area may not be compensated for by their occurrence in other areas (i.e., fragility plus recovery plus uniqueness/rarity); (ii) those taxa whose vulnerability may be related to their functional importance for other species (e.g., fragility plus recovery plus functional significance); and (iii) those taxa whose vulnerability may relate to their physical structural complexity of the habitat they provide for other species (e.g., fragility plus recovery plus structural complexity). Used together, these combinations of the FAO's VME criteria can provide a direct line of insight into the potential consequences of taxon-specific impacts of bottom fishing. For example, consequences such as the potential loss of rare species, habitat areas for spawning fish, and habitats with high diversity. Within a management context, this information can help target mitigation strategies towards those taxa whose loss may result in broad and/or local ecosystem-level impacts. For example, while management is required to prevent SAIs on all VMEs, it may be desirable to focus on management measures that protect those VME indicator taxa that have a disproportionately important role in ecosystem functioning (SPRFMO, 2021c).

One of the issues noted in this review were that, in many occasions, expert reviewers indicate a lack of information to evaluate a FAO criterion. For example, expert reviewers could not evaluate the "Recovery" criterion for many taxa of the order Alcyonacea (soft corals and gorgonians), or the "uniqueness or rarity" and "functional significance" for most taxa in the order Antipatharia due to the lack of biological and distribution information (Geange et al. 2020a).

Summary of main issues regarding VME indicator taxa

- In some RFMOs, the lists of VME indicators include few taxa and more work is needed.
- Expert reviewers often indicate a lack of information to evaluate candidate VME indicators against FAO criteria. It is necessary to carry out research to fill the gaps regarding biological information of benthic organisms and their distribution, in order to allow their evaluation against FAO criteria.

2.3 Approaches to identification of VMEs

Vulnerable marine ecosystems are best identified using high quality underwater imagery (Remotely Operated Vehicles – ROV, towed camera, etc.) (Morato et al. 2018). Underwater imagery allows accurate and quantitative description of community composition and associated fauna, determination of the extent of the associated habitat, and the damage caused by particular fishing gears (e.g., Hansen et al., 2013; Ardron et al. 2014). This has been done in most RFMOs (e.g., CCAMLR, NAFO, NEAFC, SEAFO, etc.), with more or less frequency. However, because of the high cost of operations associated with such imaging technologies, observations of VMEs are only available for a tiny fraction of the area of the deep seabed (Morato et al.2018). Considering this, the commonest type of data available in RFMOs is data from bycatch records from fisheries surveys and commercial fishing operations.

At least three quantitative (or at least semi-quantitative) and repeatable approaches have been applied since Ardron et al. (2014) published an article proposing the first systematic approach towards the identification and protection of VMEs:

- The Kernel Density Estimate (KDE), used in NAFO.
- Species distribution models/Habitat suitability models, used in NAFO and SPRFMO, and being tested in other RFMOs using limited data, such as NPFC and SIOFA.
- Multi-criteria Assessment MCA, used by ICES for NEAFC.

These approaches draw on catches from scientific surveys, existing data on the distribution of VME indicator taxa, and/or visual data from scientific surveys of benthic organisms (Warawa et al. 2021). However, quantitative approaches require an important amount of data on the abundance or density of VME indicator taxa sampled over the general study area to identify VMEs and areas that are likely to be VMEs. There are many records of bycatch in research trawls in the NAFO Regulatory Area, which has allowed individual VME indicator taxa to be used for identifying VMEs with the KDE approach in the NW Atlantic Ocean (Kenchington et al. 2014). The ICES database used by Morato et al. (2018) also contains thousands of records of VME taxa from many sources that can be used to identify VME indicator taxa distributions and areas that are likely to be VMEs. Similarly, there has been a significant effort in the SPRFMO CA to identify and accumulate VME records from fisheries bycatch and conduct directed research surveys that can be used to determine VME thresholds and the distribution of VME indicator taxa (Rowden et al. 2020).

Therefore, not all of the RFMOs can apply repeatable, quantitative approaches because there are not enough data (e.g., SEAFO, CECAF, NPFC, SIOFA, WECAFC). For example, in the NE region of the NPFC Convention Area, there is limited cold-water coral abundance data available, because most of the data come from fisheries bycatch and research surveys in the NW region of the North Pacific Ocean. Due to the limited availability of abundance data, scientist have not been able to fully apply quantitative approaches as described above (Warawa et al. 2021).

A more detailed analysis of the advantages and disadvantages of various methods to identify VMEs is presented below.

Research surveys

Research surveys can provide bycatch data for benthic organisms (and some can also provide visual data, such as underwater imagery, and map the seabed habitats).

One of the problems in using bycatch data from trawl surveys to inform on the presence of VMEs lies in the fact that bottom fishing gear are poor sampling tools for VME indicator organisms and that bycatch data may not represent the true benthic community composition and densities. Thus, there is a large amount of uncertainty associated with bycatch data (Auster et al., 2011, Hansen et al. 2013, Morato et al. 2018).

As it was already pointed out in Deliverable 2 "Guidelines for improving by-catch management in DSF- Task 3", sampling of benthic organisms using trawling gears is destructive, which is a major concern considering the fragility of benthic organisms conforming VMEs. This has been stressed by the DSCC (2020a), that recommended that bottom trawl fisheries research surveys should avoid all areas where VMEs are known or are likely to occur and non-destructive sampling should be employed, particularly in areas where bottom fishing is prohibited. To this regard, established surveys could try to develop sampling plans that avoid locations where VMEs are known, for example, if a sampling station falls inside a closed VME area, the sampling could be carried out just outside the closed area (this kind of strategy is used in surveys in the NAFO area, Pers. Comm.). However, any restructuration or change in the survey plans must be carefully considered, because this may negatively affect the quantity and quality of the data collected by a particular survey. Bottom trawl surveys usually provide fundamental data for assessing the condition of exploited fish stocks and for monitoring the general status of the marine ecosystem. For this, surveys follow standardized protocols to ensure the quantity and quality of data is maintained over time. In this context, any change (e.g., changes in sampling strategy and effort, gear, tow lengths or speed) can all impact the comparability of a survey over time, introducing biases or affecting the indices produced from the surveys (e.g., the index of fish abundance, typically the number or weight of fish caught per unit of effort) (ICES, 2020c).

Underwater imagery can be incorporated into surveys to obtain information on the location and characteristics of potential VMEs, for example, by using remote operated vehicles (ROVs) or towed cameras (e.g., Dinn et al., 2020, Beazley and Kenchington, 2015; McIntyre, 2016). However, video surveys do have their limitations with respect to species identification and complementary methods are often needed (e.g., an Agassiz trawl to obtain specimens) to cover a representative area and acquire some degree of taxonomic certainty (McIntyre, 2016).

Another promising method to survey potential VMEs without destructing them is using environmental DNA (eDNA) [1]. The term eDNA refers to any DNA that is collected from an environmental sample (such as water or sediments) rather than directly from an organism. eDNA originates from body cells or waste products of organisms and remains suspended in the water column or in the sediment (Ficetola et al. 2008; Taberlet et al. 2012). This technique could be used, at least in theory, to determine: a) the diversity and species composition in potential or established VMEs, and ii) the abundance and biomass of indicator species. Such an approach has been already tested to map the distribution of cold-water coral reefs in Norwegian fjords by Kutti et al. 2020. In that study, a great potential was demonstrated for eDNA measurements as a cost-efficient tool for a rapid screening of the distribution cold-water coral vertical reefs that cannot be imaged using traditional multibeam echo-sounders and difficult to detect using ROVs alone. An earlier study by Everett and Park (2017) tested an eDNA protocol for identification of deep-sea octocorals from water samples collected in a research survey along the west coast of USA. They were able to sequence eDNA from octocorals using water samples, and use these data along with image data collected during the cruise to identify taxa to the species level in a variety of habitats. They concluded that eDNA sampling has the potential to complement traditional deep-sea coral surveys by overcoming the difficulty in visually identifying deep-sea octocorals and characterizing their diversity. Although this type of non-destructive sampling appears to be promising for detection and monitoring of VMEs, its implementation in the short-term does not seem probable. There are still few studies using eDNA to detect VME species and specific pilot studies in different areas with diverse bathymetry and hydrographic conditions must be carried out to test the utility of eDNA for these purposes. Other considerations for the implementation of eDNA for detecting VME species are:

- A better understanding of how eDNA in the marine environment is originated, its state, how it is transported and how it is degraded is needed. The concentration of eDNA is dependent also on intrinsic factors of the organisms (e.g., physiology and life history) and other factors, like biomass and use of space of organisms. This information is still scarce for many VME species.

1 The use of environmental DNA (eDNA) has been also been discussed in Deliverable 2 "Guidelines for improving by-catch management in DSF- Task 3". Most of this information is already presented there but has been added here because it is relevant.

- eDNA is a sensitive method, and there are many potential sources of error. Some of these errors are associated to collection, laboratory and bioinformatics procedures and include contamination, inhibition, amplification and sequencing errors, computational artifacts and inaccurate taxonomic assignment. From these errors, the most serious is probably the risk of contamination and hence the possibility of false positive results, but also the misassignments of species due to incompleteness or errors in public genomic databases. These sources of error must be considered when developing and fine-tuning protocols
- The sequences available in public databases are far from being complete and may not contain sufficient reference sequences for VME indicator species, therefore, an assessment of the species inhabiting the area of study is highly desirable, in order to build ad hoc databases. This can be done through dedicated surveys to collect samples and expert taxonomists to identify the species.
- Taxonomy itself can be problematic for many VME species and needs further research. For example, in the SPRFMO area, bamboo corals that grow as unbranched colonies have generally been assumed to belong to the genus *Lepidisis*. However, recent genetic and morphological data from approximately 400 bamboo coral specimens, show that whip bamboos are found in 6 different molecular clades on the bamboo evolutionary tree. It is likely that at least 6 different genera and an untold number of species are involved. Sponge taxonomy in the Pacific is still lacking, as there has been very little work on the molecular genetics of that evolutionary group and the morphological studies are just beginning (SPRFMO, 2020).
- In the literature, diverse approaches for sampling and interpreting DNA data that result in a variety of protocols have been developed (lack of standards). There is no single universal processing workflow that provides a unified and streamlined manner for satisfactorily treating eDNA data from raw sequences to taxonomic identification and diversity analysis. An ongoing project[2], where the feasibility of using eDNA to monitor biodiversity in the context of bottom trawl research surveys is being studied, has highlighted the difficulties in optimizing and reproducing eDNA protocols (i.e., published protocols). Even

2 FishGenome. "Improving cost-efficiency of fisheries research surveys and fish stocks assessments using next-generation genetic sequencing methods" Contract – EASME/EMFF/2017/1.3.2.10/ SI2.790889.

extraordinarily detailed step-by-step protocols produce strikingly different results when carried out at different laboratories, emphasizing the complexity of a broad adoption of the technique for regular monitoring.

Other disadvantages of research surveys are the high costs of carrying research surveys and that logistically, the surveys can be difficult to conduct because of the remote location of the seamounts and other VME habitats (FAO/NPFC, 2018). From the reviewed RFMOs, NAFO has the advantage that there is a regular programme of research surveys in its Regulatory Area that supply valuable data regarding VMEs. For example, there are annual trawl surveys (Spanish 3LNO surveys, the EU Flemish Cap Survey, the Canadian DFO NL Multispecies surveys) and other benthic surveys have been carried out to provide underwater imagery and samples (Surveys from the Bedford Institute of Oceanography, Fisheries and Oceans in Canada) and the NEREIDA surveys carried out by Spain, Canada, the UK and the Russian Federation).

Quantitative analyses to identify VMEs

The FAO guidelines call for the identification of areas where VMEs are either **known** or **likely to occur**. Defining a VME from indicator data will depend on the sampling method used (e.g., trawl or longline data). It may be difficult to confirm presence of a VME habitat based on bycatch data, whether from research or commercial fisheries data. This is due to the nature of the data with respect to the location of catch within the areal extent surveyed and implications for calculating the density of the VME indicators, and due to the generally unknown catchability of the species in question.

Defining the amount of a VME indicator taxon that constitutes a VME has proven difficult. As Kenchington et al. (2014) noted: "The FAO guidelines do not explicitly define the distinction between a VME and a VME indicator species/taxon, although it is clear that a single occurrence of an indicator does not constitute a VME, neither does the full distribution of a species/taxon. However, under the FAO criterion of structural complexity the term "Significant concentration" is used to identify the level of aggregation which is expected, even though it is given without an operational context."

The quantitative analyses used by NAFO have been successfully applied to identify a variety of VMEs. The KDE method itself is a simple non-parametric neighbor-based smoothing function that relies on few assumptions about the structure of the observed data and uses minimal interpolation.

Nevertheless, sufficient biomass data needs to be available to undertake this type of analyses and have confidence in the KDE estimated polygon areas representing the

VME. To this respect, it must be considered that NAFO has a regular programme of research surveys in its regulatory area that allows sufficient data collection in its regulatory area. ICES attempted to use a similar approach to this in 2019 with data from the ICES VME database within the NEAFC RA and found the lack of standardized, quantitative data in the VME database caused difficulties in applying the method (ICES, 2021). In other regions, the lack of available data is a problem too. For example, in the NE region of the NPFC's CA there is limited abundance data available of VME indicator species (mostly cold-water corals), because most of the existing abundance data in the NPFC CA are from fisheries bycatch and research surveys in the NW region of the North Pacific Ocean (Warawa et al. 2021 and references therein). This is an obstacle to the implementation of quantitative approaches.

Species distribution models (SDMs) are a commonly used method (e.g., NAFO and SPRFMO) to predict the distribution of vulnerable marine ecosystems and can be particularly useful in deep-sea regions to fill gaps in observational data. These models use data on environmental variables, such as depth and water properties, to predict the occurrence of VMEs and indicator species. A range of models exist in the peer reviewed literature for different VME types and at different spatial scales (ICES, 2020a and references therein).

The major limitation of SDM presence-only models (e.g., MaxEnt) is that sampling effort and the density of the organisms being modelled are confounded when the former is not appropriately represented in the model. Presence-only models can mistakenly identify well-sampled areas with many presence observations as areas with greater densities in contrast with less-sampled areas with fewer presence observations, even if densities are similar between areas (Winship et al., 2021).

For these types of models, absence data are fundamental to fully evaluate the occurrence of VME habitats and indicators, and, specifically, to support mapping of benthic habitats. However, verified absence data for deep-water species and habitats (e.g. VMEs) are not often generated from research surveys. This hampers the ability to perform a proper assessment of the occurrence of VMEs, as it is difficult to establish if the lack of data plotted in maps is due to the actual absence of VMEs or due to a lack of sampling in the area (ICES, 2020a). One of the topics included in the ICES Working Group on Marine Habitat Mapping (WGMHM) 2019 meeting was the issue of reliable absence data availability and its use within marine habitat mapping and SDMs (ICES, 2019). They noted that whilst SDMs can use presence-only data, they tend to be poorer than models using presence and absence data. To address this, methods have been developed by modellers to generate pseudo-absence and background data which include, for instance, designating absence status to species records that are known not to co-occur with the modelled species, or including randomly placed points within the modelled domain, often buffered away from presence observations (ICES, 2019). There are, however, limitations to these methods and it is difficult to ensure that pseudo-absence and background points truly represent absences. As such, models relying on pseudo-absence and background data are more uncertain than those using observed absence data.

Another advantage of collecting absence data is that it may become possible to identify areas where VME habitats have previously occurred but no longer do.

Semi-quantitative approaches

The Multi-criteria Assessment approach used in NEAFC is described in detail in Morato et al. (2018). This method has been developed to evaluate how likely a given area of seafloor represents a VME. The MCA is a taxa-dependent spatial method that accounts for both the quantity and quality of the available data, in this case, available in the ICES VME database.

The MCA has the following advantages (Morato et al., 2018):

- This system provides a measure of the likelihood of a cell (C-square) constituting a VME and the associated level of fishing activity.
- The system is compatible with, and makes use of all the data currently available in the ICES VME database (around 15 000 records in 2018).
- It delivers an output that is simple to visualize and understand, in order to facilitate its implementation in management deliberations. By providing an indication of uncertainty alongside predicted occurrence, the MCA allows for management decisions to be openly discussed, logically weighed, and documented.
- The ability to readily incorporate new data also makes the MCA approach appropriate for adaptive management frameworks.
- This methodology considered several of the steps proposed by Ardron et al. (2014) to identify VMEs, namely step 1 on assessing potential VME indicator taxa and habitats in a region, step 3 on considering areas already known for their ecological importance, step 4 on compiling information on the distributions of likely VME indicator species and habitats, step 6 on considering fishing impacts, and step 8 on identify ecologically important areas.

However, some concerns and limitations of the MCA approach have been identified.

- The VME Index used in the MCA approach is based on a mix of information on the presence of VME indicator groups, the characteristics of these species, and measures of their abundance. Because of this, it is hard to disentangle how each of these contributes to the index when using the final C-square gridded outputs. This means that it is difficult to infer what an index value within a specific location is likely to represent. This is relevant because clarity about the nature of the indicator ('concreteness') is vital for acceptance of outcomes by managers and stakeholders and for the appropriate use by scientists (ICES, 2020d).The process of ranking the VME indicator groups against the FAO criteria in terms of vulnerability has met some criticism, since definitions of what a VME is has already been determined by the FAO guidelines (FAO, 2009). Vulnerability should be assessed in the context of the fishing pressure in a separate step, in what is referred to as an assessment of Significant Adverse Impacts requiring knowledge of the species and gear interactions.
- There is an additional problem about the relevance of the VME abundance thresholds used in the weighting algorithm, in the first steps of the MCA. These are currently based on the NEAFC VME encounter threshold of 30 kg for corals and half of the encounter threshold value for sponges (200 kg) (Article 9 NEAFC Recommendation 19:2014). When developing the VME weighting system, these thresholds were chosen just for the purposes of trialing the system, however these have not yet been updated (ICES, 2018). These thresholds also cause problems for some VME species, like sea pens, because the recorded abundance for these species are evaluated against the VME thresholds for corals (30 kg) or sponges (200 kg). Because of this, sea pens can never attain the status of 'High VME Index' and even when bycatch totals more than 30 kg of sea pens (which represents 1000-100 000s of sea pens), they only reach the threshold to be considered as 'Medium VME Index'. At the other extreme, any amount of stony coral causes a designation as High VME Index. To date, there are no agreed thresholds for VME indicators such as gorgonians, black corals or seapens, and the value for corals (30 kg) that has been used is almost certainly too high a threshold for such VME indicators. This leads to concerns of the index becoming an index of perceived vulnerability rather than likelihood of occurrence.
- Limited applicability of the VME Index in ICES advice. The outputs from the MCA, together with known VMEs, have been mapped by WGDEC since 2017 and used to support the provision of ICES advice to the North East Atlantic

Fisheries Commission (NEAFC) and the European Commission (EC) on the distribution of VMEs in the North Atlantic. Also, areas of known VME ("VME habitats") have been used to support VME closure recommendations or extensions to closures in NEAFC waters, and a flow diagram for the use of VME habitats and VME Index data for closure recommendations was also produced by ICES. However, to date, closures have not been recommended based purely on VME Index data outputs as no significant new 'High Index, High Confidence' records have been identified by WGDEC outside of existing closure areas (ICES, 2021 and references therein).

Summary of main issues regarding VME identification

- Direct observations of VMEs (e.g., using underwater imagery) are only available for a small fraction of the seabed. This is mainly because research surveys are costly and, logistically, it can be difficult to conduct them because of the remote location of the seamounts and other VME habitats.
- Sampling carried out in research surveys using bottom trawls is destructive to VMEs.
- Regarding VME identification, not all of the RFMOs can apply repeatable, quantitative approaches because there are not enough data (e.g., SEAFO, CECAF, NPFC, SIOFA, WECAFC).

2.4 Assessment of SAIs

There is disparity regarding the assessment of SAIs in the different RFMOs. For example, NAFO's Scientific Council has carried out a very thorough reassessment of the risk of Significant Adverse Impacts (SAIs) from bottom fishing activities on VMEs in the NAFO Regulatory Area in 2021 (NAFO, 2021b). Similarly, SPRFMO has used fully quantitative or semi-quantitative assessments to carry out impact assessments bottom fishing on benthic habitats and taxa indicative of VMEs (SPRFMO, 2020: http://www.sprfmo.int/assets/2020-SC8/SC8-DW07-rev-1-Cumulative-Bottom-Fishery-Impact-Assessment-for-Australia-and-New-Zealand.pdf). In other RFMOs, the assessment of SAI is ongoing work (e.g., NPFC, SIOFA, SEAFO) while in other RFMOs there are no specific criteria or guidelines for assessing SAIs (e.g., GFCM, CECAF and WECAFC).

To illustrate the approaches followed by RFMOs that have recently completed bottom fishing impact assessments/re-assessments, we present below a summary of the assessments done by NAFO and SPRFMO.

NAFO 2021 SAI Assessment (NAFO, 2021b):

The assessment was based on estimates of the biomass distribution of VMEs, the distribution of fishing effort (VMS data), and a set of assessment metrics that considers ecosystem function and fragmentation (see Box below). The set of assessment metrics was mapped conceptually to the SAI criteria in the FAO Guidelines.

SAI Assessment Metrics Definition

- **Area/Biomass protected (low risk):** This refers to the proportion of the area or biomass of VME which is currently at low risk either because it falls within a fishery closure area and/or is in an area outside of the fishing footprint.
- **Area/Biomass impacted**. Proportion of the area or biomass of VME which has been exposed to a level of fishing effort above the defined cut-off point within any one year.
- **Area/Biomass at high-risk**. Proportion of the area or biomass of VME which falls below the defined cutoff point of fishing effort within any one year which is not protected.
- **Proportion of overlapping VME in closures.** Proportion of VME area and biomass overlapping with two or more VME types inside VME closures. The greater the proportion of overlapping VME area/biomass protected by closures the lower the risk of SAI occurring
- **Index of VME sensitivity.** The inverse of the VME impact cut-off value is used as a proxy of sensitivity as it indicates the point at which trawl duration/length exceeds the VME indicator patch size within the habitat. The higher the sensitivity the greater the risk of SAI occurring.
- **Index of fishing stability**. The proportion of the total fishing effort for each VME associated with cells repeatedly fished above the impact cut-off value over a 10 period. The greater the proportion of effort associated with areas fished repeatedly above the cut-off value in 10 out of 10 years, the more spatially stable the fishery, and therefore the lower the risk of new SAI occurring.

- **Index of VME fragmentation/proximity.** The spatial extent (size) and location (distance) of VME polygons in relation to their neighbors of the same VME type. The more fragmentation (a low index value) the greater the risk for SAI.
- **Number of important functions in unprotected portions of the VME.** The number of functional types that have important associations with VME and are present in unprotected portions of the VME. Functional types that have >50% area overlap with a VME are considered to show important associations with that VME. Because each VME can be associated with multiple functions, the more associated functions present in the unprotected portions of a VME, the greater the risk of SAI occurring at the functional level.

NAFO defined three categories to assess the protection status of VMEs: 1) Good-Low SAI risk (> 60% VME Biomass), 2) Limited-Intermediate SAI risk (between 30% and 60% VME biomass) and 3) Poor-high risk of SAI (<30% VME biomass). For more detail see Table 1 below.

Table 1. Definition of categories used to assess the protection status of VMEs in the NAFO SAI assessment. Source: NAFO, 2021b.

SAI Score[3] Categories	VME Status	Proportion of biomass protected	Projected Connectivity Among Closures	Management Action
Good (Low SAI risk) >60%	Good	> 60% VME Biomass	Good connectivity	Beneficial
	Adequate	> 60% VME Biomass	Limited connectivity or redundancy	Beneficial
Limited (Intermediate SAI risk) 30% - 60%	Incomplete	60% - 30% VME Biomass	Good connectivity	Desirable
	Limited	60% - 30% VME Biomass	Limited connectivity or redundancy	Desirable
Poor (High SAI risk) <30%	Poor	30% - 15% VME Biomass	Limited connectivity or redundancy	Essential
	Inadequate	< 15% of Biomass	Limited connectivity or redundancy	Essential

The results of this assessment indicated that small gorgonian, black coral, erect bryozoan and sea squirt VMEs have a high overall risk of SAI, whereas the large-sized sponges and large gorgonian coral VMEs have a low overall risk of SAI. The sea pen VME was assessed as having an intermediate risk of SAI.

SPRFMO 2020 SAI Assessment (SPRFMO, 2020).

SPRFMO has used fully quantitative or semi-quantitative assessments to carry out impact assessments of bottom fishing on benthic habitats and taxa indicative of VMEs. In this assessment, habitat suitability models were made for ten VME indicator taxa and, using these, estimates of the proportion of the estimated distribution of suitable habitat and abundance for each taxon outside the Bottom Trawl Management Areas (BTMAs) were calculated. These calculations were done at a range of spatial scales and using a variety of model structures and assumptions to assess sensitivity in the estimates. The results indicated that at the broadest scale, about 80% of suitable habitat or abundance of stony corals and about 90% of suitable habitat or abundance of other VME indicator taxa are outside the BTMAs (thus, at low risk of SAI). However, at finer geographical and taxonomic scales, and using different assessment approaches, the proportions of suitable habitat outside the BTMAs vary quite widely. For example, estimates for the NW Challenger Plateau average <70%, the Central-South Louisville Ridge where an average of 60% of suitable habitat and 45% of abundance of the key species of stony coral are outside the BTMA, together with 52% of suitable habitat and 48% of the abundance of other VME indicator taxa.

In the Workshop, it was pointed out that environmental impact assessments have not been done consistent with the Guidelines in some areas where bottom fishing is permitted. For example, the approach followed by SPRFMO to conduct the impact assessment has met some criticism by some NGOs. For instance, concerning the metric used to assess the performance of SPRFMO's spatial management areas. As DSCC (2020b) pointed out, this metric was the estimated proportion of each of a range of VME indicator taxa which was not exposed to fishing impacts. However, according to the UNGA resolutions, the key metric is not the proportion of VMEs not exposed to fishing impacts – it is the VMEs that are exposed to fishing impacts. Because of this, the DSCC considered the so-called 'bioregional' analysis to be completely inappropriate, and the conclusion – that "For the bioregional analysis conducted in 2018, the estimated proportion of VME indicator taxa not exposed to fishing was greater than 80% across all bioregions." – to be fundamentally misguided, as well as based on inadequate bioregional data. The issue to be analyzed is the VMEs that have been damaged by bottom trawling – not those that have not because there was no fishing. DSCC (2020b) also criticized the reliance on habitat suitability models because the relationship between habitat suitability indices and the abundance of each modelled taxon is quite uncertain and probably variable. For this reason, it urged SPRFMO to use mitigation measures of assessment, identification, closures and a move-on rule in line with UNGA Resolutions.

Another issue that was raised during the Workshop is the need to discuss what threshold would be appropriate for the protection of VMEs without causing SAI, because there is no set threshold in the Guidelines. Such a threshold would help to operationalize VME protection according to the Guidelines, and it is important because in reality, it may be reasonable to assume that a fraction of VMEs can be lost without incurring SAIs. For example, NAFO considers that a good protection status is achieved when 60% of the VME biomass has a low risk of SAI. However, some concerns were raised in the Workshop about the 60% level of protection used in NAFO, because it is not clear how this 60% percent should be applied, for example, would this 60% of protected biomass include only specific VME taxonomic groups or all VME indicator taxa in the bioregion? For the other RFMOs, it is not clear what protection level has been considered.

To improve impact assessments, the DSCC (2020b) has suggested a checklist, derived from the FAO International Guidelines and the UNGA resolutions. The impact assessment should set out at least:

- (a) identification, (b) description and (c) mapping of VMEs known or likely to occur
- (a) data and (b) methods used to identify, describe and assess the impacts of the activity, (c) the identification of gaps in knowledge, and (d) an evaluation of uncertainties in the information presented in the assessment;
- (a) identification, (b) description and (c) evaluation of the occurrence, scale and duration of likely impacts;
- cumulative impacts of activities covered by the assessment on VMEs and low- productivity fishery resources in the fishing area;
- assess individual and collective (as well as cumulative) impacts;
- risk assessment of likely impacts by the fishing operations to determine which impacts are likely to be significant adverse impacts, particularly impacts on VMEs and low productivity fishery resources; and
- (a) the proposed mitigation and management measures to be used to prevent significant adverse impacts on VMEs and ensure long term conservation and sustainable utilization of low-productivity fishery resources, and (b) the measures to be used to monitor effects of the fishing operations.

Summary of main issues regarding assessment of SAI

- Not all RFMOs gave completed impact assessments of bottom fishing activities.
- Some of the impact assessments may have not been carried out according to the Guidelines and UNGA Resolutions (e.g., SPRFMO, as criticized by DSCC, 2020b).
- There is a need to discuss what threshold would be appropriate for the protection of VMEs without causing SAI, because there is no set threshold in the Guidelines. Such a threshold would help to operationalize VME protection according to the Guidelines, and it is important because in reality, it may be reasonable to assume that a fraction of VMEs can be lost without incurring in SAIs.

2.5 Measures to protect VMEs

The majority of the RFMOs with competence over bottom fisheries on the high seas (e.g., NEAFC, NAFO, SEAFO, NPFC) have adopted regulations to prevent SAIs on VMEs through an area-based management approach, which entails establishing three types of areas (DSCC, 2020a):

1. Existing bottom fishing areas (initially delineated around a bottom fisheries "footprint" based on historic patterns of bottom fishing in the RFMO area) where bottom fishing is permitted;
2. Areas closed to bottom fishing designated to protect VMEs identified by the RFMO and/or "representative" areas of VMEs both inside and outside of existing fishing areas; and
3. Areas outside of the existing fishing areas but which have not been formally closed, where bottom fishing can only take place if a prior impact assessment is submitted and reviewed by the RFMO and a permit for "exploratory" fishing is approved – i.e., areas provisionally closed to bottom fishing.

Existing fishing areas (i.e., fishing "footprint")

As is widely recognized, the determination of the historical bottom fishing footprint is crucial for the adequate management of DSF, and in particular for the adoption and implementation of appropriate management measures for the protection of VMEs from the impacts of bottom fishing gears, including through the adoption of encounter and/or exploratory fishing protocols. The footprint definition is still under development within some RFMOs (e.g., NPFC, GCFM), while in other RFMOs, this footprint has been already established (e.g., NAFO, NEAFC and CCAMLR). To this regard, a review of the existing criteria/methods for characterization of fishing footprint in deep sea fisheries in relevant RFMOs, as well as in FAO Area 41 was carried out in Deliverable 3 "Review of existing and recommended criteria and methodologies for the establishment of historical and cumulative fishing footprints (Task 4 – Sub-task 4.1)". Therefore, this measure is not discussed further here and the information regarding the fishing footprint can be consulted in the above-mentioned deliverable.

Area closures to protect VMEs

Closing areas to bottom contact gear is the only certain method for avoiding significant adverse impacts on VMEs (Wright et al. 2015 and references therein). This is a well-establish measure to protect VMEs and such closures are used by most of the reviewed RFMOs as the main measure to protect VMEs (Table 2). The value and effectiveness of "no-take" marine reserves is well-evidenced by the literature on marine protected areas, and studies have confirmed these benefits in the context of bottom fisheries closures in the high seas (Wright et al. 2015 and references therein). However, this measure's effectiveness depends on the correct identification and definition of the area occupied by a VME. As was mentioned above, there is still a lack of empirical data (e.g., from research surveys) on the distribution of VMEs and identification of VMEs relies many times in the results of distribution models.

The effectiveness of area closures can be improved by using explicit buffer zones. In the context of the protection of VMEs from significant adverse impacts of bottom-contact fishing gears, a buffer zone is considered to be "a spatial margin of assurance around the VME to avoid adverse impact" (ICES, 2013). For example, Grant et al. (2018) showed that sediment clouds produced during bottom trawling activities taking place outside of a conservation area in British Columbia (Pacific Canada) had an impact on glass sponges found at >2 km from the source, inside the conservation area. Such buffer zones have been used by ICES, for example, to ensure the protection of VME habitats distributed along the edge of the C-squares containing VMEs in EU waters (ICES, 2020). To this regard, NAFO has recently applied a modified version of the ICES approach to creating buffer zones to the NAFO closed areas to explore whether that method could be used by NAFO to provide additional protection to the VMEs of SAI of fishing (NAFO, 2020).

Table 2. Overview of area closures implemented in relevant RFMOs/RFBs and Fishing Areas.

RFMO/Area	Area closures
CCAMLR	Area closures are established in CM-22-06 and CM 22-07. So far, CCAMLR has registered 56 VMEs.
CECAF	Although there are no current frameworks and measures to prevent SAI in the CECAF area, there is one closed area shared with SEAFO to protect VMEs.
FAO Area 41 SW Atlantic	There is no RFMO in this Area. However, the Spanish Government implemented a fishing closure for the Spanish bottom trawling fleets in the high seas of the southwest Atlantic on July 2011. The current closed area amounts to 41 300 km^2.
GFCM	GFCM uses "Fisheries Restricted Areas (FRA)". These are multi-purpose area-based management tool used to restrict fishing activities and protect essential fish habitats and deep-sea sensitive habitats. The GFCM has three Fisheries Restricted Areas in relation to VMEs.

NAFO	26 closed areas are established in Article 17 of NAFO CEM. These include different types of closures: i) Seamount Closures, ii) coral area closure, iii) High Sponge and Coral Concentration Area Closures
NEAFC	There are 13 Area closures for the protection of VMEs established in Recommendation 10 2021 (e.g., Hatton Bank 1 and 2; Rockall Bank; Logachev Mounds, West and Rockall Mounds).
NPFC	Precautionary closed off areas to fishing for potential VME conservation are established in CMM 2021-05 and 2021-06. According to this, the NPFC has two closed seamounts.
SEAFO	Eleven closed areas to all fishing gears and one closed area to all fishing gears except for pots and longlines have been defined.
SIOFA	SIOFA has established five closed areas to protect VMEs (i.e., Atlantis Bank, Coral Point, Fools Flat Point, Middle of What Point and Walter's Shoal Point). All of these areas are closed since 2018.
SPRFMO	SPRFMO has adopted a set of areas where bottom trawling (and other bottom gears) is permitted, designated as "bottom fishing management areas," but it has not formally closed any areas to bottom fishing. Areas outside of the bottom fishing management areas are provisionally closed to bottom fishing.
WECAFC	In Recommendation WECAFC/16/2016/4 established five areas that contain or are likely to contain VMEs, and requested that States act accordingly to close these areas to bottom fishing on a temporary basis and subject to review (WECAFC, 2016).

Another important aspect to be considered for the effectiveness of closures is determining the connectivity among the areas closed to protect VMEs. Population connectivity refers to the exchange of individuals among populations: it affects gene flow, regulates population size and function, and mitigates recovery from natural or anthropogenic disturbances. Many populations in the deep sea are spatially fragmented, and will become more so with increasing resource exploitation. Thus, understanding population connectivity is critical for spatial management (Hilário et al. 2015). Benthic invertebrates under protection, are all sessile as adults but rely on larval transport for dispersal and persistence. In this context, there are source and sink populations: for a given species, good quality habitats yield a demographic excess (natality greater than mortality), and are designated as 'source'. Lower quality habitats yield a demographic deficit (mortality greater than natality) and are designated as 'sink' (Dias, 1996). Larval retention in sink populations becomes very important to their persistence at least in the short-term, although such populations are susceptible to negative genetic consequences over generations (reduced fitness, inbreeding etc.). For this reason, effective area closures for the long-term conservation of VME must take into account connectivity. For example, NAFO has already started evaluating connectivity among areas closed to protect large-sized sponges, large gorgonian corals and sea pens (NAFO, 2020).

Climate change should be also considered, because it might lead to shifts in VME distributions by changing or reducing suitable habitat for VME species. Understanding how climate change can affect the distribution of deep-sea species is critically important for developing appropriate area closures and other measures. To this regard, Morato et al. (2020) carried out a study where the effects of climate change on habitat suitability for VMe species were determined. They used environmental niche modelling along with the best available species occurrence data and environmental parameters to model habitat suitability for key cold-water coral and commercially important deep-sea fish species under present-day (1951–2000) environmental conditions and to project changes under severe, high emissions future (2081–2100) climate projections (RCP8.5 warming scenario) for the North Atlantic Ocean. Their results showed a projected decrease of 28%–100% in suitable habitat for cold-water corals and a shift in suitable habitat for deep-sea fishes of 2.0°–9.9° towards higher latitudes.

Provisionally closed areas

Provisionally closed areas are areas that have not yet been opened to fishing, and occur outside of permitted, or existing, fishing areas (the fisheries footprint) designated by the RFMO. These areas are not formally closed to bottom trawl fishing but are areas where no fishing is permitted without first conducting an impact assessment and following an exploratory fisheries protocol before the area can be designated as open to bottom trawling (DSCC, 2020a). Regarding exploratory fishing in new areas, most RFMOs have developed protocols to carry out risk assessments of known and anticipated impacts of bottom fishing (e.g., CCAMLR, NEAFC, NAFO, SEAFO, SPRFMO).

This has been the main approach followed by SPRFMO, where there are no designated VMEs and associated closures (all areas outside the defined fishing areas are essentially closed to protect VMEs), and that avoiding significant adverse impacts on VMEs is considered mostly at a broad, regional scale, rather than a local scale (Cryer and Soeffker, 2019 -SPRFMO). However, this approach has received criticism because it allows bottom fishing to continue and only aims at minimizing, but not fully preventing, SAI on VMEs (i.e., by establishing proper area closures) (DSCC, 2020b).

DSCC (2020a) recently advised that the UNGA should recommend that sites where VMEs have occurred or were likely to have occurred in the past, but which may have been damaged or destroyed by bottom fishing, be placed off limits, at least to bottom trawling, and provided an opportunity to regenerate and potentially recover. This is in line with the UN Decade on Ecosystem Restoration (2021-2030), which aims at preventing, halting and reversing the degradation of ecosystems worldwide (https://www.decadeonrestoration.org/), and should be given more attention. However, to put this recommendation into practice, the first step would be to identify VMEs that existed and were damaged or destroyed and this may not be straightforward, because it would require the analysis of historical data (bycatch data or other records) that may not be available. To this regard, recent studies are exploring the use of habitat suitability models to provide estimates for a pre-fishing baseline of the distribution and biomass of VME indicator taxa (Downie et al., 2021). In that study, it was possible to identify areas of suitable *Geodia* sponges habitat that are currently impacted by fishing, suggesting that past sponge habitats have been impacted by bottom trawling activities.

Overall, there have been few studies documenting the recovery of destroyed VMEs. Recently, there has been evidence that indicates that long-term protection of heavily trawled seamounts does allow for measurable recovery of seamount deep-sea coral communities on time scales of 30 to 40 years (Baco et al., 2019). The observations in that study suggest that the recovering communities observed contain some, but not all, of the elements of the predisturbance communities. Therefore, the question of whether the recovering community is an alternative community or an early community that, with successive community change, will eventually return to an assemblage similar to the predisturbance communities (composed of long-lived octocorals and antipatharians) is still open. In areas beyond national jurisdiction, RFMOs should consider that the current protocol of allowing continued bottom-contact fishing at sites that have already experienced heavy trawling may cause damage to remnant VME populations. If these remnant populations are large enough to be reproductively viable, then they are likely to play a critical role in the recovery process as a source of propagules for heavily disturbed areas on seamounts, and further impacts could thereby limit the recovery process. The time scales for recovery observed on these seamounts additionally suggest that short-term closures would not allow sufficient time for affected communities to recover; instead, a long-term or even permanent closure will be needed for significant recovery to be attained on seamounts (Baco et al. 2019).

Another aspect to consider with regards to this recommendation is the potential conflicts with the fishing sector that would see their fishing grounds diminish when new areas of closure are increasingly proposed.

Summary of main issues regarding area closures to prevent SAIs

- Some RFMOs have not implemented closure areas to specifically protect VMEs (e.g., SPRFMO, GFCM)
- The identification and delineation of the area closures is not a straightforward process (see Section 2.2.).
- There is still a lack of empirical data on the distribution of VMEs within the high seas, which means that spatial management is often informed by model predictions of the spatial distribution of VME indicator taxa. Models, however, have a level of uncertainty associated.
- The VME closures typically represent only a proportion of the full extent (where known) of the VME present, especially where such areas coincide with a defined fishing footprint (e.g., NAFO, NEAFC) (Bell et al., 2018).
- In most cases, it is likely impossible to directly assess whether these areas are meeting their conservation objectives, since they usually lack the requisite baseline data to determine the effectiveness of management decisions (Bell et al., 2018).
- There is a lack of application of precautionary approach in many areas where there is not enough data.
- While area closures can offer protection from direct impacts of bottom-contact fishing gears, the long-term viability of the protected populations will depend on identifying and protecting sources of recruitment and connectivity pathways (Wang et al. 2020 and references therein). Connectivity of closed areas has not been considered in most RFMOs.
- Closure areas in many RFMOs do not consider buffer zones. In the context of the protection of VMEs from significant adverse impacts of bottom-contact fishing gears, a buffer zone is considered to be "a spatial margin of assurance around the VME to avoid adverse impact" (ICES, 2013a).
- Climate change has not been given enough attention and should be considered when implementing measures to protect VMEs.
- Restoration of VMEs in previously fished areas has not been received enough attention. This is something that needs to be considered, because recent studies suggest that long-term protection of heavily trawled seamounts does allow for measurable recovery of seamount deep-sea coral communities on time scales of 30 to 40 years (e.g., Baco et al., 2019).

Other measures

Move-on rules, also referred to as encounter protocols, were initially instituted in the early 1990s in Canadian snow crab fishery and groundfish fisheries to reduce wastage of unmarketable catches of target species (Kenchington, 2011). In response to the UNGA requirements to ‘prevent significant adverse impacts’ to areas where VMEs are ‘known or likely to occur’, numerous RFMOs have adopted move-on rules as a first measure to prevent ongoing fishing in areas where ‘evidence’ of VMEs is encountered during fishing operations (Figure below). These move-on rules require fishing vessels to move a predetermined minimum distance from locations where some pre-determined quantity of species indicative of VMEs are captured in fishing gear. In the event that a fishing vessel exceeds a predetermined threshold (weight, volume and/or biodiversity) of VME indicator species, a move-on rule may be triggered requiring the vessel to move a predetermined minimum distance from its current fishing area (Hansen et al. 2013).

The main advantage of move-on rules is that they provide an immediate response that prevents further damage to possible VMEs encountered during fishing operations. Actually, move-on rules can serve as “back stops” or “insurance” to the main management measures (e.g., area closures) in case these turn out to be deeply flawed. For instance, a move-on rule can put a quick stop to fishing in a place where large amounts of sensitive and structural benthic fauna are recovered when none or little was predicted by the VME habitat suitability models used to design the spatial management regime (Cryer et al. 2018)

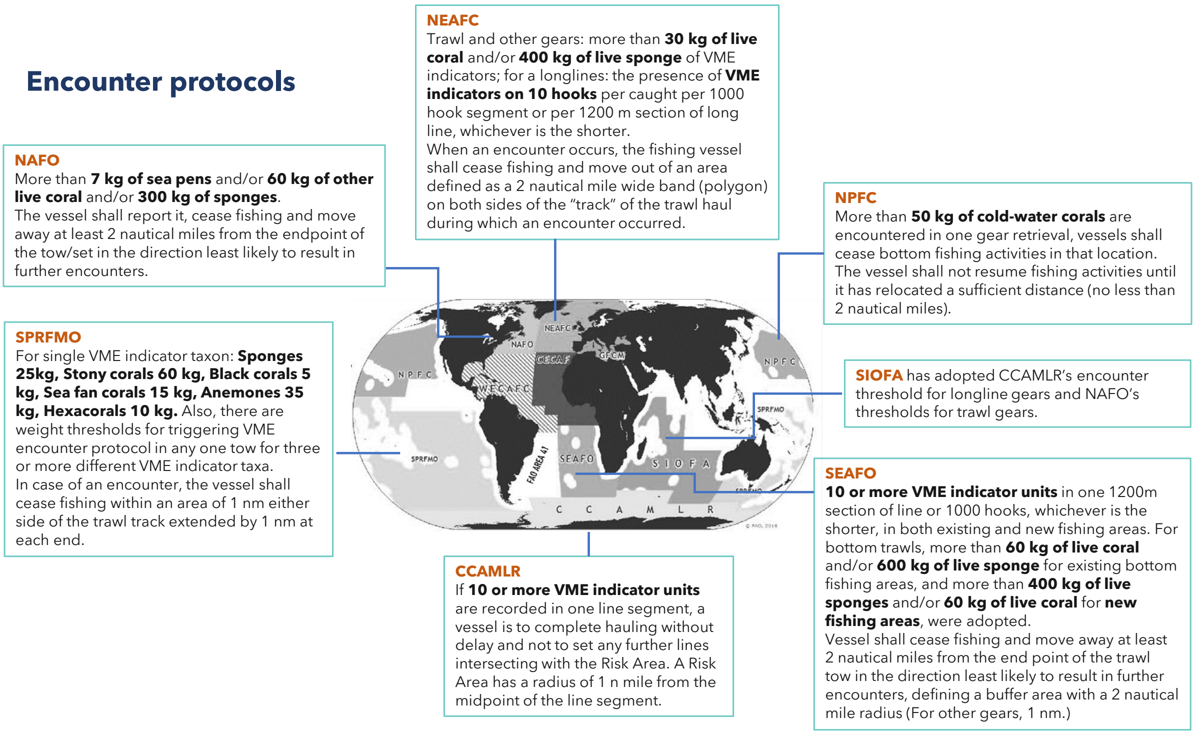

Figure 2. Overview of existing encounter protocols in relevant RFMOs

Encounter thresholds that trigger move-on rules should ideally be specific to area, gear type and taxon, and based on historic bycatch levels and catchability estimates (Ardron et al., 2014). However, in many occasions the historic data of bycatch levels are not available and catchability has not been estimated, so the set encounter thresholds may not be appropriate. Because of this, there is a need of revising encounter thresholds as new bycatch data becomes available. Some RFMOs have already established thresholds using data-informed approaches (e.g., using cumulative catch rate curves in SPRFMO or GIS modelling approaches in NAFO, etc.). Others, however, have set arbitrary encounter thresholds or have used thresholds derived for other regions. For example, NEAFC initially set arbitrary threshold values that mirrored earlier regulations in the adjacent NAFO area. Although these thresholds have been lowered and revised based on the available information of the spatial distribution patterns of a broad range of VME indicator species (ICES, 2012), no quantitative assessment has been carried out. SEAFO also established the threshold following the example of NAFO, and an adapted version of the CCAMLR encounter protocols is applied in the SEAFO area for non-trawl gear in both existing and new fishing areas. This is also the case of SIOFA, that has adopted CCAMLR's encounter protocol for longline gears and NAFO's thresholds for trawl gears.

VME indicators bycatch is assumed to be an indicator of in situ VME biomass and composition, however, the limited studies that have evaluated this assumption indicate that bottom-fishing gear (which is designed to catch fish) is very inefficient at sampling/retaining VMEs, such that large quantities of VMEs might be destroyed on the seabed before an amount exceeding encounter thresholds is brought to the surface (Auster et al., 2011). For instance, with an encounter threshold set at 30 kg, a catch efficiency of 5% could potentially mean 600 kg of stony corals on the seafloor had been impacted (Geange et al., 2020b and references therein).

Another issue with encounter thresholds is that sub-threshold encounters are not reported in many RFMOs/RFBs, which limits the information collected regarding VMEs. In SEAFO, all encounters are presented in their scientific reports, even sub-threshold encounters. In NAFO and NPFC, only above threshold encounters are reported, and none has been presented so far (FAO/NPFC, 2018).

Other issues were identified in the Workshop, regarding the implementation of measures to avoid SAIs were political issues and the lack of resources in RFMOs to carry out the scientific research needed.

RFMO decision making procedures may also hamper conservation outcomes. Many RFMOs adopt decisions by consensus, which "favors the 'law of least ambitious program', where policy reform will only progress to the level deemed acceptable by those least interested in reform"; other RFMOs provide for majority voting on conservation measures, but allow members to opt out if they do not agree (Cremers et al., 2020). RFMOs also continue to face many significant challenges in ensuring the implementation and enforcement of conservation and management measures. Significant capacity issues remain, including a lack of staff members with expertise in MCS and compliance and a lack of resources to analyze the data captured through MCS measures. Noncompliance by some members (or non-members) can undermine the effectiveness of conservation and management measures, but members of RFMOs have generally been reluctant to censure other members (Cremers et al., 2020).

Finally, it is important to mention that there is wider societal debate around bottom contacting gears and their role in the future of seafood production, as it was discussed during the Workshop. This has implications for the future fitness of the FAO Deep Sea Guidelines particularly in the context of nature-positive decision-making. The still-in-negotiation text of the BBNJ treaty (https://www.un.org/bbnj/) and the CBD's Global Biodiversity Framework will be pushing States to go beyond minimizing impact and towards restoration and recovery. This means acknowledging the need to think beyond existing measures proposed in the guidelines, e.g., fishing gear innovation, decisions driven by socio-economic tradeoffs around healthy seabed value *vs* catch value, etc.

Summary of main issues regarding encounter protocols to prevent SAIs

- Some RFMOs have not established encounter thresholds/protocols (e.g., GFCM).
- Encounter thresholds that trigger move-on rules should ideally be specific to area, gear type and taxon, and based on historic bycatch levels and catchability estimates (Ardron et al., 2014). However, in many occasions the historic data of bycatch levels are not available and catchability has not been estimated, so the set encounter thresholds may not be appropriate. Because of this, there is a need of revising encounter thresholds as new data becomes available.

2.6 Data collection

Data regarding VMEs is collected in different ways, for example in research surveys (e.g., catches of VME indicators and underwater imagery) or recording bycatch data from fisheries (collected through scientific observers). However, the availability of VME data is very different throughout the RFMOs. For example, NAFO has a regular program of research surveys in its Regulatory Area that supply valuable data regarding VMEs (annual Spanish 3LNO surveys, the EU Flemish Cap Survey, the Canadian DFO NL Multispecies surveys) and other benthic surveys have been carried out to provide underwater imagery and samples (Surveys from the Bedford Institute of Oceanography, Fisheries and Oceans in Canada) and the 2009-2010 NEREIDA surveys carried out by Spain, Canada, the UK and the Russian Federation). It also has 100% observer coverage that provides bycatch data of VME indicators. In other regions data are limited. For example, in the NE region of the NPFC Convention Area, there is limited cold-water coral abundance data available, because most of the data come from fisheries bycatch and research surveys in the NW region of the North Pacific Ocean. Therefore, not all of the RFMOs can apply repeatable, quantitative approaches for VME identification because there are not enough data (e.g., SEAFO, CECAF, NPFC, SIOFA, WECAFC).

Geange et al., (2020a) suggest that where practical, comprehensive descriptions of the location (including depth, latitude and longitude), taxonomy (to the highest possible taxonomic resolution achievable), and biomass (ideally the number of individuals as well as weight would be recorded) of deep-sea benthic invertebrates is routinely collected by fisheries observers and research programs. For example, abundance or biomass thresholds can be used to identify coral reef habitats that provide carbon processing and biodiversity functions, or to characterize species diversity, functional diversity and ecological functions (Geange et al. 2020a and references therein).

Winship et al., (2021) recommend that VME taxa biological data from fine-scale surveys be recorded to quantify presence-absence, abundance, biomass, or density (abundance or biomass per unit area) with a measure of effort for each sampling unit (e.g., area surveyed). From a practical standpoint, resource managers are most interested in identifying areas of potential high density or diversity of vulnerable VME taxa rather than simply presence. Future sampling programs should record biological data at the highest taxonomic resolution possible. Models developed using data with low taxonomic resolution may mix species with very different life-histories and environmental requirements, resulting in overly broad predicted distributions and potentially increased model uncertainty. Models of functional groups or otherwise reduced taxonomic resolution may be sufficient to address some management applications, but in some cases, models may be needed for specific taxa like species of concern (e.g., endangered species). We recognize that the identification of VME taxa species, especially from images alone, can be difficult and their taxonomy is an active area of research, so these issues can be challenging to the development of models with high taxonomic resolution.

Summary of main issues regarding data collection

- Accurate identification of some VME indicator taxa can be difficult. Identification guides and training of observers are necessary. Some RFMOs have prepared ID Guides (e.g., CCAMLR, NAFO, SEAFO, SIOFA, and SPRFMO) but not all have developed such guides.
- Data for modelling may not have enough quality or resolution. For example, models developed using data with low taxonomic resolution data may mix species with very different life-histories and environmental requirements, resulting in overly broad predicted distributions and potentially increased model uncertainty (Winship et al., 2021).

2.7 Monitoring, control and surveillance frameworks in place

Monitoring, control and surveillance systems (MCS) are necessary to establish what and how much is being caught, where, how, and by whom. This provides data needed for stock assessment and broader ecosystem considerations and to determine the extent to which CMMs are being complied with (Lenel, 2020). Thus, adequate MCS ensure that CMMs related to VMEs are followed. It also addresses issues such as IUU, that may affect VMEs directly because IUU fishing often uses illegal fishing methods (such as bottom trawling in forbidden areas), which can seriously damage the the seabed environment and its diversity. Moreover, there is the problem that, in order to avoid inspection, illegal fishing gear is abandoned directly into the sea, causing a large number of ghost fishing gear that can damage marine ecosystems, including VMEs (Dong and Guo, 2022).

Recently, Lenel (2020) has carried out a thorough review of the monitoring, control and surveillance of DSF in the high seas (including all of the RFMOs that were reviewed here). The main conclusions of that review are presented here.

- The deep-sea RFMO/As have all exerted considerable effort in the adoption and implementation of comprehensive MCS measures. The MCS implemented by the deep-sea RFMO/As have been developed with due consideration of their specific requirements including target species, type of fishing operations, priorities of CPs, fishing fleet capacity, assets available for surveillance and inspection and identified risks.
- The need for these MCS measures cannot not be underestimated. CMMs agreed by States and adopted by the deep-sea RFMO/As will fail without compliance by those involved in fishing operations and responsible for enforcement. IUU fishing remains a constant threat for all of the deep-sea RFMO/As and the coordinated, consistent, and rigorous implementation and further development of the MCS and enforcement regimes are essential to address this threat.
- CCAMLR, GFCM, NAFO and NEAFC were all established prior to 1982. SEAFO was established more than 15 years ago and NPFC, SIOFA and SPRFMO have been established in the last decade. Some of the longer established deep-sea RFMO/As have undertaken processes to evaluate and refine their MCS measures and to trial new technology. Some of the more recently established RFMO/As are just starting to adopt and implement MCS and often look to the longer established deep-sea RFMO/A’s for guidance. It is clear that in developing and implementing and reviewing and refining MCS there are many

areas of overlap that present opportunities for collaboration and information sharing.

- While all the deep-sea RFMOs have implemented measures to establish IUU vessel lists that respond to their conservation and management mandates and the recommendations of the IPOA-IUU, there is scope for improvement and harmonization of these measures. Harmonization is a critical need, particularly for those RFMOs that manage similar species, share the same oceans or have overlapping areas of competence.
- In an ideal world, cross-listing procedures would be established across all of the deep-sea RFMOs. To support this cross-listing, the criteria for including and removing a vessel from an IUU vessel list would be harmonized. The processes, decision-making and timeframes would also be harmonized. However, each RFMO differs, among other things, in political and regional context and this will in reality limit an RFMO's ability to harmonize IUU vessel listing procedures.
- The next logical option therefore would be the establishment of a combined deep-sea RFMO IUU vessel list maintained by a third party such as FAO. This would require some harmonization of the information required and the criteria for IUU vessel listing and adoption of standard data management practices for storing and exchanging information.
- RFMOs should take a proactive approach, including through their secretariats, to engage with other initiatives including those of Interpol and on the issues of marine insurance and WTO subsidies. This is because some studies have identified marine insurance as one of the main sources of leverage in the fight against IUU fishing. Restricting or eliminating access to insurance to IUU-listed vessels could alter the associated balance of costs and benefits in favour of reducing IUU fishing activity.
- While all the deep-sea RFMO/As have implemented CMMs that establish MCS measures and provide for compliance and enforcement, there is scope for improvement and harmonization of these measures. The exchange of information and of lessons learnt is an ongoing need, particularly for those RFMO/As that manage similar species, share the same oceans, have overlapping areas of competence or are working on similar activities and projects. There is scope for the harmonization and integration of several MCS measures including records of fishing vessels, IUU vessel lists and PSM. While the harmonization and integration of MCS can be difficult in an international

context, the benefits would be far-reaching. Particularly for the deep-sea RFMO/A that are supported by small secretariats.

- Memorandums of understanding (MoUs) have been established between several of the deep-sea RFMO/As but this is not common to all. MoUs provide a formal mechanism for cooperation and information sharing and could be developed and implemented across the deep-sea RFMO/As to support the harmonization and integration of MCS and facilitate greater cooperation and exchange of information.
- A less formal mechanism for the cooperation and exchange of information between the secretariats of the deep-sea RFMO/As would also be very beneficial. Opportunities should be explored for the secretariats to collaborate on activities and projects including those related to data management, capacity building and testing new technologies.

Although the above-mentioned conclusions are not specific to VMEs, it is clear that by addressing the issues such as IUU and by improving cooperation and information sharing among RFMOs, the protection of VMEs can be enhanced. For example, by implementing similar quantitative approaches to identify VMEs to those used in RFMOs with more experience, or sharing information on which measures are working better. Although this has been done already to some extent by RFMOs, either formally or informally, there is room for improvent as the Lenel (2020) has shown.

Summary of main issues regarding Monitoring, Control and Surveillance

- IUU fishing remains a constant threat for VMEs in all of the deep-sea RFMOs
- There is room for improvement regarding cooperation and information sharing among RFMOs, which could aid in develeoping better approaches for identifying VMEs, assessing the impacts of bottom fishing and improving conservation measures for VMEs .

3. Good practices and recommendations

Definitions and key concepts

- Create operational definitions for key concepts (VME, VME indicator, significant concentration or threshold of VME indicators indicating the presence of VME, VME elements and features, etc.) is necessary in order to consistently identify VMEs. Operational definitions for key concepts have been established in NAFO (2013) and by ICES (2020)—relevant for NEAFC. Although they are not incorporated in their adopted conservation measures, they are used by the scientific bodies that provide advice to these RFMOs.
- Evaluate the appropriate spatial scale of the ecosystem, that is, to determine the real extension of the VMEs considering not only habitat structure or the biogenic structure of VMEs but including also information on rare or endangered species, life history characteristics of individual species, the connectivity among different areas, and the functional roles of these VME associated species in the ecosystems.Once this has been determined, it is also necessary to define adequate thresholds for protection levels of the VMEs (see Assessment of SAIs below).

VME indicators.

- Create lists of regional VME indicator taxa using the FAO criteria (individually or in combination) and update those lists as new information becomes available.
- Carry out research to fill the gaps regarding biological information of benthic organisms and their distribution, in order to allow their evaluation against FAO criteria. As was noted in this review, expert reviewers often indicate a lack of information to evaluate a FAO criterion. For example, expert reviewers could not evaluate the “Recovery” criterion for many taxa of the order Alcyonacea (soft corals and gorgonians), or the “uniqueness or rarity” and “functional significance” for most taxa in the order Antipatharia due to the lack of biological and distribution information (Geange et al. 2020a)

Approaches to the identification of VMEs

- Ideally, VMEs should be identified using direct observations, from high quality underwater imagery (Remotely Operated Vehicles – ROV, towed camera, etc.), as this allows accurate and quantitative description of community composition and associated fauna, determination of the extent of the associated habitat, and the damage caused by particular fishing gears. This type of data collection could be incorporated in many research surveys and this possibility shall be explored.

- Research of other non-destructive sampling methods, such as eDNA shall be promoted, because there are still many gaps that prevent the implementation of this modern methodology.
- Bottom trawl fisheries research surveys should avoid all areas where VMEs are known or are likely to occur, particularly in areas where bottom fishing is prohibited. To this regard, established surveys could try to develop sampling plans that avoid locations where VMEs are known, for example, if a sampling station falls inside a closed VME area, the sampling could be carried out just outside the closed area
- If bycatch data of VME taxa is available or is likely to become available, quantitative (or at least semi-quantitative) and reproducible approaches shall be considered for the identification of VMEs (e.g., the Kernel Density Estimate (KDE), Species distribution models/Habitat suitability models, Multi-criteria Assessment MCA).
- Collection of absence data (locations where VME taxa are not present) shall be encouraged, because they are fundamental to fully evaluate the occurrence of VME habitats and indicators, and, specifically, to support mapping of benthic habitats. Such data facilitates the ability to perform a proper assessment of the occurrence of VMEs, as it is difficult to establish if the lack of data plotted in maps is due to the actual absence of VMEs or due to a lack of sampling in the area.

Assessment of SAIs

- Quantitative impact assessments of bottom fishing on benthic habitats and taxa indicative of VMEs should be carried out.
- The question of what are appropriate protection levels for VMEs should be discussed, because there is no set threshold in the Guidelines. Such a threshold would help to operationalize VME protection according to the Guidelines, and it is important because in reality, it may be reasonable to assume that a fraction of VMEs can be lost without incurring SAIs.

As suggested by DSCC (2020b), the impact assessment should set out at least the following aspects:

- identification, description and mapping of VMEs known or likely to occur

- data and methods used to identify, describe and assess the impacts of the activity, the identification of gaps in knowledge, and an evaluation of uncertainties in the information presented in the assessment;
- identification, description and evaluation of the occurrence, scale and duration of likely impacts;
- cumulative impacts of activities covered by the assessment on VMEs and low-productivity fishery resources in the fishing area;
- assess individual and collective (as well as cumulative) impacts;
- risk assessment of likely impacts by the fishing operations to determine which impacts are likely to be significant adverse impacts, particularly impacts on VMEs and low productivity fishery resources; and
- the proposed mitigation and management measures to be used to prevent significant adverse impacts on VMEs and ensure long term conservation and sustainable utilization of low-productivity fishery resources, and the measures to be used to monitor effects of the fishing operations.
- Assess SAIs by bottom fisheries on relevant VME indicator taxa as the VME indicator taxa lists are updated, that is, consider new identified taxa in SAIs assessments.
-

Measures to avoid SAIs

- Closing areas to bottom contact gear is the only certain method for avoiding significant adverse impacts on VMEs, and the establishment of appropriate spatial management measures shall be encouraged. The effectiveness of existing area closures can be improved by using explicit buffer zones and by considering the connectivity among the areas closed to protect VMEs.
- Give attention to the restoration of impacted VMEs. RFMOs should consider that allowing continued bottom-contact fishing at sites that have already experienced heavy trawling may cause damage to remnant VME populations. If these remnant populations are large enough to be reproductively viable, then they are likely to play a critical role in the recovery process as a source of propagules for heavily disturbed areas on seamounts. A long-term or even permanent closure will be needed for significant recovery to be attained on seamounts (e.g., Baco et al. 2019).
- Refine the current thresholds on the basis of new scientific information, including bycatch levels and catchability estimates, and use taxon-specific and gear-specific thresholds (FAO/NPFC, 2018). Data-informed approaches to establish meaningful encounter thresholds shall be promoted. Some RFMOs

have already established thresholds using data-informed approaches (e.g., using cumulative catch rate curves in SPRFMO or GIS modelling approaches in NAFO, etc.), these approaches shall be promoted as more data becomes available in the different RFMOs.

- Reporting of sub-threshold encounters may help improving the information collected regarding VMEs.
- Move-on rules. Further refining the move-on distance shall be considered in relation to the size and distribution of observed VME patches, as well as the size of fishable seamounts.
- Regarding the areas provisionally closed because thresholds have been exceeded (but also for areas closed on the basis of other evidence, such as data from surveys), it is necessary to carry out an assessment of the available evidence by a relevant scientific advisory body before re-opening can be considered. However, this process may not be straightforward, as the available evidence may not be enough to make a definite decision (re-opening vs remaining closed). An example of this is the case of NAFO area 14 (For more information, see Deliverable 2 "Guidelines for improving by-catch management in DSF", in the section "Critical assessment of identified measures: Benthic organisms related to VMEs).
- In addition to this, it is necessary to consider and evaluate SAIs in relation to other human activities besides bottom fishing, such as seabed mining.

The following are some recommendations from the FAO/NPFC Workshop held in 2018, that are relevant for all RFMOs:

- Assess and monitor the recovery of VME sites and protect recovering sites in addition to pristine VME sites
- Develop a standardized approach and metrics to assess the cumulative impact of all bottom fisheries on VMEs through time.
- Develop measurable objectives for determining the occurrence of SAIs, for example, NAFO has established a 60% biomass threshold as as the desirable protection level for VMEs in its regulatory area.

Data collection programs

- Continue work on the identification guides for VME indicators (those RFMOs that have not elaborated guides, such as NEAFC).
- Consolidate all available data including bycatch, scientific surveys, fisheries independent surveys, historical literature, the fishing industry, and potentially

relevant information from within EEZs, to get more detailed information about interactions between VMEs and bottom fisheries.

- Data collection programs regarding VME taxa should at least include comprehensive descriptions of the location (including depth, latitude and longitude); records of presence and absence; abundance, biomass, or density (abundance or biomass per unit area) with a measure of effort for each sampling unit (e.g., area surveyed).
- Sampling programs should record biological data at the highest taxonomic resolution possible.
- Consider conducting standardized training programs for observers and development of the regional observer programs.

Monitoring, control and surveillance

- Memorandums of understanding (MoUs) have been established between several of the deep-sea RFMOs but this is not common to all. MoUs provide a formal mechanism for cooperation and information sharing. The implementation of MoUs across the RFMOs is useful to support the harmonization and integration of MCS and facilitate greater cooperation and exchange of information.
- A less formal mechanism for the cooperation and exchange of information between the secretariats of the deep-sea RFMOs may also be very beneficial. Opportunities should be explored for the secretariats to collaborate on activities and projects including those related to data management, capacity building and testing new technologies.

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Annex I.

CCAMLR

1. Definitions and interpretation of key concepts (e.g., VMEs, VME indicators, SAIs)

Definitions are found in Conservation Measure 22-06 (2019) "Bottom fishing in the Convention Area", and CM 22-07 "Interim measure for bottom fishing activities subject to Conservation Measure 22-06 encountering potential vulnerable marine ecosystems in the Convention Area".

- The term **"vulnerable marine ecosystems**" in the context of CCAMLR includes seamounts, hydrothermal vents, cold water corals and sponge fields.
- The term **"bottom fishing activities"** includes the use of any gear that interacts with the bottom.
- According to CM 22-07 (2013), a **"VME indicator organism"** means any benthic organism listed in the CCAMLR VME Taxa Classification Guide (https://www.ccamlr.org/en/system/files/VME-guide.pdf).
- **"VME indicator unit"** means either one liter of those VME indicator organisms that can be placed in a 10-litre container, or one kilogram of those VME indicator organisms that do not fit into a 10-litre container.
- **"Line segment"** means a 1 000-hook section of line or a 1 200 m section of line, whichever is the shorter, and for pot lines a 1 200 m section.

"Risk Area" means an area where 10 or more VME indicator units are recovered within a single line segment. A Risk Area has a radius of 1 n mile from the midpoint4 of the line segment from which the VME indicator units are recovered. However, Members may require their vessels to observe a larger Risk Area in accordance with their domestic laws.

2. VME indicator species

According to CM 22-07 (2013), a '**VME indicator organism**' means any benthic organism listed in the CCAMLR VME Taxa Classification Guide (https://www.ccamlr.org/en/system/files/VME-guide.pdf). This guide includes:

- Gorgonians (Gorgonacea: 5 families)
- Hydroids (Hydroidellina)
- Hydrocorals (Stylasterids)
- Stony corals (Scleractinia)
- Black corals (Antipatheria)
- Zoanthids (Zoantharia)

- Sponges (Hexactinellida, Demospongiae)
- Anemones, soft corals, Sea pens (Cnideria)
- Sea squirts (Ascidiacea)
- Lace corals (Bryozoan)
- Chemosynthetic organisms (various)
- Lamp shells (Brachiopoda)
- Acorn worms (Pteribranchia)
- Serpulid tube worms (Serpulidae)
- Zenophyophors (Zenophyophora)
- Goose and acorn barnacles (Bathylasmatidae)
- Antarctic scallop (Adamussium colbecki)
- Sea lilies, etc (Echinoderms: 3 orders)

Photographic identification guides have been developed to allow for rapid identification of VME taxa in the SPRFMO and CCAMLR fisheries based on non-technical and easily discernible characteristics. These identification cards are designed to be used by scientific observers to ensure, in conjunction with specific training, the accurate identification of key VME taxa by observers at sea.

The selection of CCAMLR VME indicator species was initially based on the SPRFMO VME taxa list developed by New Zealand's for their high-seas fisheries in the south Pacific Ocean (Parker et al., 2009). CCAMLR subsequently revised and expanded this list of taxa at a dedicated VME identification workshop held in 2009 (CCAMLR, 2009). This workshop produced a revised list of VME characteristics/criteria for the CCAMLR area:

- Functional significance of habitat forming taxa.
- Longevity as indicative of potential recovery time in the event of disturbance. This was judged on a three-tier scale: low (<15 years), medium (15–30 years) or high (>30 years).
- Slow growth rate as a contributor to long recovery times. Judged on a three-tier scale: low for fast growth rates, medium for moderate growth or high for slow growth rates.
- Fragility or susceptibility to physical damage from fishing gear. Judged on a three-tier scale: low for high resistance, medium for moderate resistance or high for tall, brittle or easily damaged taxa.
- Potential for larval dispersal as an indicator for potential of recolonisation after disturbance event. Judged on a three-tier scale: low for broadcast spawners,

high for brooding taxa or medium when a combination of both types was observed.

- Lack of adult motility. Motility may not necessarily preclude taxa from vulnerability to habitat disturbance, however lack of motility may increase risk and decrease resilience because adults are unable to move away from danger or recolonise a previously disturbed location. Motility was judged on a three-tier scale: low for typically motile groups, medium for taxa with limited potential for movement or high for completely sessile groups.
- Rare or unique populations. Dense or isolated populations are intrinsically vulnerable to disturbances due to their reduced potential for recovery. Motility was judged on a three-tier scale: medium or low for increasing patch size or increasing frequency of occurrence or high for isolated populations.

Using these criteria, the workshop then identified 21 taxonomic groups (including, or subdividing, the 10 identified by Parker et al. 2009) considered to constitute VME taxa or taxa that are often found in association with VME taxa in the CCAMLR area. Higher taxonomic groupings (Phylum, Class or Order) were retained to facilitate VME taxa identification, again resulting in the likelihood that some species within these taxonomic groupings may not be vulnerable to fishing activity due to their specific life history traits (Parker et al., 2009).

3. Identification and assessment of VMEs

The location of all VMEs, VME Risk Areas and Fine Scale rectangles are (identified through commercial fishing and surveys) are stored by the Secretariat in a VME registry and are publicly available for download[3]. An online GIS tool is also publicly available (https://www.ccamlr.org/en/data/online-gis) where the location of VMEs can be mapped out. WG EMM evaluates the proposals for additions to the CCAMLR VME registry. WG EMM has enumerated possible approaches that could be used to justify the notification of a potential VME under CM 22-06, for example:

- anomalously high densities of VME taxa;
- observed rare or unique benthic communities;
- high diversity of VME taxa;
- benthic communities likely to be of particular importance for ecosystem function or species' life cycles; or

[3] https://www.ccamlr.org/en/document/data/ccamlr-vme-registry.

- benthic communities with other characteristics likely to be vulnerable to bottom fisheries activities. Spatial scale and sampling considerations of any of these approaches should also be taken into consideration.

Some examples of how VMEs have been identified in CCAMLR are presented next. In 2018, five sites were proposed to the Working Group on Ecosystem Monitoring and Management (WG EMM) for their inclusion in the CCAMLR VME registry in accordance with CM 22-06: three based on significant VME indicator taxa abundances, one based on high density and diversity of cold-water coral taxa, and one based on rare and unique populations. These sites were identified from a series of manned submersible dives along the northern Antarctic Peninsula and South Shetland Islands in Subarea 48.1. In 2010, two potential VMEs were identified in two areas with anomalously high densities of pterobranchs and sea pens from a fishery independent research trawl survey in the South Orkney Islands, following the guidelines set out in CM 22-06. These areas were identified based on occurrence and density from underwater video transects Moreover, Bowden et al., 2011 described the extreme uniqueness of these assemblages (similarly dense communities of stalked crinoids have never before been observed) and their potential high significance for scientific understanding of the evolutionary and biogeographic history of Southern Ocean benthic invertebrate fauna (i.e., these areas are thought to be persistent remnants of a formerly widespread archaic benthic assemblage, with indications of great age). The observed communities bear closer resemblance to fossil strata from the later Paleocene and Eocene eras than to any observed extant community. The WG EMM agreed that these were extraordinarily rare or unique benthic communities of high scientific significance and also agreed that the area surveyed was sufficiently large to draw meaningful conclusions as to the rarity of the observed communities. The Working Group recommended that the areas proposed be approved by the Scientific Committee for inclusion on the VME registry.

4. Assessment of SAIs and measures to prevent SAI

CM 22-06 (2019) sets out procedures to assess whether bottom fishing activities are likely to have SAI on VMEs by using the best available scientific information as well as the history of bottom fishing in areas proposed (assessed by the Scientific Committee).

Each Contracting Party proposing to participate in bottom fishing activities are required to submit a preliminary assessment based on the pro forma in Annex 22-06/A by 1st June prior to the season in which it intends to fish. For the preliminary assessment of potential SAIs by bottom fishing, Contracting Parties are required to provide detailed descriptions of each fishing gear and deployment process; expected behavior of the fishing gear; estimated footprint associated with possible unusual fishing events (e.g. gear loss, line breakage); estimated footprint index; estimated 'impact index' (i.e. the estimated within maximum area within which contact with the seafloor may occur per unit of fishing effort); and scale of proposed fishing activity. Contracting Parties are also responsible for outlining mitigations measures such as gear modifications or methods of deployment aimed at reducing and/or avoiding SAIs on VMEs.

5. Data collection programs

CCAMLR has established a number of programs to collect the data required for the effective management of the Southern Ocean, these include fisheries monitoring, scientific observers on fishing vessels, and ecosystem monitoring and marine debris programs. The Scientific Committee acts on advice from various Working Groups, the Working Group on Fish Stock Assessment (WG-FSA) provides advice on aspects of the effects of fisheries on non-target species including VMEs, data collection by scientific observers and approaches to the precautionary management of data-poor fisheries (https://www.ccamlr.org/en/science/working-group-fish-stock-assessment-wg-fsa).

CCAMLR's Scheme of International Scientific Observation (SISO) is one of the most important sources of scientific information for assessing the impact of fishing on the ecosystem. The scheme plays a crucial role in developing approaches to reduce the impact of fishing on the ecosystem by collecting data on the effectiveness of various mitigation measures. All vessels fishing in CCAMLR fisheries are required to carry an observer. Observers record information on the gear configuration, measures to reduce incidental mortality of seabirds and marine mammals, fishing operations, catch composition, biological measurements of target and by-catch species, details of fish tagging and tag-recaptures, vessel sightings and data on indicators of VMEs. All of these data are submitted by observers to the CCAMLR Secretariat on standardised logbook forms. The Secretariat coordinates implementation of the scheme through a network of national technical coordinators designated by Members. (https://www.ccamlr.org/en/science/ccamlr-scheme-international-scientific-observation).

While direct evidence of VMEs is recorded by CCAMLR and from the observer program, other methods have been employed to collect data on VMEs (e.g., fishery independent research surveys).

In the most recent WG-FSA report (2019)[4], the WG noted that a combination of electronic monitoring (EM) results and benthic camera results could provide a good assessment of the accuracy of VME reporting by vessels and provide an estimate of organisms lost during hauling. The Working Group noted that EM could be used for assessing VME taxa and encouraged members to provide analyses of data on the detection of VME indicator species during hauling comparing observer-derived observations with EM. New methods and technology are also being developed that can be used to assess impacts of gears more directly on VMEs (e.g., benthic cameras and movement sensors deployed on auto longlines). Systematic camera deployments on lines would help to develop a greater understanding of benthic habitats, VME indicator taxa distribution and could be used to inform on the development of VME management strategies in the future.

Based on the 2009 VME workshop (CCAMLR, 2009), the following documents have been used for VME data collection:

- WS-VME-09/4 indicated how VMEs might be located by considering physical mechanisms of trophic focusing which are determined by the interactions of oceanographic dynamics and geomorphology.
- WS-VME-09/9 outlined an approach to locating chemosynthetic communities using a range of data acquired through a variety of different surveys such as seismic reflection surveys. The Workshop noted that the SCAR Action Group would also compile a field guide to chemosynthetic communities to allow observers to classify them in by-catch.
- WS-VME-09/10 described the development of an Antarctic-wide geomorphic map of the sea floor for use in locating potential VME sites and for bioregionalisation. The geomorphic map is based on global bathymetric datasets to provide the most uniform coverage of the entire region. The value of the approach to VME detection is that it locates seamounts over 12 km in diameter even in areas lacking ship-based data.
- The Workshop agreed that geomorphic mapping should be made available via the CCAMLR Secretariat so that individual VME locations could be overlaid on it to investigate possible relationships between VME distributions and geomorphology. It was recognised that polygon data like this are difficult to include in statistical modelling exercises that use gridded data. However, the

[4] WG-FSA Report 2019 is available at: https://www.ccamlr.org/en/system/files/e-sc-38-a7_1.pdf.

geomorphology does provide seamount locations and insights into environmental characteristics in areas where there are no other data.

- WG-EMM-09/32 presented results from two surveys on the Antarctic Peninsula margin and the South Orkney Islands. The surveys used benthic trawls and video transects to collect benthic samples. VME taxa were common at almost every station so the investigators defined a threshold weight of 10 kg per 1200 m^2 trawled to be analogous to the trigger set out in Conservation Measure 22-07.

The Workshop discussed the applicability of a threshold for defining a potential VME identified during research. CM 22-06, Annex B, requires only the presence of VME organisms, but it was recognised that this could apply to almost every station sampled in this study, and that this was not consistent with the spirit of the conservation measure. The Workshop recommended that CCAMLR Members develop mechanisms for acquiring non-fisheries research information from national programs and to provide information that could be useful for identifying potential VME areas (CCAMLR, 2009).

The Scientific Committee (SC) provides advice to the Commission as to whether proposed fishing activities are likely to contribute to having SAIs on VMEs, and assesses whether the proposed mitigation measures outlined in the preliminary assessment would prevent such impacts. The SC may inform their assessment by utilizing additional information from other fisheries in the region or similar fisheries elsewhere.

The Commission will take in to account the advice and recommendations set forth by the SC relating to bottom fishing activities and adopt CMMs to prevent SAIs on VMEs. Specifically, the Commission may allow, prohibit or restrict bottom fishing activities within particular areas and/or require specific mitigation measures for bottom fishing activities.

In terms of management to prevent SAIs on VMEs, the Secretariat is responsible for recording the location of the Risk Area as well as notifying relevant fisheries and associated Flag States that the Risk Area is closed. (CM 22-07).

Measures to prevent SAI

- Area closures (CM-22-06 and CM 22-07)
- Bottom trawling gear prohibitions (CM 22-05 2008)
- Assessments of proposed bottom fisheries to determine SAIs on VMEs (CM 22-06, last update 2015).

- *Encounter thresholds and move-on rule (CM 22-07).* An encounter threshold in CCAMLR is established for bottom fishing in CM 22-07: If **10 or more VME indicator units are recorded in one line segment**, a vessel is to complete hauling without delay any lines intersecting with the Risk Area without delay and not to set any further lines intersecting with the Risk Area. A **line segment** is a 1000-hook section of line or a 1200 m section of line, whichever is the shorter, and for pot lines a 1200 m section. A **Risk Area** has a radius of 1 n mile from the midpoint4 of the line segment from which the VME indicator units are recovered. However, Members may require their vessels to observe a larger Risk Area in accordance with their domestic laws.
- The current encounter thresholds were introduced with the adoption of Conservation Measure 22-07 (2008) (Interim measure for bottom fishing activities subject to Conservation Measure 22-06 encountering potential Vulnerable Marine Ecosystems in the Convention Area). This measure was part of the **precautionary approach** for managing bottom fisheries with respect to VMEs endorsed by the Commission.

6. Monitoring, control and surveillance frameworks in place

Members' obligations pursuant to CM 21-02 (exploratory fisheries), all Contracting Parties whose vessels participate in bottom fishing activities shall:

- ensure that their vessels are equipped and configured so that they can comply with all relevant conservation measures;
- ensure that each vessel carries at least one CCAMLR-designated scientific observer to collect data in accordance with this and other conservation measures;
- submit data pursuant to Data Collection Plans for bottom fisheries to be developed by the Scientific Committee and included in conservation measures;
- be prohibited from continuing participation in the relevant bottom fishery if data arising from CMMs relevant to that bottom fishery have not been submitted to CCAMLR;
- for the most recent season in which fishing occurred, until the relevant data have been submitted to CCAMLR and the Scientific Committee has been allowed an opportunity to review the data.

The Secretariat is required to annually compile a list of vessels authorized to fish pursuant to CM 22-06 and shall make this list publicly available on CCAMLR's website.

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CECAF

1. Definitions and interpretation of key concepts (e.g., VMEs, VME indicators, SAIs)

The key concepts used during the FAO/CECAF DSF & VME WS (FAO, 2017) were mainly those adopted by Deep-sea Fisheries Guidelines (FAO, 2009), although certain considerations were taken into account:

- **"Vulnerable marine ecosystem (VME)":** The guidelines do not define VMEs, but they describe vulnerability and provide five criteria for such ecosystems: i) uniqueness or rarity, ii) functional significance of the habitat, iii) fragility, iv) life-history traits of component species that make recovery difficult and v) structural complexity.
- **"Significant adverse impacts (SAIs)":** Adverse impacts are, in this context, negative effects on a VME resulting from damage caused during the operation of bottom-contact fishing gear. SAI are those impacts that are considered to be severe enough to compromise ecosystem integrity, structure and function, and which results in the loss of the wide range of services that these ecosystems provide. CECAF considers that the scale and significance of impacts, as stated in the Guidelines, depends on: intensity or severity, timing and duration, spatial extent relative to habitat area, sensitivity or vulnerability of the ecosystem, ability and rate of an ecosystem recovery and alterations in function. (FAO, 2009; 2017).

2. VME indicator species

There is not an official list of indicator species/taxa adopted by CECAF. However, some species/taxa commonly used as indicators in other zones have been reported in the area, more specifically in waters off Mauritania and/or off Morocco and Western Sahara which are the best studied areas so far. A list of potential indicators species in CECAF was provided in García-Isarch et al. (2019).

3. Identification and assessment of VMEs

There are no specific criteria for identification of existing and potential VMEs established for CECAF. During the FAO/CECAF DSF & VME WS (FAO, 2017), examples given from other areas (i.e.: NAFO) were considered for its potential application to CECAF, noting that:

- Some areas are closed on a precautionary basis, using VME features such as seamounts or canyons, for example. However, this approach requires research surveys to be conducted in order to determine if the area does constitute a VME and very expensive research surveys would be necessary to acquire geomorfological layers of the whole area and biological visual sampling to map VMEs through habitat suitability models.

- The identification of VMEs could be done without detailed information on the species composition and just considering that the densities/biomasses of various habitat forming species (HFS) groups (VME indicators as sponges, sea pens, large and small gorgonian corals) to identify when these densities/biomasses reach established thresholds to constitute sensitive habitats. However, this approach needs a significant amount of data which are lacking, because most data are usually collected on other areas through surveys aiming stock assessment.
- Another tool used to obtain information on VMEs is expert opinion that can be provided by the fishing sector (this being known as traditional or local ecological knowledge), or by scientists familiar with the literature of the area or with direct experience on research or commercial vessels.

Although no VMEs have been defined by CECAF (apart the one overlapped with SEAFO), there are some indications on the occurrence of vulnerable ecosystems in the EEZs of some Coastal States that should be considered by national authorities for their potential designation as VMEs. This information comes mainly from international surveys (i.e: from Spain, Germany) or regional programs as the EAF-Nansen project. The last has conducted several surveys onboard the R/V Dr Fridtjof Nansen both inside the EEZs and in the ABNJ of the CECAF region. There have not been traditional *ad hoc* scientific surveys for mapping sensitive areas in West Africa coordinated either by CECAF or by the Coastal States. However, the new EAF-Nansen Programme, implemented in 2017, includes the identification of vulnerable marine habitats, mapping biodiversity, particularly on the sea-floor, and the characterization of ecosystems, as some of the research activities that will be conducted onboard the R/V Dr Fridtjof Nansen are foreseen to take place in the western and eastern maritime areas of Africa and thus, including CECAF waters. The R/V Dr Fridtjof Nansen initiated the 2020 survey programme with a survey for Bottom Habitat studies in predefined areas from North Mauritania to North Morocco, during 25 days between January and February. The main aims of this survey were to collect samples, visual data, and map seabed habitats in support of improved fisheries management in an ecosystem context (see https://www.fao.org/in-action/eaf-zansen/background/history/en/).

4. Assessment of SAIs and measures to prevent SAI

There are not current frameworks and measures to prevent SAI in the CECAF area. There are not regular fishery independent surveys to measure SAI and only some information has been collected in fishing vessels (i.e: IEO Programs of observation onboard EU demersal deep-sea trawlers).

Recommendations to identify VMEs were provided during the FAO/CECAF DSF & VME WS held in 2017. First, it was suggested to compile all information of existing VMEs in a background report to be used as a basis for further discussions on the characterization of VMEs. It was also recommended to develop mechanisms for storing or compiling information from databases relevant to VMEs from commercial and research vessels in the area. Other needs as scientific surveys to investigate the presence of VMEs or other sensitive communities, habitats and species or needs for identification of VME indicator taxa and/or species were also stressed (FAO, 2017).

Based on available information, the design of a procedure for the identification of likely or known VMEs was recommended together with the risk assessment of SAI from fisheries using bottom contact gears. Mitigation measures should be adopted, as necessary (FAO, 2017).

As mentioned before, CECAF lacks regulatory power to establish any management measure and thus, including spatial management measures. However, it should be noted that a small portion of the central eastern Atlantic falls under the competence of both CECAF and SEAFO. In 2011, SEAFO (with regulatory powers) designated a VME in the overlapping area and closed it to bottom fishing (Tandstad, 2016).

5. Data collection programs

There is not any implemented data collection program in relation to DSF and VMS in the CECAF area. It should be noted the existing challenges in the regions with regards to fisheries monitoring and data collection (FAO, 2017), mainly related to lack of funding and capacity.

Some recommendations were made during the FAO/CECAF DSF & VME WS related to the development of mechanisms (and/or a database) for storing or compiling information from databases relevant to deep-sea fisheries and VMEs from commercial and research vessels in the CECAF area.

It was also stressed the need of scientific surveys, giving priority to deeper areas that have not been previously fished or where limited fishing has occurred (e.g., seamounts), to investigate the abundance and distribution of potentially new deep-sea resources, and/or the presence of VMEs or other sensitive communities, habitats and species.

The development of a process for the identification of the existing deep-sea bottom fishing areas within the CECAF area, including the consideration of the use of reference period and georeferenced information was also recommended.

Another relevant recommendation in relation to data collection was to investigate the possibility of using VMS information from commercial vessels fishing in the CECAF area to map and monitor deep-sea fisheries in respect to possible VME areas, as well as to perform interviews with fishermen.

It was finally recommended that the CECAF Scientific Sub-Committee should develop data collection protocols that can support the assessment of the state of developing and currently unassessed deep-sea fisheries stocks and provide the appropriate advice to the CECAF Committee for the management of these stocks. As there are deep-sea fisheries that could be potentially developed in CECAF, management measures should be implemented to ensure the sustainability of these fisheries and the minimization of their impacts on benthic ecosystems. In order to do this, all existing data on deep-sea fisheries and benthic ecosystems should be compiled and formulated into management advice for decision-makers (FAO, 2017).

6. Monitoring, control and surveillance frameworks in place

No MCS frameworks are in place in the CECAF region in relation to DSF and VME.

References

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FAO Area 41 (SW Atlantic)

1. Definitions and interpretation of key concepts (e.g., VMEs, VME indicators, SAIs)

N/A

2. VME indicator species

N/A

3. Identification and assessment of VMEs

Research surveys (2007-2010) carried out by Spain with the purpose of identifying VMEs in the high-seas of the SW Atlantic.. Research surveys were multidisciplinary, and used several methods to survey the area: Seabed mapping (Multibeam bathymetry, very-high resolution seismic profiles), collection of samples (Scientific trawl sets, Rock dredges and Box corers), collection of environmental variables (CTD), Visual ground-truth validation (Photo/video ROV). With the information obtained in these surveys, a closed area in SW Atlantic closed area (41 300 km^2) was established.

VMEs were studied at depths of approximately 200–1500 m. The obtained data has great scientific value because this is a poorly studied area. Nine large areas with presence of VMEs were identified and designated as candidate areas for closure to bottom fishing. Based on the scientific advice, the Spanish Government implemented a fishing closure, as mentioned above, for the Spanish bottom trawling fleets in the high seas of the southwest Atlantic on July 2011. (Duran Muñoz et al. 2012).

4. Assessment of SAIs and measures to prevent SAI

N/A

5. Data collection programs

N/A

6. Monitoring, control and surveillance frameworks in place

N/A

References

Durán Muñoz, P., Sayago-Gil, M., Murillo, F.J., Del Rio, J.L., López-Abellán, L.J., Sacau, M. and Sarralde, R (2012) ’Actions taken by fishing Nations towards identification and protection of vulnerable marine ecosystems in the high seas: The Spanish case (Atlantic Ocean)'. Marine Policy, 36: 536-543.

GFCM

1. Definitions and interpretation of key concepts (e.g., VMEs, VME indicators, SAIs)

In the GFCM the following definitions are established in "Resolution GFCM/43/2019/6 on the establishment of a set of measures to protect vulnerable marine ecosystems formed by cnidarian (coral) communities in the Mediterranean Sea", in its Annex 1.:

- **"Vulnerable marine ecosystems (VMEs)"**. This term refers to paragraphs 42 and 43 of the FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas;
- **"VME indicator taxa".** Refers to the species or group of species used as signal of VME occurrence. The list of Mediterranean VME indicator taxa is defined in Annex 1of Appendix 17 of report of the forty-second session of the GFCM;
- **"VME protocol".** Refers to the protocols for the protection of VMEs in the GFCM area of application as endorsed by the GFCM at its forty-second session (Appendix 17)
- **"Deep sea fisheries"** are fisheries carried out by fishing vessels above 15 m LOA, operating with contact bottom fishing gear and fishing for *Aristaeomorpha foliacea*, *Aristeus antennatus* or *Plesionika martia* and fisheries carried out by fishing vessels above 15 m LOA operating with contact gear (bottom trawls, longlines, gillnets and pots and traps)
- **"Significant adverse impacts (SAIs)".** Refers to those that compromise ecosystem integrity (i.e., ecosystem structure or function) in a manner that: i) impairs the ability of affected populations to replace themselves; ii) degrades the long-term natural productivity of habitats; or iii) causes, on more than a temporary basis, significant loss of species richness, habitat or community types;
- **"Encounter".** This term refers to an encounter with VME indicator taxa and is defined as any catch of VME indicator taxa by any deep-sea fisheries, until possible revision of the current VME protocol, which may establish threshold levels in line with SAC advice, based on data and information gathered upon the implementation of the protocols and measures established in the resolution;
- **"Fisheries restricted area (FRA)"** refers to the spatial protection measures in the GFCM area of application, and

- **"Key species"** or "**indicator species"** mean marine organisms pertaining to the species defined in Annex 2 of the resolution (only includes coral species).

2. VME indicator species

The GFCM (2017) created a first list of VME Indicator Features, Habitats and Taxa for the Mediterranean Sea, updated by GFCM (2018) as follows:

Mediterranean VME indicator features. The following features potentially support VMEs: Seamounts and volcanic ridges, canyons and trenches, steep slopes, submarine reliefs (slumped blocks, ridges, cobble fields, etc.), cold seeps (pockmarks, mud volcanoes, reducing sediment, anoxic pools, methanogenetic hard bottoms), hydrothermal vents.

Mediterranean VME indicator habitats. The following habitats potentially support VMEs: Cold-water coral reefs, coral gardens (hard-bottom coral gardens, soft-bottom coral gardens), sea pen fields, deep-sea sponge aggregations ("Ostur" sponge aggregations, hard-bottom sponge gardens, glass sponge communities, soft-bottom sponge gardens), tube-dwelling anemone patches, crinoid fields, oyster reefs and other giant bivalves, seep and vent communities, other dense emergent fauna.

Mediterranean VME indicator taxa include:

- Cnidaria (Anthozoa): Hexacorallia (Antipatharia, Scleractinia); Octocorallia (Alcyonacea, Pennatulacea); Ceriantharia
- Cnidaria (Hydrozoa): Hydroidolina
- Porifera (sponges): Demospongiae; Hexactinellida (Amphidiscophora, Hexasterophora)
- Bryozoa (Gymnolaemata, Stenolaemata)
- Echinodermata (Crinoidea): Articulata
- Mollusca (Bivalvia): Gryphaeidae (Neopycnodonte cochlear, N. zibrowii), Heterodonta (Lucinoida) (e.g. *Lucinoma kazani*), Pteriomorphia (Mytiloida) (e.g. *Idas modiolaeformis*)
- Annelida (Polychaeta): Sedentaria (Canalipalpata) (e.g. *Lamellibrachia anaximandri*, *Siboglinum* spp.)
- Arthropoda (Malacostraca): Eumalacostraca (Amphipoda) (e.g. *Haploops* spp.)

However, the only existing conservation measure regarding VMEs, Resolution GFCM/43/2019/6, is focused on protecting cnidarian (coral) communities and leaves out other VME indicators recognized by GFCM (such as sponges and bryozoans). There are 15 species of cnidarian considered as VME Indicators in this resolution and they are listed in its Annex 2 (e.g, black corals *Antipathella subpinnata*, *Antipathes* *dichotoma* and *Antipathes fragilis*, *soft coral Callogorgia verticillate,* stony cup corals *Dendrophyllia ramea*, stony corals *Lophelia pertusa and Madrepora oculata*, etc.). Thus, GFCM still needs to implement conservation measures that take into account the other VME taxa identified in the Mediterranean.

3. Identification and assessment of VMEs

The GFCM has not yet defined VMEs within its management measures. Through the application of the ecosystem approach to fisheries, the GFCM has adopted several Fisheries Restricted Areas (FRAs) as a multi-purpose area-based management tool used to restrict fishing activities and protect essential fish habitats and deep-sea sensitive habitats. Unlike VMEs, FRA have been defined by the GFCM as "a geographically-defined area in which all or certain fishing activities are temporarily or permanently banned or restricted in order to improve the exploitation and conservation of harvested living aquatic resources or the protection of marine ecosystems". According to this definition, an FRA can be established to protect any kind of marine resource and habitat (e.g., aggregations of vulnerable sponges, seamount areas, coralligenous formations, seagrass meadows, spawning grounds and reproduction sites for fish resources, etc.) from relevant fishing activities. The proposal for the establishment of a new FRA is submitted to the GFCM by a contracting party or a cooperative noncontracting party (CPC), institution or scientist, through the compilation of a form, providing information on the area, site description, biological features, human activities and impacts, legal status and objective of the FRA, including other elements. A review process is then undertaken prior to the decision of the Commission regarding the adoption of the FRA. In 2006, Recommendation GFCM/30/2006/319 established three FRAs in international waters in which fishing activities with towed dredges and bottom trawl nets were permanently prohibited. The aim of the prohibition was to protect deep-sea vulnerable habitats. They are not specifically designated as VMEs by the GFCM, but the management measure applied is similar to the VME closures in other regions (GFCM, 2020).

4. Assessment of SAIs and measures to prevent SAI

There are not specific criteria or guidelines for assessing SAIs. The Scientific Advisory Committee (GFCM, 2019) recommended to adopt a binding decision on mapping the fishing footprint of DSF according to existing agreed protocols, highlighting the need for a clear roadmap and timetable for action. It also endorsed the development of the GFCM georeferenced database on sensitive benthic species and habitats, aimed to support the identification of priority areas for which measures to prevent significant adverse impact (SAI) from fisheries on potential VMEs could be developed. In a second instance, and once the database is populated with relevant information and priorities can be identified, protection measures to prevent SAI should be adopted.

Measures to prevent SAI

- Bottom trawling below 1000 m prohibition.
- Fisheries restricted areas (FRAs), a specific area-based management tool to protect VMEs in the region. Four areas have been closed to bottom fishing as a result of FRA designations.
- *Encounter thresholds and move-on rule*. No encounter thresholds have been set in GFCM. Resolution GFCM/43/2019/6 only establishes that an "encounter" is defined as any bycatch of VME indicator taxa by any deep-sea fisheries, until possible revision of the current VME protocol (in Annex 1 of the Res. GFCM/43/2019/6) which may establish threshold levels in line with SAC advice, based on data and information gathered upon the implementation of the protocols and measures established in this resolution

5. Data collection programs

Currently, there is not a specific data collection program focused on VME. The GFCM framework for the collection and transmission of fisheries-related data in the GFCM area of application (Mediterranean and Black Sea) is the Data Collection Reference Framework (DCRF; GFCM, 2018) The DCRF is an instrument supporting the implementation of the strategytowards the sustainability of Mediterranean and Black Sea fisheries through the identification and collection of fisheries-related data necessary to improve the formulation of sound scientific advice by relevant GFCM subsidiary bodies. The DCRF aims to be instrumental in achieving an efficient data collection programme throughout the entire region and better integrating data collection and subregional multiannual management plans. The is regularly reviewed by relevant GFCM subsidiary bodies in light of possible requirements emanating from the GFCM Commission, including through new recommendations.

The GFCM has recently launched a process similar to those carried out in other regional fisheries management organizations with the competence over deep-sea fisheries to formulate rules guiding deep-sea fisheries and mapping their deep-sea fishing footprint (FAO, 2020). According to endorsed protocols, contracting parties and cooperating non-contracting parties (CPCs) with vessels involved in deep-sea bottom fisheries are required to submit comprehensive maps of existing deep-sea bottom fishing areas (exploited at least within a five-year period prior to present) to the GFCM Secretariat, who will, in turn, produce composite maps, preferably by gear type, of the existing deep-sea bottom fishing areas within the GFCM area of application. Priority is given to bottom trawl fisheries at depths below 300 m.

Regarding the scientific monitoring plan for VME-FRAs, the Working Group on Marine Protected Areas (WGMPA) 2019 (GFCM, 2019b) considered it challenging to address the issue of assessing the effectiveness of those FRAs established to protect different types of sensitive benthic habitats (e.g., cold-water coral assemblages, sponge fields, chemosynthetic communities) and recognized that for the VME-FRAs already in place, it would be difficult to establish scientific monitoring plans that were not initially foreseen when the FRAs were established. For future VME-FRAs, the WGMPA (2019) advised that any new FRA proposal should include a suggested monitoring plan specifically designed for the characteristics (biological and ecological) of the benthic habitat subject to the protection measure, giving priority as much as possible to non-destructive survey methods, such as those that rely on the use of ROVs or gliders.

The WGMPA (2019) reaffirmed the importance of developing a database on VME indicator features, habitats and species in the Mediterranean Sea. Regarding the standard form to collect and submit information to be included in the GFCM geodatabase, the WGMPA agreed to use a standardized Excel sheet (adapted from the VME template created through the joint ICES/ NAFO WGDEC). Based on this, the GFCM Database of Sensitive Benthic Habitats and Species was launched in 2020 as a scientific tool to support the work carried out on deep-sea benthic ecosystems.

6. Monitoring, control and surveillance frameworks in place

In the GFCM, there are different recommendations and resolutions related to monitoring, control and surveillance:

- Recommendation GFCM/33/2009/6 concerning the establishment of a GFCM record of vessels over 15 meters authorized to operate in the GFCM area of application, amending Recommendation GFCM/29/2005/2. An Authorized Vessel List is maintained containing information on all vessels that are equipped and used for commercial fishing activity in the GFCM area of application and contracting parties and cooperating noncontracting
- Recommendation GFCM/41/2017/6 on the submission of data on fishing activities in the GFCM area of application. Catch and effort data are to be collected by the member or cooperating NCPs and reported by 30 June for the previous year for use in stock assessments.
- Recommendation GFCM/33/2009/6 concerning the establishment of a GFCM record of vessels over 15 meters authorized to operate in the GFCM area of application, amending Recommendation GFCM/29/2005/2. Vessels over 15

meters undertaking transshipment activities are to carry valid certificates of vessel registration and authorization to fish/tranship. There are other recommendations that also incorporate transshipment regulation, (e.g., Recommendation GFCM/42/2018/2 and Recommendation GFCM/41/2017/7.

- Resolution GFCM/38/2014/1 on Guidelines on VMS and related control systems in the GFCM area of competence. Each flag Party and Cooperating NCP is to require their flagged commercial fishing vessels exceeding 15 meters in length to carry a satellite-based VMS and to automatically transmit data every two hours to the State's fishery monitoring center or an equivalent authority.
- Resolution GFCM/32/2008/1 on reporting on the implementation of GFCM management measures. The GFCM implements a regional scheme on Port State Measures which allows for the carrying out of inspections on vessels by Members and Cooperating non-members within their ports.
- Recommendation GFCM/38/2014/2 concerning the identification of non-compliance, amending and repealing Recommendation GFCM/34/2010/3. GFCM undergoes an annual clarification and identification process whereby the GFCM Secretariat requests all Contracting Parties, cooperating non-Contracting Parties and relevant non-Contracting Parties to report on the implementation of GFCM management measures and on the transmission of data for the previous reference year. The Compliance Committee then discusses and adopts two compliance tables (i.e., compliance table on the implementation of management measures and compliance table on the submission of data). Where lack of compliance is detected at country level, the Compliance Committee decides on the most appropriate course of action.

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NAFO

1. Definitions and interpretation of key concepts (e.g., VMEs, VME indicators, SAIs)

The following definitions are included in **Article 15, Chapter II of the NAFO CEM** (NAFO, 2021a).

- **"Vulnerable marine ecosystems (VMEs)"** refers to paragraphs 42 and 43 of the FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas;
- **"VME indicator element"** refers to topographical, hydrophysical or geological features which potentially support VMEs, as specified in Part VII of Annex I.E;
- **"VME indicator species"** refers to species that signal the occurrence of vulnerable marine ecosystems, as specified in Part VI of Annex I.E.
- "**Significant adverse impacts"** refers to paragraphs 17 to 20 of the FAO International Guidelines for the Management of Deep Sea Fisheries in the High Seas;

In addition, NAFO established in 2013 **operational definitions** of some of the key concepts (NAFO, 2013):

- **"Vulnerable Marine Ecosystem (VME)"**. Under the structure-forming criterion, it is a regional habitat that contains VME indicator species at or above significant concentration levels. These habitats are structurally complex, characterized by higher diversities and/or different benthic communities, and provide a platform for ecosystem functions/processes closely linked to these characteristics. The spatial scale of these habitats is larger than the footprint of a higher concentration observation. This means that habitats not only include the area where a dense aggregation of VME organisms are observed, but also include other areas where smaller aggregations of VME organisms are present. NAFO has used quantitative methods to objectively define areas that contain VME indicator species at or above significant concentration levels. These areas are not simply defined by the individual tows above the threshold value but also all of the smaller catches within the delimited polygon. These smaller catches may represent recruitment or smaller species in the VME indicator group. These larger areas are the **VMEs proper** unless post-hoc considerations suggest otherwise.

VMEs occur throughout the NRA and their spatial arrangement may be important to recruitment processes and to overall ecosystem

- **"VME elements"**. These are topographical, hydrophysical or geological features which are associated with VME indicator species in a global context and have the potential to support VMEs. NAFO has approved a list of features that qualify as physical VME indicator elements (NCEM Annex I.E.VII). This definition is in line with the FAO Guidelines (as stated in the ANNEX of the Guidelines).
- **"Higher concentration observations of VME indicator species"** (a.k.a. "**Significant concentrations**"). These are specific locations where there are individual records of VME indicator species at densities at or above a threshold value that, for that specific VME indicator species, is associated with the formation of highly aggregated groups of that species. These higher concentration locations have been the basis for the delineation of the polygons referred as "Areas of higher sponge and coral concentrations" in NCEM Article 16.5, which are closed to bottom fishing activities.
- **"VME indicator species"**. These are species that met one or more of the FAO Guidelines criteria for possible VMEs. Their simple presence is not an automatic indication of VMEs, but when found in significant aggregations with conspecifics, or other VME indicator species, can constitute a VME. NAFO has approved a list of taxa that qualify as VME indicator species (NCEM Annex I.E.VI).

2. VME indicator species

VME Indicator Species in NAFO:

- Large-sized sponges (Porifera) 17 species (or spp.)
- Stony corals (Cnidaria) 4 species
- Small gorgonian corals (Cnidaria) 8 species
- Large gorgonian corals (Cnidaria) 18 species
- Sea pens (Cnidaria)13 species
- Tube-dwelling anemones (Cnidaria) 1 species
- Erect bryozoans (Bryozoa) 1 species
- Sea lilies (Crinoids) 3 species
- Sea squirts (Chordata) 1 species

List of Physical VME Indicator Elements:

- Seamounts, Canyons, Knolls, Southeast shoal, Steep flanks >6.4°

Identification of what species/habitats qualify as VME indicators is based on five criteria established by FAO in 2009. Murillo et al., (2011) reviewed over 500 taxa known to occur in the NAFO Regulatory Area (NRA) against the FAO criteria for a VME Indicator. According to WG ESA (NAFO, 2020), the 88 VME indicator species thus far identified as occurring in the NRA, including the seamounts, were **mostly identified on the basis of 5th criterion, structural complexity**, although many also possessed one or more of the other traits. Large-sized sponges, sea pens, small and large gorgonian corals, erect bryozoans, sea squirts (*Boltenia ovifera*), tube-dwelling (cerianthid) anemones, sea lilies (crinoids), stony corals, black corals and xenophyophores all meet the criteria for VME indicators and are known to produce dense aggregations. Thus, these species are listed as VME indicators in Annex I.E. of the NAFO Conservation and Enforcement Measures (NAFO, 2021a).

3. Identification and assessment of VMEs

NAFO mostly uses data from research trawl surveys and applies two different (complementary) methodologies to identify VMEs:

- Kernel density estimation (KDE) to quantitatively identify significant concentrations of VME indicator taxa, and
- Species distribution models (SDMs) have been used to complement the KDE to further evaluate the configuration of the VMEs and to identify areas where VMEs are likely to occur. In NAFO, the VME areas so identified have been subjected to follow up in situ surveys (ICES, 2021 WGDEC)

In NAFO, for a VME indicator to qualify as a VME, it should be present in significant concentrations (habitat forming), or in the case of uniqueness or rarity, be associated with an area or ecosystem whose loss could not be compensated for by similar areas or ecosystems elsewhere (FAO, 2009). Identification of what species/habitats qualify as VME indicators is based on five criteria established by FAO in 2009. Murillo et al., (2011) reviewed over 500 taxa known to occur in the NAFO Regulatory Area (NRA) against the FAO criteria for a VME Indicator. The 88 VME indicator species thus far identified as occurring in the NRA, including the seamounts, were **mostly identified on the basis of 5th criterion, structural complexity**, although many also possessed one or more of the other traits. Large-sized sponges, sea pens, small and large gorgonian corals, erect bryozoans, sea squirts (*Boltenia ovifera*), tube-dwelling (cerianthid) anemones, sea lilies (crinoids), stony corals, black corals and xenophyophores all meet the criteria for VME indicators and are known to produce dense aggregations. They created **operational definitions** (NAFO, 2013) for VME indicators, VME elements, higher concentration observations of VME indicator species (i.e., "significant concentrations") and VMEs. To quantitatively identify significant concentrations of VME indicator taxa in the NRA, kernel density estimation (KDE) was applied to research vessel trawl survey data. In response to a request from the NAFO Commission and following the procedures applied in 2013, these analyses were updated in 2019 using all available data from the Canadian and EU-Spanish trawl survey data in support of the current review of the closed areas (NAFO, 2020).

4. Assessment of SAIs and measures to prevent SAI

NAFO follows the criteria established in paragraphs 17 to 20 of the FAO Guidelines for assessing SAIs (Article 15 – NAFO, 2021a).

NAFO's SC completed the assessment of the risk of Significant Adverse Impacts (SAIs) from bottom fishing activities on VMEs in the NRA in 2021 (NAFO, 2021b). The assessment was based on estimates of the biomass distribution of VMEs, the distribution of fishing effort (VMS data), and a set of assessment metrics that considers ecosystem function and fragmentation. Structurally, the assessment is similar to that conducted in 2016 but with greater spatial resolution of updated survey trawl biomass and commercial fishing effort. The greater spatial resolution applied in the present assessment (from 5km to 1km) results in more precise and generally larger estimates of the area and biomass protected by the current VME closures, relative to the 2020 review of VME closures. Results indicated that small gorgonian, black coral, erect bryozoan and sea squirt VMEs have a high overall risk of SAI, whereas the large-sized sponges and large gorgonian coral VMEs have a low overall risk of SAI. The sea pen VME was assessed as having an intermediate risk of SAI.

Measures to prevent SAI

NAFO has established the following measures related to preventing SAIs (NAFO, 2021a):

- **Area Restrictions for Bottom Fishing Activities** (Seamount Closures, coral area closure, High Sponge and Coral Concentration Area Closures) (Article 17 NEFO CEM).
- **Exploratory bottom fishing activities** are subject to a prior exploration conducted in accordance with the exploratory protocol set out in Article 18 Annex I.E. Any Contracting Party proposing to participate in exploratory bottom fishing activities shall submit, in support of their proposal, **a preliminary assessment of the known and anticipated impacts of the bottom fishing activity,** which will be exercised by the vessels entitled to fly its flag, **on VMEs** (Art. 19 NAFO CEM). The Commission shall **adopt conservation and**

management measures to prevent significant adverse impacts of the exploratory fishing activities on VMEs, taking account of advice and recommendations provided by the Scientific Council and the Joint Commission-Scientific Council Working Group on Ecosystem Approach Framework to Fisheries Management (Art. 20 NAFO CEM). The Scientific Council is in charge of evaluating and provide advice to the Commission regarding exploratory bottom fishing activities (Art. 21 NAFO CEM). The Commission shall, taking account of advice and recommendations provided by the Scientific Council and the Joint Commission-Scientific Council Working Group on Ecosystem Approach Framework to Fisheries Management either to: (a) authorize the bottom fishing activity for part or all of the area in which exploratory bottom fishing was carried out and include this area in the footprint, or (b) discontinue the exploratory bottom fishing activity and, if necessary, close part or all of the area where which exploratory bottom fishing was carried out, or (c) authorize the continued conduct of exploratory bottom fishing activity, in line with Article 18 with a view to gather more information.

- **Encounter thresholds**. In Article 22 of the NAFO CEM, NAFO defines what constitutes an encounter, according to paragraph 67 of the FAO Guidelines. An encounter with VME indicator species is defined as catch per set (e.g., trawl tow, longline set, or gill net set) of more than 7 kg of sea pens and/or 60 kg of other live coral and/or 300 kg of sponges. (NAFO, 2021a). The threshold values were determined using a data-informed approach (corals) and GIS modelling (sea pens and sponges) (Kenchington et al. 2011; ICES, 2013): the thresholds for sea pens (7kg) and sponges (300 kg) were determined based on research vessel trawl catch and considering catchability through comparison of trawl catch and *in situ* biomass. The encounter value for other live corals was established through assessment of the cumulative research trawl catch for the Flemish Cap and the Grand Bank Areas.
- Article 22 (NAFO, 2021a) sets out provisions in case that an encounter occurs during fishing. The master of the vessel shall **report the encounter** without delay to the flag State Contracting Party including the position that is provided by the vessel, either the end point of the tow or set or another position that is closest to the exact encounter location, the VME indicator species encountered, the quantity (kg) of VME indicator species encountered; and **cease fishing and move away at least 2 nautical miles** from the endpoint of the tow/set in the direction least likely to result in further encounters. The captain shall use his best judgment based on all available sources of information.

5. Data collection programs

Article 30 - Observer Program (NAFO, 2021a). The purpose of the Observer Program is to collect reliable information and data on activities in the NAFO Regulatory Area. The information and data collected through the Observer Program shall be made available to any NAFO body requesting it. Observers assigned to their vessels shall, at a minimum, perform the duties listed below:

- record for each haul/set, in the format indicated in Annex II.M, hereafter referred to as the observer trip report: the quantity of all catch, by species, including for discards and VMEs indicators as referred to in Annex I.E.VI:
    - as recorded in the vessel fishing and production logbooks,
    - as estimated independently by the observer. For hauls where independent observer estimations are not possible, the relevant data cells should be left blank and noted in the comments section;
    - record in the observer trip report any discrepancy identified between the different sources of catch data;
    - gear type, mesh size, attachments;
    - effort data;
    - longitude and latitude, fishing depth; and in the case of trawl fisheries, the time from the end of setting to the start of gear retrieval. In any other case, the start of setting and the end of retrieval;
- monitor the vessel's stowage plan referred to in Article 28, and record in the observer report any discrepancies identified;
- record any observed interruption or interference with the Vessel Monitoring System (VMS);
- only set vessel's instruments with the Master's agreement;
- transmit daily, whether the vessel is fishing or not, before 12:00 UTC to the Fisheries Monitoring Centre (FMC) of the flag State Contracting Party, in accordance with Annex II.G, the OBR report, by division, with the information for the day preceding the report;
- perform such work, including for scientific purposes, as the Commission may request;
- submit the observer report, in a computer readable form, where possible with the associated images taken by the observer as attachment as soon as possible after leaving the Regulatory Area and at the latest at arrival of the

vessel in port, to the flag State Contracting Party, immediately upon arrival in port, to the local port inspection authority if an inspection in port occurs;

- make themselves available to inspectors at sea, or in port upon arrival of the vessel, for the purposes of providing information related to the fishing activities of the vessel;
- referring to any incidents of discrepancies with the CEM: report without delay to the competent authority of the flag State Contracting Party of the vessel, any discrepancy with the CEM,
- for all observed hauls/sets that contain Greenland shark, record the number, estimated weight, length (estimated if measured length is not possible), sex, and catch disposition (alive, dead, unknown) of each individual Greenland shark per haul or set.

Every fishing vessel shall at all times in the Regulatory Area carry at least one independent and impartial observer. The Observer's role is to maintain records on fishing activity, collect and perform scientific data and work as requested by the Commission, and monitor compliance with the Conservation and Enforcement Measures. However, this article also establishes circumstances for when 100% observer coverage may not be necessary. Observer coverage is never allowed to drop below 25% on any NAFO fisheries.

6. Monitoring, control and surveillance frameworks in place

In NAFO, there are different recommendations and resolutions related to monitoring, control and surveillance:

- Vessel authorization and records of fishing vessels (Art. 25 of NAFO CEM). A register of all fishing vessels is maintained by the NAFO Executive Secretary of all fishing vessels authorized to undertake fishing activities and is available through the NAFO MCS website (NAFO 2021a).
- Catch and effort data reporting (Art 28 of NAFO CEM). For the purposes of monitoring catch, each fishing vessel shall utilize a fishing logbook, a production logbook and a stowage plan to record fishing activities in the Regulatory Area. Every fishing vessel shall transmit electronically to its FMC a catch report with the quantity of catch retained and quantity discarded by species for the day preceding the report, by Division, including nil catch returns, sent daily. Catch shall be reported at the species level. The estimated weight of sharks caught per haul or set shall also be recorded. Each Contracting Party shall ensure that its FMC, immediately upon receipt, transmits electronically the catch reports to the Executive Secretary. Each

Contracting Party shall report its provisional monthly catches by species and stock area, and its provisional monthly fishing days for the 3M shrimp fishery to the Executive Secretary within 30 days.

- Transshipment monitoring and control (Article 1.19, Article 26.6, Article 28.6.e of NEFO CEM) (NAFO 2021a): NAFO defines transshipping as a transfer, over the side, from one fishing vessel to another, of fisheries resources or products. In the case of chartered vessels, transshipments at-sea must only be done with the prior authorization of the chartering Contracting Party and under the supervision of an on-board observer. The transshipment must be reported 24 hours prior to its occurrence to the flag State Contracting Party's Fisheries Monitoring Centre by the donor vessel and one hour after by the receiving vessel. For all fishing efforts, transshipment is to be reported by the donor vessel to its competent authority at least 24 hours before transshipment and by the receiving vessel no later than 1 hour after transshipment.
- VMS. NAFO Conservation and Enforcement Measures (NAFO, 2021a) Article 29. Every fishing vessel operating in the Regulatory Area shall be equipped with a satellite monitoring device capable of continuous automatic transmission of position to its land-based Fisheries Monitoring Centre, at a frequently of no less than once an hour.
- Surveillance and inspection. NAFO Conservation and Enforcement Measures (NAFO, 2021a) Chapter VI At-Sea Inspection and Surveillance Scheme Articles 31-41. NAFO has an At-sea Inspection and Surveillance Scheme. Contracting Parties with more than 15 vessels are required to have an inspector within the Regulatory Area. Contracting Parties with an inspection presence are authorized to conduct at-sea inspections of vessels operating inside the Regulatory Area.
- Port State Monitoring. NAFO Conservation and Enforcement Measures (2021) Article 10, Chapter VII Port State Control Articles 42-47. Port State CPs are required to carry out inspections of at least 15 % of all landings or transshipments of vessels of another Contracting Party during each reporting year. Port inspections are also required for all landings of Greenland halibut caught in the Regulatory Area (Article 10.4.e)
- Compliance evaluation. The Annual Compliance Review shall be completed yearly in accordance with Rules 5.1 and 5.2 of the Commission Rules of Procedure. The scope of the review is to determine how international fisheries complied with the annually updated NAFO Conservation and Enforcement

Measures when fishing in the NAFO Regulatory Area, and assess the performance of NAFO Contracting Parties with regard to their reporting obligations. The format of the compliance review is being continuously developed by the Standing Committee on International Control (STACTIC).

- Pre-season notification. Article 25.1 and 2 (NAFO 2021a). Each Contracting Party shall notify the NAFO Executive Secretary the individual authorization for each vessel from the list of notified vessels it has authorized to conduct fishing activities in the Regulatory Area no later than 30 days before the start of the fishing activities for the calendar year. A Contracting party shall also notify the NAFO Executive Secretary seven days prior to the commencement of a fishery research period of all research vessels entitled to fly its flag it has authorized to conduct research activities in the Regulatory Area and provide their respective Research Plans.

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NEAFC

1. Definitions and interpretation of key concepts (e.g., VMEs, VME indicators, SAIs)

Definitions of VMEs, VME indicators and SAI are included in Recommendation 19:2014:

- The term "**VME"** has the same meaning and characteristics as those contained in paragraphs 42 and 43 of the FAO Guidelines.
- The term **"significant adverse impacts"** has the same meaning and characteristics as those described in paragraphs 17-20 of the FAO Guidelines.
- **"VME indicators"** are those included in Annex 5 of Rec. 19-2014. Annex five contains a list of seven habitat types as well as physical elements for the NEAFC Regulatory Area, with the taxa most likely to be found in these habitats. The list includes VME habitats such as Cold-water coral reefs, coral gardens (hard and soft-bottom), deep-sea sponge aggregations (including hard-bottom sponge gardens and glass sponge communities), sea pen fields, tube-dwelling anemone patches, mud- and sand-emergent fauna, and bryozoan patches. Physical elements include isolated seamounts, stee-slopes and peaks on mid-oceanic ridges, knolls, canyon-like features and steep flanks >6.4°.

2. VME indicator species

"VME indicators" are those included in Annex 5 of Rec. 19-2014. Annex five contains a list of seven habitat types as well as physical elements for the NEAFC Regulatory Area, with the taxa most likely to be found in these habitats. The list includes VME habitats such as Cold-water coral reefs, coral gardens (hard and soft-bottom), deep-sea sponge aggregations (including hard-bottom sponge gardens and glass sponge communities), sea pen fields, tube-dwelling anemone patches, mud- and sand-emergent fauna, and bryozoan patches. The list is as follows:

VME Habitat type (examples listed)

- Cold-water coral reef
  - *Lophelia pertusa* reef (1 sp)
  - *Solenosmilia variabilis* reef (1 sp)
- Coral garden
  - Hard bottom garden
    - Hard bottom gorgonian and black coral gardens (9 families)

        - Colonial scleractinians on rocky outcrops (2 species)
        - Non-reefal scleractinian aggregations (2 species)
    - Soft-bottom coral gardens
        - Soft-bottom gorgonian and black coral gardens (1 family)
        - Cup-coral fields (2 families)
        - Cauliflower coral fields (1 family)
- Deep-sea sponge aggregations
    - Other sponge aggregations (3 families)
    - Hard-bottom sponge gardens (4 families)
    - Glass sponge communities (2 families)
- Seapen fields (8 families)
- Tube-dwelling anemone patches (1 family)
- Mud- and sand-emergent fauna (5 families)
- Bryzoan patches

Physical elements

Isolated seamounts, Steep-slopes and peaks on mid-ocean ridges, Knolls, Canyon-like features, Steep flanks >6.4°

3. Identification and assessment of VMEs

NEAFC uses Multi-criteria Assessment (MCA) to identify VMEs. This is a VME weighting system that assigns each VME indicator a score of between 1 and 5, based on expert judgement for each of the five FAO criteria for what classifies a habitat as a VME, and also examines whether the quantity of VME indicators is above or below NEAFC weight thresholds (30 kg for live corals or 400 kg for live sponges, as in NEAFC Rec. 19 2014). The final VME weighting output shows the likelihood of encountering a VME for each for each c-square (0.050 x 0.050) grid cell.

The motive for choosing the MCA method over other, more quantitative methods such as Kernel Density Estimation, was that the ICES VME database integrates data from a wide variety of sources, resulting in a heterogeneous dataset. For example, the database includes records from a diversity of sampling methods (e.g., trawling, ROV, longline and box cores), ranging from an individual coral colony observed in a single image, to a 500 kg bycatch of sponges obtained during a bottom trawl. Such differences prevent a coherent integration of the data into a more robust quantitative analysis without losing substantial amounts of data in the analysis (ICES, 2021).

4. Assessment of SAIs and measures to prevent SAI

In 2013, Recommendation 12 2013 (no longer in force) required that each Contracting Party proposing to participate in bottom fishing shall submit to the Secretary information on and, where possible, an initial assessment of the known and anticipated impacts of its bottom fishing activities on vulnerable marine ecosystems, in advance of the next meeting of PECMAS. These submissions shall also include the mitigation measures proposed by the Contracting Party to prevent such impacts. The Secretary shall promptly forward these submissions to PECMAS and to the Commission. The submission of such information shall be carried out in accordance with guidance developed by PECMAS on the basis of advice from ICES or, in the absence of such guidance, to the best of the Contracting Party's ability. On the basis of an assessment made by ICES, according to its own internally developed procedures and standards, PECMAS shall provide advice to the Commission as to whether the proposed bottom fishing activity would have significant adverse impacts on vulnerable marine ecosystems and, if so, whether mitigation measures would prevent such impacts. In this assessment, any other necessary information required, including information from other fisheries in the region or similar fisheries elsewhere may be used.

According to Gianni et al., (2016), no impact assessments were submitted to the NEAFC Secretariat or PECMAS by any Contracting Party until 2015, despite this provision. Assessments based on fisheries and non-fisheries related surveys (for example, a major multinational survey led by Spain in the Hatton Bank area (Durán Muñoz et al. 2012) have, however, been done for a significant portion, of the areas where bottom fishing is permitted – the so-called "existing bottom fishing areas" or fisheries footprint – to determine whether there are likely to be VMEs. As a result, several areas where VMEs are either known or deemed likely to occur within the footprint have been closed to bottom fishing. ICES WGDEC provides annual reviews of the closed areas (e.g., ICES, 2020 and 2021)

Recommendation 10 2021 requires impact assessments for exploratory bottom fishing. According to this measure, assessments should address, inter alia:

- Type(s) of fishing conducted or contemplated, including vessels and gear types, fishing areas, target and potential by catch species, fishing effort levels and duration of fishing (harvesting plan);
- Best available scientific and technical information on the current state of fishery resources and baseline information on the ecosystems, habitats and communities in the fishing area, against which future changes are to be compared;

- Identification, description and mapping (geographical location and extent) of VMEs known or likely to occur in the fishing area;
- Identification, description and evaluation of the occurrence, character, scale and duration of likely impacts, including cumulative impacts of the proposed fishery on VMEs in the fishing area;
- Data and methods used to identify, describe and assess the impacts of the activity, the identification of gaps in knowledge, and an evaluation of uncertainties in the information presented in the assessment;
- Risk assessment of likely impacts by the fishing operations to determine which impacts on VMEs are likely to be significant adverse impacts; and
- Mitigation and management measures to be used to prevent significant adverse impacts on VMEs and the measures to be used to monitor effects of the fishing operations.

Measures to prevent SAI (Recommendation 10 2021)

- Area closures for the protection of VMEs in the Regulatory Area shall be based on advice by ICES and on the procedures set out in recommendations regulating fishing in the Regulatory Area. Bottom fishing shall be prohibited in the following areas, within the coordinates as defined in Annex 2 of Rec. 19-2014 (NEAFC, 2021). There are 13 Area closures for the protection of VMEs:
    - Northern MAR Area;
    - Middle MAR Area (Charlie-Gibbs Fracture Zone and sub-Polar Frontal Region);
    - Southern MAR Area;
    - Altair Seamount;
    - Antialtair Seamount;
    - Hatton Bank 1;
    - Rockall Bank;
    - Logachev Mounds;
    - West Rockall Mounds;
    - Edora’s bank;
    - Southwest Rockall Bank;
    - Hatton-Rockall Basin; and
    - Hatton Bank 2.
- *Encounter thresholds and move-on rule*. Rec. 10 2021: Exceeding bycatch thresholds triggers move-on-rule. For trawls, longlines and other gears: (a) Trawl and other gears: the presence of more than 30 kg of live coral and/or

400 kg of live sponge of VME indicators; and (b) for a longline set: the presence of VME indicators on 10 hooks per caught per 1000 hook segment or per 1200 m section of long line, whichever is the shorter. In 2012, ICES advised that the encounter thresholds (at that moment: corals: 60 kg; sponges: 800 kg) were too high and advised that a reduction of between 30% and 70% for both live corals and sponges would be more likely to achieve conservation objectives. Those threshold values had been set arbitrarily in NEAFC and mirrored earlier regulations in the adjacent NAFO area to the west, which were intended as interim measures until the NAFO Scientific Council could suggest scientifically based measures. The ICES (2012) advice was based on the available information of the spatial distribution patterns of a broad range of VME indicator species (but no quantitative assessment was carried out). Then in the 2012 NEAFC Annual meeting, Norway presented a proposal to lower the thresholds for encounters with primary VME indicator species by 50%, in accordance with the scientific advice from ICES (NEAFC, 2012). It was agreed to adopt the proposal, and the current thresholds were set in Recommendation 12: 2013. In 2013, ICES suggested to adapt the SEAFO and CCMLAR thresholds and to use a threshold of 10 VME indicators caught per 1000 hook segment or per 1200 m section of long line, whichever is the shorter, to indicate the presence of a VME (ICES, 2013b).

When an encounter occurs, the fishing vessel shall cease fishing and move out of an area defined as a 2 nautical mile wide band (polygon) on both sides of the "track" of the trawl haul during which an encounter occurred. The "track" is defined as the line joining consecutive VMS positions, supplemented by more exact information, between the start and the end of the tow, extended by 2 nautical miles at both ends; if an encounter is discovered in connection with other bottom fishing gears the fishing vessel shall cease fishing and move away at least 2 nautical miles from the position that the evidence suggests is closest to the exact encounter location. The master shall use his or her best judgment based on all available sources of information; and the master shall report the incident without delay to its flag state, which shall forward the information to the Secretary immediately. Contracting Parties may if they so wish also require their vessels to report the incident directly to the Secretary. The Secretary shall immediately inform all Contracting Parties, and ICES, and archive the information received, and shall at the same time implement a temporary closure. The Permanent Committee on Management and Science (PECMAS) shall examine the temporary closure, and any relevant ICES advice, and if, on the basis of assessment by ICES, PECMAS advises that the area has or is likely to have a VME, the Secretary shall request Contracting Parties to maintain the temporary closure until such time that the Commission has acted upon the advice from PECMAS.

5. Data collection programs

The is no observer programme established by the NEAFC Scheme. Observers are required only in Exploratory fishing (Recommendation 10 2021): The relevant Contracting Party shall ensure that vessels flying its flag and conducting exploratory bottom fishing have a scientific observer on board. Observers shall collect data in accordance with the VME Data Collection Protocol as set out in Annex 3. This protocol establishes that observers shall:

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

The joint ICES/NAFO Working Group on Deep-water Ecology (WGDEC) collates new information on the distribution of Vulnerable Marine Ecosystems (VMEs) for use in annual ICES advisory processes (including those for NEAFC). ICES Member States submit VME data following ICES data calls. In 2020-2021, 11 160 new VME presence records and 3985 absence records were submitted and uploaded into the VME database. Of the newly submitted presence records, 273 were within the NEAFC Regulatory Area (ICES, 2021). Following decisions at WGDEC 2020, a VME Data QA subgroup was initiated to undertake a quality control review of new data submissions in advance of the WGDEC meeting.

6. Monitoring, control and surveillance frameworks in place

NEAFC's Scheme of Control and Enforcement sets out the rules and means by which NEAFC Contracting Party and Cooperating Non-Contracting Party vessels are managed (NEAFC, 2021):

There are publicly accessible fisheries statistics and annual compliance reports as well as the NEAFC vessel register. In addition to at sea monitoring and potential inspections, NEAFC has a system of controls at ports of its Contracting Parties aligned with the FAO Port States Measures Agreement. This system is innovative in that it also includes electronic exchange of information to support inspections.

These control measures have been a successful instrument to combat illegal, unreported or unregulated (IUU) in the NEAFC regulatory area. NEAFC nevertheless continues to cooperate with its sister RFMOs through the sharing and publication of IUU lists.

The most current development in NEAFC with regard to monitoring of fisheries activity is the ongoing implementation of a new Electronic Reporting System. This system, which enables reporting of electronic logbook data, will be able to enhance aspects of fisheries information, such as bycatch, which could significantly enhance the ability of science to support an ecosystem-based approach.

Additional technical measures should be noted as a contribution to reducing impacts on marine ecosystems. NEAFC has in place limits on net mesh size, a ban on the use of gill nets in water deeper than 200m, the use of sorting grids to allow fish to escape shrimp nets, and bans on shark finning and bans on discarding as some of its older regulations. In addition, regulations on lost abandoned and discarded fishing nets aim not only to reduce marine pollution but address the problem of ghost fishing.

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NPFC

1. Definitions and interpretation of key concepts (e.g., VMEs, VME indicators, SAIs)

Definitions of VMEs are provided in Annex 2 of CMM 021-05 and 2021-06, in its "Science-based standards and criteria for identification of VMEs and assessment of significant adverse impacts on VMEs and marine species". The science-based standards and criteria are consistent with the FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas, taking into account the work of other RFMOs implementing management of deep-sea bottom fisheries in accordance with UNGA Resolution 61/105.

- **"Vulnerability".** This concept is used as in the FAO Guidelines, paragraphs 14, 15 and 16.).
- **"Vulnerable marine ecosystem (VME)".** A marine ecosystem is to be classified as vulnerable based on its characteristics. The definition uses the 5 criteria in the FAO Guidelines to be used for the identification of VMEs.
- **"Significant adverse impacts (SAIs)".** This concept is used as in FAO Guidelines, paragraphs 17, 18, 19 and 20. Thus, SAIs are those that compromise ecosystem integrity (i.e., ecosystem structure or function) in a manner that: (i) impairs the ability of affected populations to replace themselves; (ii) degrades the long-term natural productivity of habitats; or (iii) causes, on more than a temporary basis, significant loss of species richness, habitat or community types.

Management response in NPFC may vary, depending on the size of the ecological unit in the Convention Area. Therefore, the spatial extent of the ecological unit is to be decided first. That is, whether the ecological unit is the entire Area, or the current fishing ground, namely, the Emperor Seamount and Northern Hawaiian Ridge area (hereinafter called "the ES-NHR area"), or a group of the seamounts within the ESNHR area, or each seamount in the ES-NHR area, is to be decided using the above criteria.

2. VME indicator species

The NPFC currently recognizes four taxonomic groups of corals (Alcyonacea (excluding Gorgonians), Antipatharia, Gorgonacea (now within the Alcyonacea), and Scleractinia) as VME indicator taxa (NPFC 2019, 2021a).

3. Identification and assessment of VMEs

NPFC does not have a consensus quantitative method for defining VMEs. It has recently developed a decision tree to help identify data that can be used to define VMEs in the NW and NE parts of the NPFC Convention Area. The decision tree gives priority to visual surveys for identifying VMEs, if surveys cannot be undertaken, then Species Distribution Models (SDMs) and other approaches (such as bycatch from research surveys) are considered. Areas likely to contain VMEs are considered of high priority to undertake visual surveys.

Recently, Canada has proposed a quantitative method of VME identification for the NE part of the NPFC that integrates visual data and model predictions (SDMs) but this method still has to be reviewed and has been applied only in one case study (Cobb Seamount) (Warawa et al. 2021). In the NW part of the NPFC CA, Japan recently used seafloor images, fisheries bycatch data, research surveys and a KDE method to map concentrations of fishing effort and areas of overlap between the distribution of VME indicator taxa and fishing activities. Then, areas that where potential VMEs where visually surveyed and qualitatively assessed relative to the five FAO criteria for identification of VMEs. (Warawa et al., 2021).

4. Assessment of SAIs and measures to prevent SAI

In Annex 2 of Conservation and Management Measures (CMM) 2021-05 and 2021-06, the NPFC have set out Science-based Standards and Criteria, to assess Significant Adverse Impacts (SAIs) of bottom fisheries on VMEs. These are consistent with the FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas, taking into account the work of other RFMOs implementing management of deep-sea bottom fisheries in accordance with UNGA Resolution 61/105. The standards and criteria are to be modified from time to time as more data are collected through research activities and monitoring of fishing operations. The Science-based Standards and Criteria set out in Annex 2 are to provide guidelines for each member of the Commission for assessing individual bottom trawling activities (i.e., by each gear). Using the best available information, each member of the Commission is required to assess whether bottom fishing activities are likely to have SAIs on VMEs or marine species (in combination with identification of potential VME species or areas where they are known or likely to occur).

Each member of the Commission is to conduct assessments to establish if bottom fishing activities are likely to produce SAIs in a given seamount or other VMEs. Such an impact assessment is to address, inter alia:

- Type of fishing conducted or contemplated, including vessel and gear types, fishing areas, target and potential bycatch species, fishing effort levels and duration of fishing;
- Best available scientific and technical information on the current state of fishery resources, and baseline information on the ecosystems, habitats and communities in the fishing area, against which future changes are to be compared;
- Identification, description and mapping of VMEs known or likely to occur in the fishing area;
- The data and methods used to identify, describe and assess the impacts of the activity, identification of gaps in knowledge, and an evaluation of uncertainties in the information presented in the assessment;
- Identification, description and evaluation of the occurrence, scale and duration of likely impacts, including cumulative impacts of activities covered by the assessment on VMEs and low-productivity fishery resources in the fishing area;
- Risk assessment of likely impacts by the fishing operations to determine which impacts are likely to be SAIs, particularly impacts on VMEs and low-productivity fishery resources (Risk assessments are to take into account, as appropriate, differing conditions prevailing in areas where fisheries are well established and in areas where fisheries have not taken place or only occur occasionally);
- The proposed mitigation and management measures to be used to prevent SAIs on VMEs and ensure long-term conservation and sustainable utilization of low productivity fishery resources, and the measures to be used to monitor effects of the fishing operations.

Impact assessments are to consider, as appropriate, the information referred to in these Standards and Criteria, as well as relevant information from similar or related fisheries, species and ecosystems. Where an assessment concludes that the area does not contain VMEs or that significant adverse impacts on VMEs or marine species are not likely, such assessments are to be repeated when there have been significant changes to the fishery or other activities in the area, or when natural processes are thought to have undergone significant changes.

Measures to prevent SAI

NPFC has established the following measures related to preventing SAIs

- Precautionary closed off areas to fishing for potential VME conservation (defined areas on seamounts are available in in CMM 2021-05 and 2021-06).

- Distance between the footrope of the gillnet and sea floor is greater than 70 cm.
- Encounter thresholds (CMM 2021-05 and CMM 2019-06). When in the course of fishing operations, cold water corals more than 50 kg are encountered in one gear retrieval, Members of the Commission shall require vessels flying their flag to cease bottom fishing activities in that location. Cold water corals include: Alcyonacea, Antipatharia, Gorgonacea, and Scleractinia. This threshold was established following the example of NAFO. Sponges and hydrocoral taxa are under consideration by the Scientific Committee of NPFC for inclusion.

5. Data collection programs

There are currently national scientific observer programs in place for Members that fish bottom fish and the development of an observer program for both science and compliance purpose is under consideration. An example of the scientific observer scheme data and reporting formats is in CMM 2019-06 For Bottom Fisheries and Protection of VMEs in the North Eastern Pacific Ocean Annexes 4 and 5.

6. Monitoring, control and surveillance frameworks in place

- CMM 2021-01 On Information Requirements for Vessel Registration. Vessels authorized by Members to conduct fishing activities in the Convention Area must be submitted to the NPFC for inclusion on the NPFC Vessel Registry. The NPFC Vessel Registry is made publicly available through the NPFC website, with appropriate consideration of Members' confidentiality laws.
- CMM 2019-02 To Establish a List of Vessels Presumed to Have Carried Out IUU Activities in the NPFC Convention Area. At least 70 days before the meeting of the Technical and Compliance Committee (TCC), members are required to transmit to the Executive Secretary information and documentation on vessels presumed to be carrying out IUU activities in the year previous. The process begins with the Executive Secretary drawing up the draft list, the TCC drawing up the provisional list and the Commission deciding the final list. Members may comment on the list throughout the listing process.
- Under the Convention, the Commission has responsibility for setting TACs (Article 7.1.a). However, the CMMs contain very few specific catch allocation, with only CMM 2021-05 For Bottom Fisheries and Protection of VMEs in the NW Pacific Ocean containing some catch limitations on North Pacific armorhead However, there are data reporting requirements contained in CMM

2019-07 Conservation and Management Measure for Chub Mackerel paragraph 6, and CMM 2021-11 Conservation and Management Measure for Japanese Sardine and Japanese Flying Squid paragraph 6, which state that members and cooperating non-members "shall provide their data on [catch] … in accordance with the data requirements adopted by the Commission in the Annual Report by the end of February, every year." Members' report catch and effort data by fishery in their Annual Reports. Annual Reports and catch and effort data are not available to the public.

- CMM 2016-03 on the Interim Transshipment Procedures for the NPFC. The NPFC definition of fishing activities includes transshipment activities, as such, transshipment vessels which are flagged to a Member are to be included on the NPFC Vessel Registry. Transshipment vessels which are flagged to a non-Member State can be used in the Convention Area providing that the vessel information and written undertaking by the owner and master of the vessel is provided to the NPFC Executive Secretary for inclusion on the NPFC Interim Register of non-member Carrier Vessels.
- CMM 2021-12 On the Vessel Monitoring System (VMS). The VMS forms an important part of the Commission's MCS regime to ensure compliance with, and enforcement of, the provisions of the Convention and CMMs. The purpose of the VMS is to continuously monitor the positions and movements of all fishing vessels in the Convention Area for compliance purposes. VMS data may also be used to support scientific processes as agreed by the Commission. The VMS applies to all authorized NPFC vessels in the Convention Area.
- CMM 2021-09 For High Seas Boarding and Inspection Procedures for the NPFC. Contracting parties and their authorized inspectors are empowered to carry out high seas boarding and inspection of any other contracting party vessel, as long as they notify the Executive Secretary of their intention to conduct such boarding and inspection. The CMM sets out detailed procedures for inspection and pre-inspection communication with the vessel.
- CMM 2019-13 For the Compliance Monitoring Scheme. The purpose of the Compliance CMM is to improve compliance among Contracting Parties by identifying specific incidences of non-compliance as well as trends and areas where technical assistance or capacity building may be extended to Contracting Parties. Members and CNCPs provide reports and data to the Executive Secretary on their national compliance for the calendar year preceding the meeting of the Technical and Compliance Committee (TCC). From this and any other data, the Executive Secretary produces a draft report

for the consideration of the TCC. The Executive Secretary is to provide the report to Contracting Parties at least 60 days before the TCC meeting.

References

NPFC (2019). 'CMM 2019-05 Conservation and Management Measure for Bottom Fisheries and Protection of Vulnerable Marine Ecosystems in the Northeastern Pacific Ocean', North Pacific Fisheries Commission. Available at: https://www.npfc.int/system/files/2019-11/CMM%202019-06%20FOR%20BOTTOM%20FISHERIES%20AND%20PROTECTION%20OF%20VULNERABLE%20MARINE%20ECOSYSTEMS%20IN%20THE%20NORTHEASTERN%20PACIFIC%20OCEAN.pdf [Verified 18th August 2021].

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SEAFO

1. Definitions and interpretation of key concepts (e.g., VMEs, VME indicators, SAIs)

SEAFO Conservation Measure (CM) 30-15 refers to FAO Guidelines for the Management of Deep-Sea Fisheries in the High Seas (FAO, 2009) to define a **Vulnerable Marine Ecosystem (VME)** which establishes the criteria for the identification of VMEs such as their uniqueness, significance of the habitat, fragility, Life-history traits of component species that make recovery difficult or also their structural complexity. Additionally, it states that these criteria should be adapted and additional criteria should be developed as experience and knowledge accumulate, or to address particular local or regional needs.

- A **"VME encounter"** is defined to be an incidental catch of corals and sponges above the established threshold levels (which are different depending on the fishing gear).
- A **"VME indicator unit"** is established for bottom longlines and pots as one liter or kg of VME-indicator organisms recovered during hauling for each 1200m section of the gear (or 1000 hooks in the case of longlines, whichever is the shorter).
- Similarly, this CM refers to FAO, 2009 guidelines to define a **"Significant Adverse Impact" (SAI)** as those that compromise ecosystem integrity in a manner that: (i) impairs the ability of affected populations to replace themselves; (ii) degrades the long-term natural productivity of habitats; or (iii) causes, on more than a temporary basis, significant loss of species richness, habitat or community types.
- **"Exploratory bottom fishing"** means all commercial bottom fishing activities outside area closures and existing bottom fishing areas, or fisheries within existing bottom fishing areas when a new fishing method and/or strategy are attempted to be used.

2. VME indicator species

VME Indicators listed by SC (SEAFO, 2016 and 2017) are the following:

- Sponges (Porifera)
- Gorgonian corals (Gorgonacea)
- Hydrocorals (Anthoathecatae)

- Stony corals (Scleractinia)
- Black corals (Anthipatharia)
- Zoanthids (Zoantharia)
- Soft corals (Alcyonacea)
- Sea pens (Pennatulacea)
- Erect bryozoans (Bryozoa)
- Sea lilies (Crinoidea)
- Basket stars (Ophiuroidea)
- Annelida (Serpulidae)
- Sea squirts (Ascidiacea)
- Tube-dwelling Sea anemones (Ceriantharia)

Although only Sponges and Corals are defined as VMEs in SEAFO, observers on board shall monitor any set for evidence of presence of VMEs and to identify coral, sponges and other organisms to the lowest level possible. The list of organisms to collect that are included in the observer logbook are:

Actiniaria, *Adamussium colbecki*, Alcyonacea, Annelida, Anthoathecatae, Anthozoa, Antipatharia, Bathylasmatidae, Brachiopoda, Bryozoa, Chemosynthetic, Chordata, Cidaroida, Cnidaria, Crinoidea, Demospongiae, Echinodermata,Echinoidea, Euryalida, Hexactinellida, Hydrozoa, Ophiurida, Pectinidae, Pterobranchia,Scleractinia, Serpulidae, Stylasteridae, Xenophyophora and Zoanthidea.

There is a SEAFO identification guide for observers (Ramos et al, 2009) to help identification on board to a Class/Order taxonomic level

3. Identification and assessment of VMEs

In January-February 2015 the R/V Dr Fridtjof Nansen conducted a 29-day cruise to seamounts in the SEAFO Convention Area. The cruise was part of a scientific study conducted by an international team of scientists, most of whom represented the SEAFO Contracting Parties. The overall objective of the study was to conduct basic mapping and identification of vulnerable marine ecosystems (VMEs) and fisheries resources on selected seamounts and seamount complexes in the SEAFO Convention Area. The investigation included studies at the following seamounts: Schmitt-Ott, Wüst (2 locations), Vema, Valdivia (4 locations), and Ewing. SEAFO Conservation Measure 29/14 classified the three first seamounts as closed to fishing, while Valdivia and Ewing were ‘existing fishing areas’ and thus open to fishing. Unfortunately, bad weather forecasts prevented studies on the Discovery seamounts, i.e., the southernmost planned study area where longline fisheries for Patagonian toothfish are being conducted (IMR, 2015).

The survey report presented the first results on bathymetry, VME-indicator organism presence, fisheries resources, and evidence of human footprint in the different study areas. Data were submitted to SEAFO and the biological collection was deposited in the IZIKO South African Museum in Cape Town. To select candidate closure areas best available bathymetry data were compiled to locate subareas recognized in the FAO guidelines as VME features, i.e., areas and habitats likely to have VMEs such as seamounts. In implementing its area-based management, fishing was assumed restricted to the upper 2000m of any feature, hence an updated map of areas shallower than 2000m was the basis of further selection. In SEAFO such areas are seamounts or seamount complexes of various sizes and shapes (IMR, 2015).

4. Assessment of SAIs and measures to prevent SAI

The FAO Guidelines (FAO, 2009) are used as a reference to determine the scale and significance of an impact. The factors to be considered are the intensity of the impact, the spatial extent of the impact relative to the availability of the habitat type affected, the sensitivity/vulnerability of the ecosystem to the impact, the ability of an ecosystem to recover from harm, and the rate of such recovery, the extent to which ecosystem functions may be altered by the impact and the timing and duration of the impact relative to the period in which a species needs the habitat during one or more of its life-history stages. SEAFO should apply the precautionary approach in their determinations regarding the nature and duration of impacts.

Measures to prevent SAI

Despite a shortage of data on the occurrence of VMEs, SEAFO has introduced comprehensive measures to protect such ecosystems from significant adverse impacts within the convention area. The convention area has been divided into agreed limited 'existing fishing areas', i.e. areas were fisheries were conducted within a recent reference period, and more extensive 'new fishing areas' where this was not the case.

The objective of the CM30/15 "on Bottom Fishing Activities and Vulnerable Marine Ecosystems in the SEAFO Convention Area" is to ensure the implementation of effective measures to prevent significant adverse impacts of bottom fishing activities on vulnerable marine ecosystems that, based on the best available scientific information, are known or likely to occur in the Convention Area.

Eleven **closed areas** to all fishing gears and one closed area to all fishing gears except for pots and longlines were defined.

Exploratory fisheries. The relevant Contracting Party shall forward to the Executive Secretary a Notice of Intent to undertake exploratory bottom fishing at least 60 days prior to the proposed start of the fishery. The Notice of Intent should include, among other information, a mitigation plan including measures to prevent significant adverse impact to VMEs that may be encountered during the fishery. Each Contracting Party proposing to undertake exploratory bottom fishing shall submit to the Executive Secretary, in addition to the Notice of Intent, a preliminary assessment of the known and anticipated impacts of the proposed bottom fishing activity. The CPs preliminary assessment shall as a minimum demonstrate that every effort has been made to provide the information requested. The CP should address individual request point by point in order to facilitate SC evaluation:

- type(s) of fishing conducted or contemplated, including vessels and gear types, fishing areas, target and potential by catch species, fishing effort levels and duration of fishing (harvesting plan);
- best available scientific and technical information on the current state of fishery resources and baseline information on the ecosystems, habitats and communities in the fishing area, against which future changes are to be compared;
- identification, description and mapping (geographical location and extent) of VMEs known or likely to occur in the fishing area;
- identification, description and evaluation of the occurrence, character, scale and duration of likely impacts, including cumulative impacts of the proposed fishery on VMEs in the fishing area;
- data and methods used to identify, describe and assess the impacts of the activity, the identification of gaps in knowledge, and an evaluation of uncertainties in the information presented in the assessment;
- risk assessment of likely impacts by the fishing operations to determine which impacts on VMEs are likely to be significant adverse impacts; and
- mitigation and management measures to be used to prevent significant adverse impacts on VMEs and the measures to be used to monitor effects of the fishing operations.

SC requires that information provided is documented with references to published sources or other sources that SC can access/consult. If SC deems the contents of the submitted assessment, including the proposed mitigation measures, insufficiently rigorous and balanced to assess the risk of SAI, then the proposal shall not be approved.

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

When evaluating the preliminary assessment of the known and anticipated impacts of the proposed bottom fishing activity, preference shall be given by the relevant Contracting Party to exploratory bottom fishing using fishing gear and methods with the least bottom contact, in well-mapped areas and at times when impacts are likely to have the least adverse impacts on organisms other than the target species.

Encounter thresholds. For longlines, SEAFO has established a threshold of at least 10 VME indicator units in one 1200-meter section of line or 1000 hooks, whichever is the shorter, in both existing and new fishing areas. For bottom trawls, revised threshold levels of more than 60 kg of live coral and/or 600 kg of live sponge for existing bottom fishing areas, and more than 400 kg of live sponges and/or 60 kg of live coral for new fishing areas, were adopted. The move on rule in SEAFO was initially triggered in cases where threshold levels of bycatch of 100 kg of "live" coral or 1,000 kg of sponges or more are encountered per tow or set of the gear. These thresholds were revised down in 2009 to 60 kg of live coral and 800 kg of live sponge. For bottom trawls, revised threshold levels of more than 60 kg of live coral and/or 600 kg of live sponge for existing bottom fishing areas, and more than 400 kg of live sponges and/or 60 kg of live coral for new fishing areas, were adopted. The Scientific Committee recommended in 2012 that the threshold for the trawl tow be further reduced to no more than 300 kg of live sponges and/or 30 kg of live coral in existing fishing areas, and no more than 200 kg of live sponges and/or 30 kg of live coral in new fishing areas. This recommendation was based on a review of available information from NAFO and NEAFC regarding their protocols for threshold levels of VME indicators. However, the Commission did not agree to lower the threshold to these levels (SEAFO, 2020). The Scientific Committee recommended in 2011 that an adapted version of the CCAMLR encounter protocols be applied in the SEAFO area for non-trawl gear in both existing and new fishing areas, which resulted in current thresholds for longline fisheries.

A VME encounter's **move-on rule** is set as defined below:

- If an encounter is discovered the vessel master shall cease fishing and move away at least 2 nautical miles from the end point of the trawl tow in the direction least likely to result in further encounters, defining a buffer area with a 2 nautical mile radius;
- if an encounter is discovered in connection with other bottom fishing gears the fishing vessel shall cease fishing and move away at least 1 nautical miles from the position that the evidence suggests is closest to the exact encounter location, defining a buffer area with a 1 nautical mile radius. The master shall use his or her best judgment based on all available sources of information; and
- the master shall report the incident, including the track of the trawl or position determined under sub-paragraphs (i) and (ii), without delay to its flag State, which shall forward the information to the Executive Secretary immediately. Contracting Parties may if they so wish also require their vessels to report the incident directly to the Executive Secretary.
- The Executive Secretary shall immediately inform all Contracting Parties, and archive the information received and shall, if the encounter happened outside existing fishing areas, at the same time implement a temporary closure. The temporary closure shall correspond to the buffer area defined above.

5. Data collection programs

A SEAFO reporting obligations table is available on the SEAFO website and updated every year. Article 10 of the System of Observation, Inspection, Compliance and Enforcement (2019) states that each Contracting Party vessel shall keep a bound fishing logbook and within 30 days of leaving the CA, for each haul should be reported:

- the catch retained on board by species in live weight (Kg) and an estimation of the amount of fishery resources discarded (kg), by species;
- all non-TAC species discarded for which the total live weight is less than 10 kg, may be reported using the 3-Alpha Code MZZ (Miscellaneous Marine Species);
- the type of gear (trawl, pots, longline, etc.);
- the description of gear (number of hooks, number of pots, size of the trawl, etc.);
- the longitude and latitude co-ordinates of shooting and hauling; and
- the date and time of shooting and hauling (UTC).

Article 11 indicates that each Contracting Party shall ensure that its vessels shall communicate catch reports to its Fishing Monitoring Centre (FMC) in accordance with the specifications set out in Annex II A by electronic means, or other appropriate means. The fishing logbook data shall be submitted to the Secretariat in the electronic format as provided in the Reporting Forms section on the SEAFO website.

Article 12 states that each Contracting Party shall report to the Executive Secretary the aggregated retained and discarded catch of fishery resources listed in an Annex (Annex I), and by-catch species, in kilogram per species on a quarterly basis. Such reports shall be submitted within 30 days following the end of the quarter in which the fishing occurred.

Article 18 regulates the Scientific observer program. Each CP shall ensure that all its vessels operating in the Convention Area shall carry scientific observers qualified by the flag State. Flag States shall ensure that the relevant data is transmitted to Executive Secretary in the format specified by the Scientific Committee using the scientific observer forms and report template as provided in the Reporting Forms section on the SEAFO website. The submission of this information is within 30 days of leaving the Convention Area. This information shall take into account the need to maintain confidentiality of non-aggregated data.

6. Monitoring, control and surveillance frameworks in place

For the purpose of the CM 30/15 (which was preceded by the CM 29/14), SEAFO is taking into account the guidance provided by the FAO in the framework of the Code of Conduct for Responsible Fisheries and any other internationally agreed standards, as appropriate. All RFMOs, including SEAFO, have committed to these international concerns and guidelines, and one of the responses has been to close subareas of their convention/regulatory areas to fishing practices and gears known or likely to cause significant adverse impacts to VMEs.

Scientific research activities in SEAFO closures should adhere to the guidelines for scientific research adopted by the Commission in 2014.

To pursuit an exploratory bottom fishing, the relevant Contracting Party shall forward to the Executive Secretary a Notice of Intent to undertake exploratory bottom fishing at least 60 days prior to the proposed start of the fishery. The Notice of Intent shall include, among other information, a catch monitoring plan, including recording/reporting of all species caught as well as a mitigation plan, including measures to prevent significant adverse impact to VMEs that may be encountered during the fishery.

Each Contracting Party shall ensure that its vessels implement a satellite-based vessel monitoring system (VMS) following the protocol described in the SEAFO System of Observation, Inspection, Compliance and Enforcement (2019).

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SIOFA

1. Definitions and interpretation of key concepts (e.g., VMEs, VME indicators, SAIs)

Definitions and interpretation of key concepts (e.g., VMEs and SAIs) used in the RFMO/Fishing area are set in CMM 2020/01. "Conservation and Management Measure for the Interim Management of Bottom Fishing in the Agreement Area":

- **"Vulnerable marine ecosystem" (VME)** means a marine ecosystem identified using the criteria outlined in paragraph 42 of the FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas (FAO, 2009).
- **"Bottom fishing"** means fishing using any gear type likely to come in contact with the seafloor or benthic organisms during the normal course of operations.
- **"SIOFA bottom fishing footprint"** means a map of the spatial extent of historical bottom fishing in the Agreement Area, for all vessels flagged to all Contracting Parties, CNCPs and PFEs over a period to be defined by the Meeting of the Parties.

2. VME indicator species

The following VME indicators are listed in Annex 1 of CMM 2020-01:

- Chemosynthetic organisms (CXV) (no taxa specified)
- Cnidaria (CNI), which can be, if possible, detailed in recording as: Gorgonacea (GGW) (Order), Anthoathecatae (AZN) (Order), Stylasteridae (AXT) (Family), Scleractinia (CSS) (Order), Antipatharia (AQZ) (Order), Zoantharia (ZOT) (Order), Actiniaria (ATX) (Order), Alcyonacea (AJZ) (Order), Pennatulacea (NTW) (Order)
- Porifera (PFR), which can be, if possible, detailed in recording as: Hexactinellida (HXY) (Class), Demospongiae (DMO) (Class)
- Ascidiacea (SSX) (Class)
- Bryozoans (BZN) (Phylum)
- Brachiopoda (BRQ) (Phylum)
- Pterobranchia (HET)
- Serpulidae (SZS) (Family)
- Xenophyophora (XEF) (Phylum)
- Bathylasmatidae (BWY) (Family)

- Stalked crinoids (CWD) (Class)
- Euryalida (OEQ) (Order)
- Cidaroida (CVD) (Order)

3. Identification and assessment of VMEs

CMM 2020/01. Conservation and Management Measure for the Interim Management of Bottom Fishing in the Agreement Area. Identification and assessment of VMEs. The Meeting of the Parties shall cooperate to identify, on the basis of the best available scientific information including advice and recommendations provided by the Scientific Committee, areas where VMEs are known or likely to occur in the Agreement Area and to map these sites, and provide such data and information to all CCPs for circulation.

There is an ongoing project to map bioregions based on VME indicator taxa distribution data (SIOFA, 2021). The objectives of this project are:

- To provide maps of observed bioregions based on the observed distribution of VME indicator taxa,
- provide predictive bioregions based on the individual modelled distributions of VME indicator taxa, and
- to provide an alternative set of predictive bioregions based on the modelled relationship between observed bioregions and the environment.

VME indicator taxa data have been collected and collated from various publicly available repositories and that of the SIOFA Secretariat, as well as publicly available data on environmental variables. The accuracy of these data have been investigated. The completeness index has also been calculated (observed richness/theoretical richness) to understand how under-sampled the SIOFA Area might be. Ensemble modelling will be applied to account for unspecified uncertainties.

Preliminary results indicate that:

- The majority of the records occurred above 1,000 m water depth, reflecting the aggregated distribution of records in coastal areas.
- Large areas of scant information dominated the center of the SIOFA Area.
- There are few distribution data for VME indicator taxa within the SIOFA Area. The spatial distribution of the completeness index suggested that the SIOFA Area is critically under-sampled, with only 63% of the species richness of the area currently known.
- Data held by the SIOFA Secretariat are at a very coarse taxonomic level.

4. Assessment of SAIs and measures to prevent SAI

According to CMM 2020/01, the Scientific Committee shall develop and provide advice and recommendations to the Meeting of the Parties on a SIOFA Bottom Fishing Impact Assessment (SIOFA BFIA). The SIOFA BFIA shall take into account the activities of all fishing vessels to which this CMM applies that, at the time the SIOFA BFIA is prepared, are engaged in, or intending to engage in, bottom fishing within the agreed SIOFA bottom fishing footprint. The Scientific Committee shall consider all BFIAs received under paragraph 21 and 27b. at its ordinary meeting in 2018 or, if the BFIA is submitted under paragraph 22b. or 27b., at the next ordinary meeting of the Scientific Committee, and provide advice in its meeting report as to: a. the likely cumulative impacts of bottom fishing impact activity from vessels flying the flag of a Cooperating/Contracting Party (CCP) in the Agreement Area; and b. whether each BFIA meets an appropriate standard in light of international standards and the SIOFA BFIAS, where applicable.

All BFIAs, including the SIOFA BFIA, shall:

- be prepared, to the extent possible, in accordance with the FAO International guidelines for the management of deep-sea fisheries resources in the high seas;
- meet the standards of the SIOFA BFIAS (if the BFIA is prepared after the Meeting of the Parties has adopted the BFIAS);
- take into account areas identified where VMEs are known or are likely to occur in the area to be fished;
- take into account all relevant information provided pursuant to paragraphs 20 and 18, and in addition, for the SIOFA BFIA, paragraph 21 and 22;
- be updated when a substantial change in the fishery has occurred, such that it is likely that the risk or impacts of the fishery may have changed;
- assess, to the extent possible, the historical and anticipated cumulative impact of all bottom fishing activity in the Agreement Area, if applicable;
- address whether the proposed activities achieve the objectives described in paragraph 1 of this CMM and Article 2 of the Agreement; and
- h. be made publicly available on the SIOFA website, once developed.

Following the FAO Guidelines, the BFIA for proposed bottom fishing activities in the SIOFA Area should provide information under the following sections (SIOFA, 2017):

- Description of the Proposed Fishing Activities. Assessments shall contain a detailed fishing plan, providing a quantified description of the planned fishing activities

- Mapping and Description of Proposed Fishing Areas. Maps of the proposed fishing areas in relation to available information on VMEs and seabed bathymetry should be presented
- The risk assessments should evaluate the potential impact of the 'hazards': Fishing activity, this will need to be evaluated for each gear type used by a participant's vessels (e.g., trawling, longlining, etc.); loss of bottom fishing gear, including the risk of ghost fishing and ongoing physical impact of lost gear and for each activity (hazard) to be evaluated a brief description of the expected impacts should be provided, in terms of what may be affected and how. These will be guided by the UNGA Resolutions 61/105 and 64/72 and the FAO Guidelines.
- Interactions with VMEs. This section should specifically address the expected and potential interaction and impacts of the proposed fishing gear on VMEs
- Information on Status of the Deep-sea Stocks to be Fished. This section should provide information on the estimated state of the deep-water stocks of the intended target and by-catch species
- Monitoring, Management and Mitigation Measures. Monitoring, management and mitigation measures would be expected to address the risks identified in the impact assessment.

In determining the level of risk (low, medium, high) posed by an activity, the elements that should be specifically evaluated are:

- Intensity - The intensity or severity of the impact at the specific site affected. This may be quantified by previous studies or an expert evaluation of the magnitude of the impact. e.g., None (no detectable impact); Low (some physical damage to some taxa/colonies); Medium (substantial damage to a small proportion of colonies/taxa, or small damage to a large number of taxa at the site, likely to modify biological and ecological processes e.g., reproduction) or High (significant damage to a significant proportion, where environmental functions and processes are significantly altered such that they temporarily or permanently cease).
- Duration – how long the effects of the impact are likely to last.
- Spatial extent – The spatial impact relative to the extent of the VMEs (e.g., will fishing impact 5%, 30% or 80% of the VME distribution) and whether there may be offsite impacts (e.g., will reproduction be impacted at a broader spatial scale).
- Cumulative impact - The frequency of the impact will influence the risk, with activities occurring repeatedly at a site likely to have a greater risk. This will

depend on the amount of fishing effort and should be considered in relation to the recovery of the VMEs/taxa.

Each BFIA will need to detail how the factors listed in paragraphs 17-20 of the FAO Guidelines (FAO, 2009) were used to develop a definition of 'significance' for the purposes of the assessment. This should include at a minimum the criteria:

- The intensity or severity of the impact at the specific site affected (i.e., are entire colonies/habitats destroyed, or just a few branches broken), this will be gear specific (and may link be guided by the Hierarchy of Bottom Fishing Impacts;
- The ecological consequence of a given impact (which depends on the distribution, density, and recovery potential of the organisms in question), including estimation of the likelihood of interaction;
- The spatial extent of the impact relative to the extent of the VME and whether there may be offsite impacts;
- The frequency of the impact and the cumulative fishing effort. The rate of impact (on a temporal and geographical scale) in relation to rates of recovery of taxa needs to be considered. Many of these criteria are difficult to measure directly for deep sea fisheries and so assumptions must be made based on studies conducted elsewhere or expert input. All assumptions must be clearly documented in the impact assessments to ensure transparency.

Measures to prevent SAI

SIOFA has establishes interim measures to prevent SAIs in CMM 2020/01 "Conservation and Management Measure for the Interim Management of Bottom Fishing in the Agreement Area".

Closed areas. SIOFA has established the following closed areas to protect VMEs:

- Atlantis Bank
- Coral Point
- Fools Flat Point
- Middle of What Point
- Walter's Shoal Point

All of these areas are closed since 2018. The VME Criteria used for these closures were: fragility, functional significance of the habitat and uniqueness or rarity.

Encounter thresholds. For longlines, the threshold that triggers the encounter protocol for longline gears is the catch/recovery of 10 or more VME-indicator units of species in a single line segment. For trawls, more than 60 kg of live corals and/or 300 Kg of sponges in any tow. SIOFA has adopted CCAMLR's encounter protocol for longline gears and NAFO's thresholds for trawl gears. In 2021, a small working group was agreed, comprising CCP's with trawl fisheries to work intersesionally to characterize, and if possible, to compile and analyze benthic bycatch data to revise the encounter thresholds.

5. Data collection programs

CMM 2021/02 Conservation and Management Measure for the Collection, Reporting, Verification and Exchange of Data relating to fishing activities in the Agreement Area (Data Standards). Regarding collection of data, Cooperating/Contracting Parties (CCPs) shall ensure that data on fishing activities, including for target, non-target and associated and dependent species such as marine mammals, marine reptiles, seabirds or 'other species of concern', are collected from vessels flying their flag that are fishing in the Agreement Area in accordance with the relevant sections of Annex A. CCPs shall collect vessel catch and effort data on a haul-by-haul basis.

Data collection and submission. CCPs shall report to the Secretariat, by 31 May each year, the data collected for the previous calendar year, in accordance with the format prescribed in the corresponding annexes. CCPs shall provide to the Secretariat, by 31 May each year, annual catch summaries for all species/groups caught in the Agreement Area during the previous calendar year. The catch summaries shall include the following information:

- Calendar year
- FAO statistical area
- Species/group name (common name and scientific name)
- Species/group code (FAO3-alpha code 19, if available)
- Annual catch total - tons raised to 'live' weight.

To assist in data collection CCPs shall implement on-board all fishing vessels flying their flag the FAO Identification guide to the deep–sea cartilaginous fishes of the Indian Ocean.

This CMM also refers to provision of historical data by CCPs. To assist with the development of a bottom fishing footprint and stock assessments, each CCP shall provide the Secretariat with all historical catch and effort, and if available observer data for vessels flying their flag and fishing in the Agreement Area at any time during period 2000-2015.

CMM 2021/02 requires that each CCP shall ensure that any vessel flying its flag and undertaking bottom fishing a. using trawl gear has 100 percent scientific observer coverage for the duration of the trip; and b. using any other bottom fishing gear type has 20 percent coverage in any fishing year. CCPS shall provide annual reports to the Scientific Committee on data collected under this scheme. All observer data collected shall be reported to the Secretariat by 31 May each year for the previous calendar year.

The following information has to be collected by observers:

- Vessel information, effort and catch data for its fishing activities in the Agreement Area, including target, non-target and associated and dependent species including marine mammals, marine reptiles, seabirds or 'other species of concern';
- Biological or other data and information relevant to the management of fishery resources in the Agreement Area, as specified in this CMM, or as identified from time to time by the Scientific Committee or through processes identified by the Meeting of the Parties; and
- Relevant scientific information related to the implementation of the provisions of the CMMs adopted by the Meeting of the Parties.

For VME taxa, observers shall collect information regarding:

- Species (identified taxonomically as far as possible or accompanied by a photograph where identification is difficult).
- An estimate of the quantity (weight (kg) or volume (m^3)) of each listed benthic species caught in the tow (and the unit of measurement).
- An overall estimate of the total quantity (weight (kg) or volume (m^3)) of all invertebrate benthic species caught in the tow (and the unit of measurement).
- Where possible, and particularly for new or scarce benthic species which do not appear in ID guides, whole samples should be collected and suitably preserved for identification on shore.
- Collect representative biological samples from the entire VME catch. (Biological samples shall be collected and frozen when requested by the scientific authority in a Contracting Party).
- For some coral species that are under the CITES list photographs should be taken.

6. Monitoring, control and surveillance frameworks in place

SIOFA records of authorized vessels. In accordance with CMM2019/07, SIOFA has established a Record of Authorized Vessels for fishing vessels authorized to fish in the Agreement Area. For the purpose of this CMM, fishing vessels that are not entered onto the SIOFA Record of Authorized Vessels are deemed not to be authorized to fish for, retain on board, tranship or land fishery resources in the Agreement Area.

SIOFA has extensive catch and effort data reporting CMMs for conservation issues, including for lost or discarded fishing gear (paragraph 7, CMM 2018/09), seabird bycatch and shark bycatch:

- CMM 2016/03 Conservation and Management Measure for Data Confidentiality and Procedures for access and use of data (Data Confidentiality)
- CMM 2018/09 Conservation and Management Measure for Control of fishing activities in the Agreement Area (Control)
- CMM 2019/02 Conservation and Management Measure for the Collection, Reporting, Verification and Exchange of Data relating to fishing activities in the Agreement Area (Data Standards)
- CMM 2019/10 Conservation and Management Measure for the Monitoring of Fisheries in the Agreement Area (Monitoring)
- CMM 2019/13 Conservation and Management Measure on mitigation of seabird bycatch in demersal longlines and other demersal fishing gears fisheries (Mitigation of Seabirds Bycatch)
- CMM 2019/12 Conservation and Management Measure for Sharks (Sharks)
- CMM 2019/02 prescribes the standards and formats for data collection and communication

Illegal, unreported and unregulated (IUU) vessels list. Combatting IUU is addressed in the following four SIOFA Conservation and Mangement Measures (CMMs): CMM 2016/04 Vessels without Nationality; CMM 2017/08 Port Inspection; CMM 2017/07 Vessel Authorization; and CMM 2018/06 IUU Vessel List. SIOFA CMM 2018/06 on the listing of IUU Vessels provides an equitable, transparent and non-discriminatory procedure for the identification of vessels which have engaged in fishing in the Agreement Area in contravention of SIOFA CMMs and for establishing a SIOFA IUU Vessel List. This CMM which is binding on all SIOFA Contracting Parties and participating fishing entities provides a set of measures aimed at ensuring that owners and operators of vessels engaging in IUU fishing activities, and any participants in such activities, are effectively deprived of the benefits accruing from those activities and effectively dissuades the actors of further illegal activities.

Register of designated ports. SIOFA Contracting Parties, CNCPs and PFEs shall designate ports to which foreign vessels may request entry. Any subsequent changes to this information shall be notified at least 30 days before the change takes place to the SIOFA Secretariat who will update the register accordingly (paragraph 2 of CMM 2017/08). This requirement applies to the ports of all Contracting Parties, CNCPs and PFEs within the coastal States, which have areas of national jurisdiction adjacent to the Agreement Area (paragraph 30). Each Contracting Party, CNCP or PFE which does not have areas of national jurisdiction adjacent to the Agreement Area shall endeavor to apply this CMM (paragraph 31).

High-Seas Boarding and Inspections procedures. In 2019, the Southern Indian Ocean Fisheries Agreement adopted a conservation and management measure for high seas boarding and inspection procedures (CMM 2019/14). The measure entered in force on October 2019.

Transshipments and Transfers. Transshipment is currently covered under CMM 2019/10. This CMM indicates the current arrangement is an interim measure (paragraph 15). For at sea transshipment, each vessel must notify its competent authority at least 7 days in advance of a 14-day period during which a transshipment is scheduled to occur. The vessel will then notify its competent authority 24 hours in advance of the estimated day during which the transshipment will occur. Transshipments are to be monitored by a qualified observer who shall provide the component authority of the observed vessel with a log sheet of the transshipment.

CMM 2019/10 Conservation and Management Measure for the Monitoring of Fisheries in the Agreement Area (Monitoring). Each CCP shall ensure that its fishing vessels are equipped with an ALC. For all fisheries, the ALC must transmit VMS data every two hours. ALCs must be tamper proof, located within a sealed unit, and affixed with an official seal.

CMM 2019/14 Conservation and Management Measure for High Seas Boarding and Inspection Procedures for the Southern Indian Ocean Fisheries Agreement (High Seas Boarding and Inspection Procedures). CMM 2019/14 is directed toward both compliance inspection and targeting suspected IUU fishing activities. Priority for inspection begins with CCP flagged vessels that are not included in the SIOFA register of vessels and ends with flagged vessels that have a known history of violating conservation measures of both the SIOFA Commission and other RFMOs.

CMM 2018/11 Conservation and Management Measure for the Establishment of a Southern Indian Ocean Fisheries Agreement (SIOFA) Compliance Monitoring Scheme (Compliance Monitoring Scheme) (CMS). SIOFA has a compliance monitoring scheme (CMS) that covers the year prior to the meeting from 1 January to 31 December. The purpose of the CMS is to facilitate improved compliance, and includes addressing the underlying causes of non-compliance, such as capacity.

References

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SPRFMO

1. Definitions and interpretation of key concepts (e.g., VMEs, VME indicators, SAIs)

Definitions are found in CMM 03-2021 "Bottom Fishing":

- The term **"Vulnerable Marine Ecosystem" (VME)** means a marine ecosystem that has the characteristics referred to in paragraph 42 of, and elaborated in the Annex to, the FAO Deepsea Fisheries Guidelines.
- The term **"VME indicator taxa"** means any benthic organism listed in Annex 5 of CMM 03-2021. Annex 5 includes a list of VME indicator taxa (e.g., sponges, stony corals, black corals, sea fans octocorals, sea pens, anemones, hexacorals, armless stars, sea lilies, bryozoans, hydrozoans, hydrocorals)
- The term **"Encounter"** means catch of a VME indicator taxa above threshold levels as set out in paragraph 27 of CMM 03-2021.

The criteria for assessing SAIs are not set out clearly. In SPRFMO there seems that there is no united view on what constitutes prevention of Significant Adverse Impacts on VMEs (SPFRMO, 2019, para 98). CMM 03-2021, however, refers in its introduction to the description in the FAO Deep-sea Fisheries Guidelines of what constitutes significant adverse impacts, factors to be considered when determining the scale and significance of an impact, what constitutes temporary impacts and factors to be considered in determining whether an impact is temporary;

2. VME indicator species

In SPRFMO, the following list of VME indicators can be found in Annex 5 of CMM 03-2021:

- Phylum Porifera (Sponges) All taxa of the classes Demospongiae and Hexactinellidae
- Phylum Cnidaria
  Class Anthozoa:
    - Order Scleractinia (Stony corals): All taxa within the following genera: *Solenosmilia; Goniocorella; Oculina; Enallopsammia; Madrepora; Lophelia*
    - Order Antipatharia (Black corals): All taxa.
    - Order Alcyonacea (True soft corals): All taxa excluding Gorgonian Alcyonacea.

- Informal group Gorgonian Alcyonacea (Sea fans octocorals): All taxa within the following suborders: Holaxonia; Calaxonia; Scleraxonia
- Order Pennatulacea (Sea pens): All taxa
- Order Actiniaria (Anemones): All taxa
- Order Zoantharia (Hexacorals): All taxa

Class Hydrozoa (Hydrozoans): All taxa within the orders Anthoathecata and Leptothecata, excluding Stylasteridae

- Order Anthoathecatae, Family Stylasteridae (Hydrocorals): All taxa

- Phylum Bryozoa (Bryozoans): All taxa within the orders Cheilostomatida and Ctenostomatida

Habitat indicators

- Phylum Echinodermata
    - Class Asteroidea
        - Order Brisingida (Armless stars): All taxa
    - Class Crinoidea (Sea lilies): All taxa

3. Identification and assessment of VMEs

In SPRFMO, species distribution models (SDMs) have been used extensively to define VMEs combined with visual ground-truthing data. For example, Georgian et al. 2019 have generated broad-scale, medium-resolution (1 km^2) species distribution models for ten VME indicator taxa within the New Zealand Exclusive Economic Zone and a portion of the SPRFMO convention area. Anderson et al. (2016) produced broad-scale species distribution models for four species of reef-forming corals in the SPRFMO area. They also tested these models using data from a systematic independent visual survey of a sub-region of the area to enable assessment of the correspondence between habitat suitability as predicted by the models, and actual presence or absence of corals.

4. Assessment of SAIs and measures to prevent SAI

Encounter thresholds

According to CMM 03-2021, the weight threshold for triggering VME encounter protocol in any one tow for a single VME indicator taxon is:

- Sponges 25kg
- Stony corals 60 kg

- Black corals 5 kg
- Seafan corals 15 kg
- Anemones 35 kg
- Hexacorals 10 kg

Also, there are weight thresholds for triggering VME encounter protocol in any one tow for three or more different VME indicator taxa.

These thresholds were originally developed using a data-informed approach that examined taxon-specific cumulative catch rate curves (Cryer et al, 2018, Geange et al., 2020)

In 2019, New Zealand presented a review of VME indicator taxa for the SPRFMO Convention Area (SC7-DW13) to the 7th Scientific Committee Meeting. In that review, New Zealand recalculated and presented the 80th and 99th percentiles using the most up-to-date bycatch data available, upon which the thresholds in CMM03-2019 were based. At the 8th SPRFMO Commission meeting in 2019, the European Union introduced a proposal (COMM8-Prop07) to make CMM03-2019 more precautionary for the avoidance of SAI on VMEs. In particular, the proposal suggested lowering the weight thresholds for all taxa triggering the VME encounter protocol. Following discussion, the European Union introduced an amended proposal lowering the thresholds for stony corals from 250 kg to 80 kg based on the 98th percentile from the calculations that were done for SC7-DW13 (noting that the 98th percentile was not presented in that review). That proposal was adopted and the thresholds lowered in CMM03-2020. In 2020, following discussion and negotiation between members, a consensus was reached to lower thresholds for three VME indicator taxa (Porifera, Scleractinia and Actinaria) and this was incorporated into CMM03-2021.

In 2021, the SC recommended to the SPRFMO Commission that the updated candidate encounter thresholds for VME indicator taxa are used to inform any future refinement of the VME indicator taxa thresholds included in Annex 6A and 6B of SPRFMO CMM03-2021

5. Data collection programs

Members and CNCPs shall submit to the Secretariat annual reports of all benthic bycatch data from vessels flying their flag, consistent with CMM 02-2021 (Data Standards), as part of their annual reports to the Scientific Committee, to enable an ongoing review of the effectiveness of the spatial management arrangements. By no later than its annual meeting in 2021, the Scientific Committee shall develop a review process to provide for ongoing monitoring and feedback.

Observer Coverage. All Members and CNCPs participating in bottom fishing pursuant to this CMM shall ensure scientific observer coverage of trips for vessels flying their flag consistent with the minimum observer coverage levels set out in Annex 8 and shall ensure that such observers collect and report data as described in CMM 02-2021 (Data Standards). The Commission shall review the appropriateness of the minimum observer coverage levels specified in Annex 8 of this CMM at its annual meeting in 2021, taking into account the bottom fishing impact assessment and the SC advice and recommendations therein. Nothing in this measure shall affect the rights of Members and CNCPs to apply higher levels of observer coverage than set out in Annex 8, in accordance with their domestic requirements.

CMM 16-2021 The SPRFMO Observer Programme. Members and cooperating NCPs are required to have national observer programmes or source observers from accredited observer programmes. Members and cooperating NCPs must ensure all vessels flying their flag carry an accredited observer. There are also specific requirements regarding observers set out in fishery CMM 01-2021 (*Trachurus murphyi*), CMM 03-2021 (bottom fishing), and CMM 13-2021 (exploratory fisheries).

Electronic Monitoring. Members and CNCPs may also require vessels flying their flag to have an electronic monitoring system installed and operating that is capable of recording (including visually) and storing recordings of fishing events for data collection and verification purposes.

6. Monitoring, control and surveillance frameworks in place

Vessel authorization and records of fishing vessels. Conservation Management Measure (CMM) 04-2020 Establishing a List of Vessels Presumed to have Carried Out IUU Fishing Activities in the SPRFMO Convention Area Members and cooperating NCPs are required to submit details of vessels presumed to have carried out IUU fishing activities to the Executive Secretary at least 120 days before the annual Commission meeting. The Executive Secretary then draws up a draft IUU vessel list, which is circulated to members and cooperating NCPs for comment. Members are cooperating NCPs are expected to monitor vessels on the draft IUU vessel list for indications of IUU fishing activity. The Compliance and Technical Committee (CTC) then consider the draft list, removing vessels if there is evidence that these vessels have not engaged in IUU fishing activities. The CTC then draws up a provisional list for the Commission’s consideration and endorsement. CMM 05-2021 Establishment of the Commission Record of Vessels Authorized to Fish in the SPRFMO Convention Area. To participate in fishing activities inside the Convention Area, Members and cooperating NCPs must authorize their flagged vessels. This information is to be submitted to the Executive Secretary and the Commissions Record of Vessels is available to the public through SPRFMO's website.

Catch and effort data reporting. CMM 02-2021 Standards for the Collection, Reporting, Verification and Exchange of Data. Each calendar year, Members and CNCPs are required to collate annual catch totals raised to "live" weight for all species/species groups caught during that year. Members and CNCPs will provide by the 30 September, their previous year's (January to December) annual catch totals. Standardized formats for various data reporting by members and cooperating NCPs to the Secretariat are detailed in Annexes 1-13.

There are also specific requirements for catch and effort data reporting set out in fishery CMM 01-2021 (*Trachurus murphyi*), CMM-03a-2021 for Deep-water species, CMM 03-2021 (bottom fishing), and CMM 13-2021 and CMMs 14a-14c-2019 (exploratory fisheries). There are also data reporting requirements under CMM 09-2017 Conservation and Management Measure for minimizing bycatch of seabirds in the SPRFMO Convention Area.

Transshipment monitoring and control. CMM 12-2018 Regulation of Transshipment and Other Transfer Activities. Only vessels recorded in the Commission Record of Vessels are authorized to engage in transshipment activities both in port and in the Convention Area. Transshipment observers are required to keep a log of observed activities.

VMS. CMM 06-2020 Establishment of the Vessel Monitoring System in the SPRFMO Convention Area. All fishing vessels shall carry an ALC capable of reporting every 15 minutes to the State's competent authority. On the failure of the ALC, manual reporting is to be done every 4 hours. VMS position reports are to be reported every hour for benthic or bentho-pelagic trawling or if operating within 20nm of an EEZ boundary, and every four hours in all other circumstances.

Surveillance and Inspection. CMM 11-2015 Boarding and Inspection Procedures in the SPRFMO Convention Area (effective 24 August 2015). The SPRFMO boarding and inspection procedures are those contained in Articles 21 and 22 of the 1995 UN Fish Stocks Agreement (UN FSA). These Articles require inspection of vessel, license, gear, equipment, records, fish products and any documents relevant to compliance with the SPRFMO CMMs. CMM 11-2015 leaves the possibility open of SPRFMO implementing their own at-sea inspection regime, consistent with the UN FSA.

Inspection in Port. CMM 07-2021 Minimum Standards of Inspection in Port. Members and cooperating NCPs are required to have a contact person and designated ports for the purposes of this CMM and notify foreign fishing vessels of relevant SPRFMO CMMs. Each port state shall ensure they have sufficient capacity to conduct inspections of foreign vessels. The SPRFMO Secretariat maintains the lists of contact persons and designated ports. Each year Members and CNCPs are required to inspect at least 5% of landing and transshipment operations in their designated ports made by notified foreign fishing vessels.

Compliance evaluation. CMM 10-2020 Conservation and Management Measure for the Establishment of a Compliance and Monitoring Scheme in the SPRFMO Convention Area

CMM 10-2020 has a strong focus on technical assistance and capacity building in monitoring and improving compliance with SPRFMO CMMs. The Commission provides yearly assessment of contracting parties' and cooperating NCPs' compliance with CMMs. The Technical and Compliance Committee submits a Provisional Compliance Report to the Commission which includes recommendations for any follow-up corrective action needed and any preventive or remedial action taken or proposed to be taken.

References

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Cryer et al. (2018) 'Methods for deriving thresholds for VME encounter protocols for SPRFMO bottom fisheries'. 6th Meeting of the Scientific Committee. SPRFMO. https://www.sprfmo.int/assets/2018-SC6/Meeting-Documents/SC6-DW09-Methods-deriving-VME-thresholds.pdf

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SPRFMO (2021) 'Conservation and management measures Compilation'. Available at: https://www.sprfmo.int/assets/Fisheries/Conservation-and-Management-Measures/2021-CMMs/SPRFMO-Conservation-and-Mangement-Measures-Compilation.pdf

WECAFC

1. Definitions and interpretation of key concepts (e.g., VMEs, VME indicators, SAIs)

There are no official definitions of VMEs and SAIs provided by WECAFC. However, the Working Group on the Management of Deep-Sea Fisheries held a workshop the first time in 2014, and considered potential VMEs in the WECAFC high seas areas through the application of the FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas (see WECAFC, 2015), and through consideration of available evidence, including ecologically or biologically significant areas (EBSAs) for the Wider Caribbean and Western Mid-Atlantic region (CBD, 2012; http://www.cbd.int/ebsa/#!/ebsas) and those proposed for the Northwest Atlantic (CBD, 2014), which were defined using the Convention on Biological Diversity (CBD) "vulnerability, fragility, sensitivity, or slow recovery" criterion (CBD Secretariat, 2009).

2. VME indicator species

There is no list of indicator species/taxa established by WECAFC.

3. Identification and assessment of VMEs

There have been no benthic surveys in the high-seas areas, and the only information available for determining the location of possible VMEs is from an assessment of the bathymetry. At the WECAFC technical workshop in 2014, the Working Group on the Management of Deep-Sea Fisheries reviewed all information available for assessing potential VME areas (WECAF, 2015). It identified four seamount areas towards the northern boundary of the WECAFC area of competence and an area along the Mid-Atlantic Ridge where hydrothermal vents are known to occur. The Working Group recommended these five areas as candidate VMEs for consideration by the Commission in 2016. A further area was noted in the south, but more information is required (WECAFC, 2015). The 2014 Technical Workshop identified the VMEs in the WECAFC area in accordance with the VME criteria detailed in the 2009 FAO Guidelines. For each of the areas, a justification, physical location, general biology and summary of known impacts are provided, with associated literature references (WECAF, 2015). The Commission then adopted a recommendation identifying the five proposed VME areas (WECAFC, 2016).

4. Assessment of SAIs and measures to prevent SAI

In July 2016, WECAFC adopted Recommendation WECAFC/16/2016/4 "on the management of deep sea fisheries in the high seas" to identify five selected and delineated areas that contain or are likely to contain VMEs, and requested that States act accordingly to close these areas to bottom fishing on a temporary basis and subject to review (WECAFC, 2016). There are no other regulations in effect to protect benthic areas in the high seas of the WECAFC area of competence (Thompson et al. 2016).

The measures included in Rec. WECAFC/16/2016/4 are the following:

- Members of WECAFC implement, as appropriate, the International Guidelines for the Management of Deep-sea Fisheries in the High Seas.
- Members of WECAFC develop data and information collection programmes and research projects, as appropriate, to assess current practice and scope for socially and economically viable and ecologically sustainable investments in DSF in the WECAFC mandate area.
- Members and non-members of WECAFC, involved in experimental, exploratory and established DSF in the high seas of the WECAFC area, report annually to the WECAFC Secretariat on their activities, including detailed catch and effort statistics at a suitable spatial resolution, to inform the membership of these activities on an annual basis.
- Members of WECAFC and non-members submit to the WECAFC Secretariat any plans to engage in DSF, including exploratory fishing and/or research on deep sea resources, in the high seas areas of the WECAFC area prior to implementation.
- Areas in the WECAFC area are identified as containing VMEs or likely to contain VMEs, and that States act accordingly as per UNGA Resolution 61/105 that these areas be closed to bottom fisheries on a temporary basis and subject to review, pending more detailed survey work and assessment by this working group (see WECAF, 2016).
- Members of WECAFC collaborate in the identification of other VMEs in the areas beyond national jurisdiction in the WECAFC mandate area. WECAFC explores options to work cooperatively with neighbouring RFBs, in particular with NAFO in regards to the seamount areas that are shared between both areas, and FAO, on the improvement and harmonization of exploratory fishing protocols, DSF management plans, precautionary measures, and collection of monitoring data and other DSF information and statistics.

5. Data collection programs

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

Data collection procedures in neighboring RFMOs presented at 2014 technical workshop were deemed too complex for WECAFC, given its advisory mandate. It was therefore suggested that a simplified data collection procedure would increase the chances of member and non-member flag States providing information on deep-sea fisheries to WECAFC. The basic information required to fulfil the requirements of implementing the FAO Deep-sea Fisheries Guidelines is: fishing location; gear used; depth and duration of deployment; catch (tons by species); effort (days fished); discards; bycatch (seabirds, turtles, corals, sponges). WECAFC requests this level of detail so that FAO DSF guidelines are adhered to at a minimum (see Appendix 3 of WECAFC 2015 for details.

6. Monitoring, control and surveillance frameworks in place

The are no stringent monitoring, control and surveillance frameworks in place that have been implemented in the WECAFC Convention Area.

References

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ANNEX II Virtual Workshop Minutes and material

Virtual Workshop Report

Improving Environmental Sustainability of Deep-Sea Fisheries with Emphasis on the Conservation of Vulnerable Marine Ecosystems (VMEs). Framework contract EASME/EMFF/2019/014

1. Background

In 2008 the European Union adopted Regulation No. 734/2008 on the protection of Vulnerable Marine Ecosystems (VMEs) in the high seas from the adverse impacts of bottom fishing gears. Its purpose was to transpose the measures contained in the United Nations General Assembly (Resolution 61/105 into Union law for ships flying flags of its Member States, for those areas of the high seas where no Regional Fisheries Management Organizations. had been established.

Considering its involvement in various RFMOs managing deep sea fisheries, DG MARE is undertaking reflection to identify options and best practices to ensure that a more coherent position can be taken in the context of the relevant RFMOs in which it participates. These orientations touch upon the need to consider improvements in scientific knowledge and corresponding best practice, and on reinforcing RFMOs action for the protection of VMEs. Specific Contract No 01

The general objective of this study is to identify best practices and develop proposals for improving the conservation of VMEs and management of Deep-sea Fisheries (DSF), serving at the same time as a tool to assess the most appropriate VME policy.

Geographically, the study covers the activities of the RFMOs where deep sea bottom fishing takes place and where VME policy and management rules are being implemented. In addition, it includes FAO Area 41 in the South West Atlantic, where no RFMO with a competence for bottom fishing exists and which falls under the scope of Council Regulation (No. 734 2008).

The partners participating in this study are: AZTI, Institute of Marine Research (IIM-CSIC), Spanish Institute of Oceanography (IEO-CSIC), Instituto Português do Mar e da Atmosfera (IPMA), MRAG Europe Ltd. And Wageningen Marine Research.

2. The Virtual Workshop

A virtual workshop was carried out on February 28th 2022 with the objective of bringing together a group of relevant experts and improve the outcomes of the work carried out by the partners in the following tasks:

- Critical review of 2008 DSF FAO Guidelines and compilation of best practices for VMEs conservation and management of DSF in the high seas (Task 1 for the purposes of the workshop).
- By-catch mitigation of vulnerable species in DSF: critical analysis and recommendations (Task 2 for the purposes of the workshop).

The experts that participated belonged to RFMOs such as the Northwest Atlantic Fisheries Organisation (NAFO), international NGOs such as the Deep Sea Conservation Coalition (DSCC) and the Pew Charitable Trusts and stakeholder organizations such as the Long-distance Fisheries Advisory Council (LDAC) (Table 1). Prior to the workshop, the consortium prepared two summary documents (one for each task; see Annex I and II) containing a compilation of the main issues and good practices regarding VMEs conservation and by-catch management in deep sea fisheries in the high seas. Participants were requested to provide feedback on identified issues and gaps but also to suggest improvements to the text in the summaries.

The Workshop was divided in three parts. Firstly, Fran Saborido-Rey (IIM-CSIC) provided a briefing of the tasks 1 and 2 (context, objectives and participants).

For the second part, Rebeca Rodríguez (IIM-CSIC) presented an overview of Task 1, regarding the "Implementation of FAO DSF Guidelines in the high seas for the protection of Vulnerable Marine Ecosystems".

- The FAO Guidelines. Summary of the provisions related to VME
- Summary of measures implemented in RFMOs to protect VMEs
- Main issues
- Good practices and recommendations

An open debate followed the presentation. In this debate, participant experts asked questions regarding the presented information, and highlighted the issues they considered important. The main points discussed are presented in the next section of this report.

Then, in the third part, the results of Task 2, "Bycatch avoidance and mitigation" were presented by Rebeca Rodríguez. The presentation included the following aspects:

- Summary of measures implemented in RFMOs for bycatch avoidance/mitigation by group (sharks and rays, marine mammals, seabirds)
- Main issues
- Good practices and recommendations

As with the previous part, an open debate followed the presentation. The outcomes of this debate are also presented in the next section.

Table 1. List of Participants

Affiliation	Position
Northwest Atlantic Fisheries Organization (NAFO)	Executive Secretary NAFO
Long Distance Advisory Council (LDAC)	General Secretary
Bedford Institute of Oceanography, Darmouth, Canada.	Research Scientist
Deep Sea Conservation Coalition (DSCC)	Co-founder, Political and Policy Advisor Deep Sea Conservation Coalition
Bangor University, UK.	Researcher
Institute of Marine Research IIM-CSIC	Researcher
Centre for Environment Fisheries and Aquaculture Science (CEFAS), UK	Researcher
Institute of Marine Research (IMR), Norway	Researcher
Sciaena	Executive Coordinator
Portuguese Institute for Sea and Atmosphere (IPMA)	Researcher
The Pew Charitable Trusts	Officer Northeast Atlantic and International Fisheries
Institute of Marine Research IIM-CSIC	Researcher -Project partner
Institute of Marine Research IIM-CSIC	Researcher -Project partner
Spanish Institute of Oceanography IEO-CSIC	Researcher- Project partner
Spanish Institute of Oceanography IEO-CSIC	Researcher -Project partner
Spanish Institute of Oceanography IEO-CSIC	Researcher -Project partner
Portuguese Institute for Sea and Atmosphere (IPMA)	Expert in Fisheries management -Project partner

DG MARE	Policy Officer - Scientific advice supporting the Common Fisheries Policy
DG MARE	International Relations Officer
CINEA	Senior Project Adviser

3. Outcomes of the workshop

3.1 Task 1. Critical review of 2008 DSF FAO Guidelines and compilation of best practices for VMEs conservation and management of DSF in the high seas

A series of issues were highlighted by the experts during the discussion of Task 1:

Identification of VMEs

- The lack of mapping is a serious impediment for establishing implementation of the Guidelines and UNGA resolutions even if those States are committed to doing so (p. 47). The main exception to this have been the surveys led by the Spanish Institute of Oceanography (IEO-CSIC) in the SW Atlantic
- In some cases (e.g., in ICES advice to NEACF and in the SPRFMO area), rare species have been identified or areas have been identified that are likely to contain rare species but because those rare species are not technically labelled as VME indicator species there has not been advice whether to protect or close those areas or other management measures to prevent SAIs. In the case of NAFO, Ellen Kenchington (Bedford Institute Canada) noted that rare species are included in the NAFO VME Indicator list. They have been identified in areas that were already closed (e.g., Orphan Knoll). They are not particularly difficult to incorporate if the information is available. Due to lack of exploration such designations may be less stable as new information becomes available.
- UNGA resolutions and The Guidelines and are about protecting biodiversity overall not just aggregated taxonomic groups. They have noticed that RFMOs ignore sometimes one or more of the VME criteria, for example, areas as well as the habitats that qualify as VMEs (p. 47, 42.1) area where rare species occur)
- Regarding VME elements such as seamounts, evidence is pointing to their protection outright as VMEs, in line with Watling and Auster (2021)[5] arguments. Seamounts may present distinct challenges compared to slope areas, in relation particularly to connectivity, and it may be worth some distinction there or further discussion on this and that could potentially relate

[5] Watling, L. and Auster, P.J., (2021). 'Vulnerable Marine Ecosystems, Communities, and Indicator Species: Confusing Concepts for Conservation of Seamounts'. Frontiers in Marine Science, 8, p.572. Doi: https://doi.org/10.3389/fmars.2021.622586

to the Annex to the Guidelines in further developing or defining or recommending criteria for VME elements.

- It is important to take a hierarchical approach to operationalizing the Guidelines and policy. For example, NAFO spent a lot of time in identifying ecosystems, and they have incorporated work from the US and Canada so that where we have ecosystems across the international boundaries they are considered as well. Identifying those boundaries is a really important first step.
- Emphasis should be put in using the precautionary approach when there is not sufficient information. Precautionary approach should be considered to protect seamounts, canyons, the slope. In NAFO, a lot of what they have been able to do is because it is data-rich in many ways, they had the NEREIDA program, time series of trawl surveys, the Spanish Oceanographic Institute input. However, a positive aspect about the policy is that through using the precautionary approach it is not necessary to have perfect information. They took that approach in NAFO, area in the high seas, where in January 2022 NAFO closed all seamounts above 4000 m, and they did not have perfect information to do that: they had the location, they had done a survey with the NOAA Okeanos explorer and work in the region that identified VME indicator species even at 4000 m. But under the precautionary approach, it allows introducing reasonable thought into where these VMEs may occur in the absence of more specific information, and that should be used more than it has been.

Scale and extension of VMEs

- Regarding the scale and extension of VMEs, discussed in the Watling and Auster (2021) paper, some of the participant experts pointed out that VMEs are more than just the taxonomic groups that form the habitat structure or the biogenic structure of VMEs. We need more info on individual VME species, including, but not limited to, rare or endangered species, life history characteristics of individual species, ecosystems connectivity is particularly important and the functional roles of these VME associated species in the ecosystems is also important. Regarding this issue, Mr. Andy Kenny (CEFAS UK) pointed out that the scientists in NAFO fully understand the ecological distinction between biological communities and ecosystems. Maybe some of the confusion or misunderstanding arises from the scale at which one is looking at VMEs. That spatial scale is very much influenced through the lens in which we are evaluating VMEs. From the perspective of marine nature conservation, protecting seascapes scale it is much broader and more all-encompassing in terms of very wide variety of habitats that are interconnected, supporting different populations of benthic organisms that are interacting amongst each other, and some of those will necessarily occur in certain locations at higher densities. However, in it is not actually through that lens that VMEs have been interpreted when we are looking at the Guidelines. The intention of the Guidelines is to ensure that we are moving towards more sustainable fishing at an ecosystem level, and towards implementing ecosystem approach to fisheries management. This is in line with the concept of SAIs (as defined in the Guidelines in Art. 18.2), which not only refers to the spatial extent of the impact but it places that spatial extent in the context of available habitat. This is quite important, because what it implies is that within

RFMOs the objective is not to protect under closure measures all VMEs but it is certainly the task of RFMOs is to ensure that sufficient VMEs are protected in order to ensure that you avoid significant adverse impacts. In the case of NAFO, they have taken that level to be at 60% (based on biomass). So, it is the biomass of the VME where 60% of that is protected that you really guarantee any SAI at that broader scale assessment. However, some concerns were also raised in the Workshop about the 60% level of protection used in NAFO, because it is not clear how this 60% percent should be applied, for example, would this 60% of protected biomass include only specific VME taxonomic groups or all VME indicator taxa in the bioregion? For the other RFMOs, it is not clear what protection level has been considered.

Significant Adverse Impacts (SAI)

- Assessing and identifying cumulative impacts could use greater emphasis, including areas where VMEs have been degraded by past or historical bottom fishing
- Environmental Impact assessments have not been done consistent with the Guidelines in many areas where bottom fishing is permitted. Matthew Gianni (DSCC) put as an example the impact assessments carried out in SPRFMO.

Measures to protect VMEs

- There is a lack of application of precautionary approach in many areas where there is no data, because it has been interpreted as "no data, no recommendation of management measures".
- There are concerns regarding the implementation of provisionally closed areas (i.e., those areas that are not formally closed but you can only fish in those areas on the basis of an exploratory fisheries protocol). The concerns focus on how well have those closures been implemented, and in the cases where such areas have been reopened, there is a concern of how rigorous the process has been.
- Very few move-on events have occurred and there are few reports of bycatch exceeding the thresholds established by RFMOs (some exception in the South Pacific) and the CCAMLR convention area but not much beyond that. Also, it may be necessary to report sub-threshold encounters.

- Socioeconomic trade-offs between protecting VMEs and impacting fishing activities must be considered. Mr. Matthew Gianni (DSCC) pointed out that this is true, but there is a political issue as well. None of the GA resolutions require this nor the UNFSA itself. There should be a broader consideration as well so the protection of VME areas is an issue not only in relation to impacts of fisheries but also the biodiversity value of these VME areas. Is there a societal value, a value that society places on protecting biodiversity of the marine environment? This also needs to be considered as part of the tradeoff. Fred Kingston (NAFO) pointed out that several problems are of political will, but there is also a real problem of resources as well, when RFMOs have to, when in terms of implementation. There is really not much guidance on how to do it, the FAO Guidelines go some way towards that, but again you have to do the basic scientific research in order to do what is needed. There has been a struggle in NAFO, where the group of scientists are extremely overworked in doing the work they have to do.

- Promote research to use less destructive gears. For example, research to determine what are the differences in the gear types, if it is possible to catch the same fish using lower impact gears, etc. Consider collaboration of the fishing industry or helping the industry to do it or following the lead of the industry. If bottom longlines can be as economically productive and produce a high value product that can be sustainably managed, they should be promoted. Or if pelagic gears can be used to catch these species, with the advantage of not impacting the bottom at all. These are the broader questions that need to brought into consideration in any sort of analysis and for recommendations. This is an ongoing societal debate, around bottom contacting gears and their role in the future of seafood production. And this has implications for the future fitness of the FAO Deep Sea Guidelines particularly in the context of nature-positive decision-making. The still in negotiation text of the BBNJ treaty and the CBD's Global Biodiversity Framework will be pushing States to go beyond minimising impact and towards restoration and recovery.

Restoration of VMEs

- UNGA has declared 2021-2030 as the Decade of Ecosystem Restoration. There is already discussion about this in the NPFC area, but more importantly, the UN FAO is one of the two agencies or organizations charged with developing a program of action to implement the UN Decade of Ecosystem Restoration. There is a real opportunity here to use that fact to promote ecosystem restoration and not just protecting what remains as part of the future application and implementation of the Guidelines and UNGA Resolutions. We would like to see areas where we have recovery, because that is a big unresolved question and one that is not clear in the policy. It is necessary to put more emphasis on this on recovery of VMEs.
- Some of these VMEs may have an important role (habitat) for commercial fish species, and thus protecting these could actually enhance fisheries productivity as opposed to be an obstacle or a cost to the fishing industry.

Fishing footprint[6]

- Several experts highlighted the importance of determining the fishing footprint. Inside the footprint there can be bottom fishing, outside the footprint, there can be no bottom fishing, unless you apply for an exploratory fishing protocol, and part of the application for the exploratory protocol is that you have catch data and you have to take into account VMEs, and once the scientific council has accepted. No mention of the footprint or the exploratory protocol, and that is also intended to protect VMEs. Defining the footprint which is actually quite important management measure. A number of the

[6] Several experts mentioned that the summaries provided to them contained no information about the fishing footprint, which is an important topic. It was briefly explained that fishing footprint was not included in this workshop because it was being addressed in another task of the project (Task 4 – Criteria for establishment of footprints and historical fishing; and the development of a framework for exploratory fisheries and scientific surveys). Nevertheless, their comments regarding the fishing footprint are included in this section.

RFMOs have to finalize their footprint. Deliverable 3: Review of existing and recommended criteria and methodologies for the establishment of historical and cumulative fishing footprints (Task 4 – Sub-task 4.1). This task was focused on the review of the existing criteria/methods for characterization of fishing footprint in Deep Sea Fishing (DSF) in relevant RFMOs, as well as in FAO Area 41. Furthermore, a framework for exploratory fisheries and scientific surveys will be developed. Although, the footprint definition is still under development within some RFMOs (e.g. NPFC, GCFM), it is advised that this exercise be based on already formulated rules on RFMOs with advanced experience (e.g. NAFO, NEAFC and CCAMLR). As is widely recognized, the determination of the historical bottom fishing footprint is crucial for the adequate management of DSF, and in particular for the adoption and implementation of appropriate management measures for the protection of VMEs from the impacts of bottom fishing gears, including through the adoption of encounter and/or exploratory fishing protocols. Lessons learnt from the experience in different RFMOs could be useful as a guideline to study the fishing footprint, regarding aspects such as data needs, data compilation and availability, data quality, data sharing and cooperation, methodology and funding.

Other

- Possibility of revisiting the Guidelines. Ellen Kenchington (Bedford Institute) pointed out that after a decade of working to apply the Guidelines that it would be a good opportunity to revisit them. South Korea had offered to host such a meeting through FAO prior to the COVID, but she did not know the current status of those discussions. It would let us clarify things from the previous guidelines and to bring in new concepts such as recovery and climate change. Andrew Kenny (CEFAS UK) added other aspects to be considered if/when updating the guidelines, such as connectivity and developments concerning VME identification criteria. To this regard, Dan Steadman (Pew Trusts) added that the Guidelines were an incredibly critical first step in the global debate about bottom contacting gear use and have very clearly led to some major conservation gains that should be celebrated. However, a lot has changed since their creation; deep sea mining is much more on the agenda, the seabed as a carbon sink is a headline environmental issue, social pressure on bottom contacting gears increases month on month. In particular, he considers that there is a lot of appetite at state level for more coherent frameworks to consistently manage the impacts of bottom contacting gears (shallow and deep-water usage). Because of this, it would be very it would be very constructive to highlight certain aspects that need revisiting e.g., because they have been difficult to operationalize either due to lack of knowledge or insufficient clarity on the intent. It would also be good to wait until after BBNJ conclusions to perhaps contextualize the policy in light of any new frameworks that develop. Matthew Gianni (DSCC) pointed out that there is some danger of course is in reopening the Guidelines to multilateral review, because some of the constructive/positive provisions could be lost if some states would see this as an opportunity to weaken or eliminate some provisions that they don't like - especially recognizing that key paragraphs/provisions of the Guidelines are legally binding on RFMO members in most regions (e.g. paras 42 and 47 of the Guidelines are included verbatim in the CMM for bottom fisheries adopted by NPFC. It would be a challenge reopening a negotiating process but there is definitely room for improvement.

- Group structure to carryout scientific work in NAFO has been an advantage. Annual meetings to review data, focus on some of these research questions, and these have been going on for over a decade, so they are much bigger than a single research projects and they enable the scientific work to advance and to have some stability to feed into the management process, having an overview of the science support structures that go into the decision making could be added as best practices and how that has impacted the provision of advice.

Other suggestions to improve the information provided in the document "Summary of the Implementation of FAO Guidelines in the high seas for the protection of Vulnerable Marine Ecosystems (VMEs)"

- The SAI section can be expanded, and include a bit more of discussion and analysis on how different gear types are assessed for their impacts on VMEs, for example, gillnets have been banned by a number of RFMOs, SEAFO and SPRFMO have separate areas to some extent for allowing fixed and mobile fishing gear; CCAMLR has banned all bottom trawling in the high seas portion of its convention area. There are some studies trying to quantify impact of bottom longline fisheries compared to bottom trawling fisheries on the seamounts in the Azores.
- Include more information about area closures, both formal and provisional, about their effectiveness.
- Emphasize that many of the problems related to the implementation are political in nature, and not necessarily as a result of ambiguities in the Guidelines.
- The UNGA has endorsed the implementation of the Guidelines overall, but it is also worth recognizing that there has been an evolution in the negotiation of the UNGA resolutions in those calls for action that have taken place after the Guidelines have been adopted, the 2009, 2011 and the 2016 resolutions, maybe include a bit more on that, for example, the emphasis on the 2011 Resolution assessing for cumulative impacts could be acknowledged.

- It would be useful to acknowledge the need to think beyond existing measures proposed in the Guidelines, such as fishing gear innovation, decisions driven by socio-economic tradeoffs around healthy seabed value vs catch value etc.

3.2 Task 2. "By-catch mitigation of vulnerable species in DSF: critical analysis and recommendations"

Suggestions to improve the information provided in the document "Summary of the By-catch mitigation of vulnerable species in DSF: critical analysis and recommendations"

Sharks and rays

- Mentioning the IPOA-sharks would help putting the information presented into context.
- For sharks, possibly mention measures against shark finning. Measure designed to take away some of the incentives to capture sharks. NAFO has implemented Prohibition of removal of shark fins and shark fins onboard.

Marine mammals

- A move-on approach would work for avoiding cetacean bycatch, but it would present the same problems as with sharks and rays, and cetaceans would probably follow fishers wherever they go.

- Graham Pierce (IIM-CSIC) mentioned that in the 2021 World Fisheries Congress, a real-time data sharing among fishers app[7], to alert of areas where bycatch was significant was presented. The app is called "BATmap" (Bycatch Avoidance Tool using mapping; https://info.batmap.co.uk/). This is a semi-automated communication system used by a group of collaborating fishing vessels for the sharing of bycatch observations to identify areas having high probability of bycatch and alert fishers about the location of these areas. This system has been used on the west coast in fisheries in Alaska and Pacific Northwest for over 20 years to successfully reduce bycatch. Something similar could be considered for preventing cetacean bycatch.

- Regarding live release in deep-sea might be an option in shallow water fisheries, but the chances of cetaceans surviving being caught at depths are close to zero.

- It was suggested that the report could refer to CITES, as it considers stricter guidelines and rules related to these species.
- The report is mostly focused on cetaceans, seabirds and sharks and rays, but it could have included some information about fish bycatch. For example, the IUCN red list has identified roundnose grenadiers in NE Atlantic as critically endangered.

General comments regarding bycatch

- As in the case of VMEs protection, there are issues of political will or political obstruction. For example, Matthew Gianni pointed out that in midwater fisheries in NEAFC, Russia consistently rejected the regulations proposed. Regarding this point, Fran Saborido-Rey (IIM-CSIC) also pointed out that there must be a balance between different users. He considers that society should play a key role but not that society should drive the decisions in all cases.

[7] Marshall, C.T. Macdonald, P. Torgerson, E. Asare, J.L. Turner, R. 2021. Design, development and deployment of a software platform for real-time reporting in the west of Scotland demersal fleet. A study commissioned by Fisheries Innovation Scotland (FIS) http://www.fiscot.org/.

- In general, there is a need for improving the quantity and quality of bycatch data.
- The possibility of climate change increasing the interactions between mammals, seabirds, etc. with fisheries should be considered (e.g., by producing changes in the migratory routes of the animals, pressure on the ecosystem, impacts on food webs, etc.). This may make bycatch a bigger problem in the future. There have been some studies that have reported, for example, that some seabirds are going further north and that colonies that existed in the past have disappeared. Thus, it is important that scientists continue to monitor the effects of climate change to inform management.

Annex I

Summary of the implementation of FAO DSF Guidelines in the high seas for the protection of Vulnerable Marine Ecosystems

Implementation of FAO DSF Guidelines in the high seas for the protection of Vulnerable Marine Ecosystems (VMEs)

1. The FAO Guidelines

The FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas (FAO, 2009) were developed for fisheries exploiting deep-sea fish stocks, in a targeted or incidental manner, in areas beyond national jurisdiction (ABNJ), including fisheries with the potential to have significant adverse impacts on vulnerable marine ecosystems (VMEs). The role of the Guidelines is to provide tools, including guidance on their application, to facilitate and encourage the efforts of States and RFMOs towards sustainable use of marine living resources exploited by deep-sea fisheries, the prevention of significant adverse impacts on deep-sea VMEs and the protection of marine biodiversity that these ecosystems contain. These Guidelines are the non-binding standard reference for the management of DSF at the present. The scope of the Guidelines covers the areas beyond national jurisdiction, but they may also be applied to the national jurisdictions of coastal states. The Guidelines were developed with a view to assisting states and RFMOs with the implementation of the United Nations General Assembly (UNGA) Resolution 61/105 of 2006, concerning responsible DSF in the marine ecosystems of the high seas.

According to the FAO Guidelines, States and RFMOs should:

- adopt and implement measures in accordance to the precautionary approach and ecosystem approach to fisheries,
- develop and adopt fishery management plans for specific DSFs
- identify areas where VMEs are known or are likely to occur and the locations of fisheries in relation to those areas (i.e., fisheries 'footprint')
- conduct assessments to establish if deep-sea fishing is likely to produce significant adverse impacts.
- develop data collection and research programs
- use science-based management approaches
- develop and use selective and cost-efficient fishing methods
- implement and enforce conservation and management measures through monitoring, control and surveillance (e.g., vessel authorizations and records of fishing vessels, catch and effort data reporting, transshipment monitoring, VMS, inspection schemes, Port State Monitoring, compliance evaluation)
- adopt measures to address IUU
- ensure transparency and public dissemination of information and enable participation of stakeholders
- RFMOs should develop mechanisms of cooperation and coordination among themselves

The FAO Guidelines provide a description of **key concepts**, such as:

Characteristics of species exploited by DSF (e.g., maturation at relatively old age, slow growth, long life expectancies, low natural mortality rates, intermittent recruitment of successful year classes and spawning that may not occur every year). These resources have low productivity and once depleted, their recovery is expected to be long and not assured.

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

Significant adverse impacts (SAIs) are those that compromise ecosystem integrity, i.e., ecosystem structure or function in a manner that: i) impairs the ability of affected populations to replace themselves; (ii) degrades the long-term natural productivity of habitats; or (iii) causes, on more than a temporary basis, significant loss of species richness, habitat or community types. Impacts should be evaluated individually or in combination and cumulatively.

The FAO Guidelines establish six factors that should be considered when determining the scale and significance of an impact (e.g., intensity or severity, spatial extent, sensitivity/vulnerability of the ecosystem, ability of an ecosystem to recover, alteration of ecosystem functions, timing and duration). It also defines temporary impacts as those that are limited in duration and allow the ecosystem to recover over an acceptable period of time (5-20 years).

A marine ecosystem shall be classified as vulnerable based on the characteristics it possesses. To identify VME and assess SAIs, the FAO Guidelines establish five **criteria**:

6) **Uniqueness** or **rarity** – an area or ecosystem that is unique or that contains rare species whose loss could be not compensated for by similar areas or ecosystems (e.g., habitats with endemic species, nurseries or discrete feeding, breeding and spawning areas).
7) **Functional significance of the habitat** – areas that are necessary for the survival, function reproduction or recovery of fish stocks or of rare, threatened and endangered species).
8) **Fragility**. Ecosystems that are highly susceptible of degradation by anthropogenic activities
9) **Life history traits** of component species that make recovery difficult (e.g., slow growth, late maturation, low or unpredictable recruitment, long life expectancy)
10) **Structural complexity** – an ecosystem that is characterized by complex physical structures created by significant concentrations of biotic and abiotic features.

The FAO Guidelines provide examples of possible VMEs (but no definitions), such as:

- potentially **vulnerable species groups, communities** and **habitats**: Cold-water corals and hydroids that form reefs and coral forests, sponge dominated communities, cold seep and hydrothermal vent communities, etc.)
- **topographical, hydrophysical** or **geological features**: submerged edges and slopes, summits and flanks of seamounts, canyons and trenches, cold seeps and hydrothermal vents.

As mentioned above, RFMOs should establish conservation and management measures to protect VMEs. The most important requirements are:

- RFMOs should **close areas where VMEs have been designated, or are known or likely to occur** (based on research surveys or modelling, for example) to prevent SAIs on VMEs and ensure long term conservation of deep-sea fish stocks.
- States and RFMOs should establish **encounter protocols** (including a definition of what constitutes an encounter) to determine how vessels should respond to encounters in the course of fishing operations.

The FAO Guidelines provides a list of other general measures to achieve long-term conservation and sustainable use of deep-sea fish stocks, ensure adequate protection and prevent SAIs, for example:

- Effort controls and/or catch controls
- Temporal and spatial restrictions or closures
- Changes in gear design, such as reduction of contact between fishing gear and the seabed, use of bycatch reduction devices or other technical measures.

2. Review of the implementation of the FAO Guidelines in RFMOs

The main objectives of this study were:

- To carry out a review of the implementation of DSF FAO guidelines (FAO, 2009) in different RFMOs with competence in the high seas and FAO Fishing Area 41 (SW Atlantic).
- To prepare a compilation of best practices and recommendations for the conservation of VMEs and management of DSF in the high seas

The following RFMOs/Fishing areas have been considered in this study (See Figure below):

- The Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR)
- The General Fisheries Council for the Mediterranean (GFCM)
- The Northwest Atlantic Fisheries Organisation (NAFO)
- The Northeast Atlantic Fisheries Commission (NEAFC)
- The Southeast Atlantic Fisheries Organisation (SEAFO)
- The South Indian Ocean Fisheries Agreement (SIOFA)
- The South Pacific Regional Fisheries Management Organisation (SPRFMO)
- Fishery Committee for the Eastern Central Atlantic (CECAF)
- Western Central Atlantic Fishery Commission (WECAFC)
- FAO Area 41 (SW Atlantic)

Overview of RFMOs/Fishing Areas considered in this study. Source: FAO, 2016.

2.1 Definitions and interpretation of key concepts

The great majority of RFMOs refer to the concept of VME established in the FAO Guidelines. From a practical point of view, however, the definition of what constitutes a VME must be further developed to create operational definitions, in order to consistently identify VMEs. The lack of operational definitions in many of the RFMOs is one of the main issues that have been identified in this review. For example, operational definitions have been established in NAFO (2013) and by ICES (2020a)–relevant for NEAFC. Although they are not incorporated in their adopted conservation measures, they are used by the scientific bodies that provide advice to these RFMOs.

Something similar happens with the definitions of VME topographical, hydrophysical or geological features or elements. The FAO Guidelines provide examples of elements, for example, submerged edges and slopes, summits and flanks of seamounts, canyons and trenches, hydrothermal vents and cold seeps. However, the Guidelines do not include precise definitions for those elements. This issue has been noted by ICES (relevant for NEAFC) and has been also addressed in NAFO. For example, the ICES Working Group for Marine Habitat Mapping (ICES, 2020b) has recently reviewed existing definitions, and developed working definitions for VME elements such as isolated seamounts; steep-slopes and peaks on mid-ocean ridges; knolls; canyons; steep flanks >6.4° and hydrothermal vents. In addition, they have identified other geomorphological features which might have merit as VME Elements, namely: guyots (isolated or groups of seamounts with a smooth, flat top); escarpments (elongated, linear, steep slopes separating gently sloping sectors of the seafloor in non-shelf areas); and glacial troughs (elongated troughs formed by shelf valleys at high latitudes incised by glacial erosion during the Pleistocene). NAFO has also interpreted the features listed in the FAO Guidelines to produce operational definitions.

On a more general matter, some experts have recently pointed out that there has been some confusion between the concepts of "community" (e.g., dense aggregations of VME indicators) and the concept of "ecosystem" (which is a broader concept, for example, that may include different populations, communities of several kinds and habitats, that are nested and interact at a functional level) (Watling and Auster, 2021). Many times, when referring to VME, people are really talking about vulnerable marine communities, which can be in fact, part of the larger ecosystem. In this context, they suggest for example, that the seamount ecosystem may extend over multiple seamounts in a biogeographic area, harboring a variety of communities and habitats, and that it is this larger ecosystem that needs to be protected to avoid disruptions of its functioning.

Main Issues

- Lack of operational definitions
- Some experts consider that there is a confusion between the concepts of "community" (e.g., dense aggregations of VME indicators) and the concept of "ecosystem"

Good practice

- Establish operational definitions of key concepts, such as VME, to facilitate consistent identification of VMEs

2.2. Identification of VMEs

In general, RFMOs have elaborated lists of regional VME indicator taxa following the criteria established in the FAO Guidelines. These lists have been included in their conservation measures to protect VMEs. Some RFMOs include a wide variety of taxa, that include corals (gorgonians, hydrocorals, stony corals, black corals), sponges, bryozoans, sea lilies, anemones, etc. (CCAMLR, NAFO, NEAFC, SPRFMO). Others however, have only included in their measures a few taxa, for example, GFCM has included only 15 species of cnidarians and NPFC only include four groups of corals, but neither has other types of organisms, such as sponges or bryozoans. In most RFMOs, the lists of VME indicators are being revised as new information becomes available.

Vulnerable marine ecosystems are best identified using high quality underwater imagery (e.g., using Remotely Operated Vehicles – ROV, towed cameras, etc.) (Morato et al. 2018). Underwater imagery allows accurate and quantitative description of community composition and associated fauna, determination of the extent of the associated habitat, and the damage caused by particular fishing gears (e.g., Hansen et al., 2013; Ardron et al. 2014). This has been done in most RFMOs (e.g., CCAMLR, NAFO, NEAFC, SEAFO, etc.), with more or less frequency. However, because of the high cost of operations associated with such imaging technologies, observations of VMEs are only available for a tiny fraction of the area of the deep seabed (Morato et al.2018). Therefore, other approaches for the identification of VMEs have been used in RFMOs.

At least three quantitative (or at least semi-quantitative) and repeatable approaches have been applied since Ardron et al. (2014) published an article proposing a systematic approach towards the identification and protection of VMEs:

- The Kernel Density Estimate (KDE), used in NAFO.
- Species distribution models/Habitat suitability models, used in NAFO and SPRFMO, and being tested in other RFMOs using limited data, such as NPFC and SIOFA.
- Multi-criteria Assessment MCA, used by ICES for NEAFC.

These approaches draw on catches from scientific surveys, existing data on the distribution of VME indicator taxa, and/or visual data from scientific surveys of benthic organisms. However, not all of the RFMOs can apply repeatable, quantitative approaches because there are not enough data (e.g., SEAFO, CECAF, NPFC, SIOFA, WECAFC).

Main Issues

- In some RFMOs, the lists of VME indicators include few taxa and more work is needed.
- Expert reviewers often indicate a lack of information to evaluate candidate VME indicators against FAO criteria. It is necessary to carry out research to fill the gaps regarding biological information of benthic organisms and their distribution, in order to allow their evaluation against FAO criteria.
- Direct observations of VMEs (e.g., using underwater imagery) are only available for a small fraction of the seabed. This is mainly because research surveys are costly and, logistically, it can be difficult to conduct them because of the remote location of the seamounts and other VME habitats.
- Sampling carried out in research surveys using bottom trawls is destructive to VMEs.
- Regarding VME identification, not all of the RFMOs can apply repeatable, quantitative approaches because there are not enough

data (e.g., SEAFO, CECAF, NPFC, SIOFA, WECAFC).

Good practice

- Create lists of regional VME indicator taxa using the FAO criteria (individually or in combination) and update those lists as new information becomes available.
- Ideally, VMEs should be identified using direct observations, from high quality underwater imagery (Remotely Operated Vehicles – ROV, towed camera, etc.), as this allows accurate and quantitative description of community composition and associated fauna, determination of the extent of the associated habitat, and the damage caused by particular fishing gears. This type of data collection could be incorporated in many research surveys and this possibility shall be explored.
- Research of other non-destructive sampling methods, such as environmental DNA (eDNA) shall be promoted (e.g., Everett and Park, 2018; Kutti et al., 2020), because there are still many gaps that prevent the implementation of this modern methodology for identification and monitoring of VMEs.
- Bottom trawl fisheries research surveys should avoid all areas where VMEs are known or are likely to occur, particularly in areas where bottom fishing is prohibited. To this regard, established surveys could try to develop sampling plans that avoid locations where VMEs are known, for example, if a sampling station falls inside a closed VME area, the sampling could be carried out just outside the closed area.
- If bycatch data of VME taxa is available or is likely to become available, quantitative (or at least semi-quantitative) and reproducible approaches shall be considered for the identification of VMEs (e.g., the Kernel Density Estimate (KDE), Species distribution models/Habitat suitability models, Multi-criteria Assessment MCA).
- Model predictions (e.g., from SDMs) have various degrees of uncertainty associated and should be validated (e.g., with visual ground-truthing data) to support management decisions.
- Collection of absence data (locations where VME taxa are not present) shall be encouraged, because they are fundamental to fully evaluate the occurrence of VME habitats and indicators, and, specifically, to support mapping of benthic habitats. Such data facilitates the ability to perform a proper assessment of the occurrence of VMEs, as it is difficult to establish if the lack of data plotted in maps is due to the actual absence of VMEs or due to a lack of sampling in the area.

2.3. Measures to protect VMEs

Closing areas to bottom contact gear is the only certain method for avoiding significant adverse impacts on VMEs (Wright et al. 2015 and references therein). This is a well-establish measure to protect VMEs and such closures are used by most of the reviewed RFMOs as the main measure to protect VMEs (See table below). However, this measure's effectiveness depends on the correct identification and definition of the area occupied by a VME. As was mentioned above, there is still a lack of empirical data (e.g., from research surveys) on the distribution of VMEs and identification of VMEs relies many times in the results of distribution models, which have varying degrees of uncertainty associated.

RFMO/Area	Area closures

CCAMLR	Area closures are established in CM-22-06 and CM 22-07.
CECAF	There are no current frameworks and measures to prevent SAI in the CECAF area
FAO Area 41 SW Atlantic	There is no RFMO in this Area. However, the Spanish Government implemented a fishing closure for the Spanish bottom trawling fleets in the high seas of the southwest Atlantic on July 2011. The current closed area amounts to 41 300 km^2.
GFCM	GFCM uses "Fisheries Restricted Areas (FRA)". These are multi-purpose area-based management tool used to restrict fishing activities and protect essential fish habitats and deep-sea sensitive habitats.
NAFO	Closed areas are established in Article 17 of NAFO CEM. These include i) Seamount Closures, ii) coral area closure, iii) High Sponge and Coral Concentration Area Closures
NEAFC	There are 13 Area closures for the protection of VMEs established in Recommendation 10 2021 (e.g., Hatton Bank 1 and 2; Rockall Bank; Logachev Mounds, West and Rockall Mounds).
NPFC	Precautionary closed off areas to fishing for potential VME conservation are established in CMM 2021-05 and 2021-06.
SEAFO	Eleven closed areas to all fishing gears and one closed area to all fishing gears except for pots and longlines have been defined.
SIOFA	SIOFA has established five closed areas to protect VMEs (i.e., Atlantis Bank, Coral Point, Fools Flat Point, Middle of What Point and Walter's Shoal Point). All of these areas are closed since 2018.
SPRFMO	SPRFMO has adopted a set of areas where bottom trawling (and other bottom gears) is permitted, designated as "bottom fishing management areas," but it has not formally closed any areas to bottom fishing. Areas outside of the bottom fishing management areas are provisionally closed to bottom fishing.
WECAFC	In Recommendation WECAFC/16/2016/4 established five areas that contain or are likely to contain VMEs, and requested that States act accordingly to close these areas to bottom fishing on a temporary basis and subject to review (WECAFC, 2016).

RFMOs have adopted **move-on rules** as a first measure to prevent ongoing fishing in areas where 'evidence' of VMEs is encountered during fishing operations. These move-on rules require fishing vessels to move a predetermined minimum distance from locations where some pre-determined quantity of species indicative of VMEs are captured in fishing gear. In the event that a fishing vessel exceeds a predetermined threshold (weight, volume and/or biodiversity) of VME indicator species, a move-on rule may be triggered requiring the vessel to move a predetermined minimum distance from its current fishing area (Hansen et al. 2013).

The main advantage of move-on rules is that they provide an immediate response that prevents further damage to possible VMEs encountered during fishing operations. Actually, move-on rules can serve as "back stops" or "insurance" to the main management measures (e.g., area closures) in case these turn out to be deeply flawed. For instance, a move-on rule can put a quick stop to fishing in a place where large amounts of sensitive and structural benthic fauna are recovered when none or little was predicted by the VME habitat suitability models used to design the spatial management regime (Cryer et al. 2018)

An overview of the encounter protocols in the different RFMOs/Fishing Areas is presented in the next table. Some RFMOs have established thresholds using data-informed approaches (e.g., using cumulative catch rate curves in SPRFMO or GIS modelling approaches in NAFO, etc.). Others, however, have set arbitrary encounter thresholds or have used thresholds derived for other regions. For example, NEAFC initially set arbitrary threshold values that mirrored earlier regulations in the adjacent NAFO area. Although these thresholds have been lowered and revised based on the available information of the spatial distribution patterns of a broad range of VME indicator species (ICES, 2012), no quantitative assessment has been carried out. SEAFO also established the threshold following the example of NAFO, and an adapted version of the CCAMLR's encounter protocols is applied in the SEAFO area for non-trawl gear in both existing and new fishing areas. This is also the case of SIOFA, that has adopted CCAMLR's encounter protocol for longline gears and NAFO's thresholds for trawl gears.

Main issues

- Some RFMOs have not implemented closure areas to specifically protect VMEs (e.g., SPRFMO, GFCM)
- The identification and delineation of the area closures is not a straightforward process (see Section 2.2.).
- There is still a lack of empirical data on the distribution of VMEs within the high seas, which means that spatial management is often informed by model predictions of the spatial distribution of VME indicator taxa. Models, however, have a level of uncertainty associated.
- The VME closures typically represent only a proportion of the full extent (where known) of the VME present, especially where such areas coincide with a defined fishing footprint (e.g., NAFO, NEAFC) (Bell et al., 2018).
- In most cases, it is likely impossible to directly assess whether these areas are meeting their conservation objectives, since they usually lack the requisite baseline data to determine the effectiveness of management decisions (Bell et al., 2018).
- While area closures can offer protection from direct impacts of bottom-contact fishing gears, the long-term viability of the protected populations will depend on identifying and protecting sources of recruitment and connectivity pathways (Wang et al. 2020 and references therein). Connectivity of closed areas has not been considered in most RFMOs.
- Area closures are likely to have negative impacts on fisheries. An ideal closure scenario protects all potential VMEs while having a minimal impact on fishing activities. In the designation process of area closures, the socio-economic trade-offs between protecting VMEs and impacting fishing activities must be considered.
- Closure areas in many RFMOs do not consider buffer zones. In the context of the protection of VMEs from significant adverse impacts of bottom-contact fishing gears, a buffer zone is considered to be "a spatial margin of assurance around the VME to avoid adverse impact" (ICES, 2013a).
- Climate change has not been given enough attention and should be

considered when implementing measures to protect VMEs.

- Some RFMOs have not established encounter thresholds/protocols (e.g., GFCM).
- Encounter thresholds that trigger move-on rules should ideally be specific to area, gear type and taxon, and based on historic bycatch levels and catchability estimates (Ardron et al., 2014). However, in many occasions the historic data of bycatch levels are not available and catchability has not been estimated, so the set encounter thresholds may not be appropriate. Because of this, there is a need of revising encounter thresholds as new data becomes available.
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Good practice

- The effectiveness of area closures can be improved by using explicit buffer zones. Such buffer zones have been used by ICES, for example, to ensure the protection of VME habitats distributed along the edge of the C-squares containing VMEs in EU waters (ICES, 2020a). To this regard, NAFO has recently applied a modified version of the ICES approach to creating buffer zones to the NAFO closed areas to explore whether that method could be used by NAFO to provide additional protection to the VMEs of SAI of fishing (NAFO, 2020).
- Another important aspect to be considered for the effectiveness of closures is determining the connectivity among the areas closed to protect VMEs. Population connectivity refers to the exchange of individuals among populations: it affects gene flow, regulates population size and function, and mitigates recovery from natural or anthropogenic disturbances.
- In general, there are concerns about the effectiveness of encounter protocols, and it is generally agreed that spatial restrictions and closures are more effective at protecting VMEs. However, encounter protocols still play an important role in areas that have not been fully mapped for the presence of VMEs. Because of this, move-on rules should be considered to be temporary measures: they can provide precautionary protection for areas showing evidence of VMEs and serve as an imperfect interim data collection measure, until objectively planned spatial closures can be implemented to protect known and highly bio-diverse VME areas. VME thresholds have been established in most RFMOs. The “robustness” of the used thresholds is not homogeneous among RFMOs. Although many have been established following using modelling and data-informed approaches (e.g., NAFO, NEAFC, SPRFMO), other thresholds are based in the approaches followed by other RFMOs (e.g., SIOFA and SEAFO use CCAMLR approach for thresholds in longline fisheries) and probably need to be revised. In this respect, it is recommended that at least data-informed thresholds are used by RFMOs.

RFMO/Area	Encounter protocols
CCAMLR	Established in CM 22-07. If 10 or more VME indicator units are recorded in one line segment, a vessel is to complete hauling without delay any lines intersecting with the Risk Area without delay and not to set any further lines intersecting with the Risk Area. A Risk Area has a radius of 1 n mile from the midpoint4 of the line segment from which the VME indicator units are recovered. However, Members may require their vessels to observe a larger Risk Area in accordance with their domestic laws.
CECAF	There is no established encounter protocol.

FAO Area 41 SW Atlantic	There is no RFMO in this Fishing Area, there is no established encounter protocol.
GFCM	No encounter protocol has been set in GFCM. Resolution GFCM/43/2019/6 only establishes that an "encounter" is defined as any bycatch of VME indicator taxa by any deep-sea fisheries, until possible revision of the current VME protocol (in Annex 1 of the Res. GFCM/43/2019/6) which may establish threshold levels in line with SAC advice.
NAFO	An encounter with VME indicator species is defined as catch per set (e.g., trawl tow, longline set, or gill net set) of more than 7 kg of sea pens and/or 60 kg of other live coral and/or 300 kg of sponges. (NAFO, 2021a). The threshold values were determined using a data-informed approach (corals) and GIS modelling (sea pens and sponges) (Kenchington et al. 2011; ICES, 2013a). If an encounter occurs, the vessel shall report it, cease fishing and move away at least 2 nautical miles from the endpoint of the tow/set in the direction least likely to result in further encounters.
NEAFC	Rec. 10 2021: For trawls, longlines and other gears: (a) Trawl and other gears: the presence of more than 30 kg of live coral and/or 400 kg of live sponge of VME indicators; and (b) for a longline set: the presence of VME indicators on 10 hooks per caught per 1000 hook segment or per 1200 m section of long line, whichever is the shorter. When an encounter occurs, the fishing vessel shall cease fishing and move out of an area defined as a 2 nautical mile wide band (polygon) on both sides of the "track" of the trawl haul during which an encounter occurred.
NPFC	Established in CMM 2021-05 and CMM 2019-06. When in the course of fishing operations, cold water corals more than 50 kg are encountered in one gear retrieval, vessels shall cease bottom fishing activities in that location. In such cases, the vessel shall not resume fishing activities until it has relocated a sufficient distance, which shall be no less than 2 nautical miles. The encounter must be reported to the Secretariat who shall immediately notify the other Members of the Commission so that appropriate measures can be adopted in respect of the relevant site.
SEAFO	Encounter threshold is 10 VME indicator units in one 1200-meter section of line or 1000 hooks, whichever is the shorter, in both existing and new fishing areas. For bottom trawls, revised threshold levels of more than 60 kg of live coral and/or 600 kg of live sponge for existing bottom fishing areas, and more than 400 kg of live sponges and/or 60 kg of live coral for new fishing areas, were adopted. If an encounter is discovered the vessel master shall cease fishing and move away at least 2 nautical miles from the end point of the trawl tow in the direction least likely to result in further encounters, defining a buffer area with a 2 nautical mile radius. For other gears, the vessel shall cease fishing and move away at least 1 nautical mile from the position that the evidence suggests is closest to the exact encounter location, defining a buffer area with a 1 nautical mile radius.
SIOFA	For longlines, the threshold that triggers the encounter protocol for longline gears is the catch/recovery of 10 or more VME-indicator units of species in a single line segment. For trawls, more than 60 kg of live corals and/or 300 Kg of sponges in any tow. In case of an encounter, the vessel shall cease bottom fishing activities within two (2) nautical miles either side of a trawl track extended by two (2) nautical miles at each end for

	bottom or mid water trawling, or fishing with any other net. For longline and trap activities - a radius of one (1) nautical mile from the midpoint of the line segment; and for all other bottom fishing gear types - a radius of one (1) nautical mile from the midpoint of the operation. SIOFA has adopted CCAMLR's encounter threshold for longline gears and NAFO's thresholds for trawl gears.
SPRFMO	According to CMM 03-2021, the weight threshold for triggering VME encounter protocol in any one tow for a single VME indicator taxon is: Sponges 25 kg, Stony corals 60 kg, Black corals 5 kg, Sea fan corals 15 kg, Anemones 35 kg, Hexacorals 10 kg. Also, there are weight thresholds for triggering VME encounter protocol in any one tow for three or more different VME indicator taxa. In case of an encounter, the vessel shall cease bottom fishing immediately within an area of one (1) nautical mile either side of the trawl track extended by one (1) nautical mile at each end and b) report the encounter immediately. Thresholds have been lowered recently for some taxa. These thresholds were originally developed using a data-informed approach that examined taxon-specific cumulative catch rate curves.
WECAFC	No established encounter protocol.

2.4. Assessment of SAIs

There is great disparity regarding the assessment of SAIs in the different RFMOs. For example, NAFO's Scientific Council has carried out a very thorough assessment of the risk of Significant Adverse Impacts (SAIs) from bottom fishing activities on VMEs in the NAFO Regulatory Area in 2021 (NAFO, 2021b). This assessment was done following the criteria established in the FAO Guidelines for assessing SAIs and it was based on estimates of the biomass distribution of VMEs, the distribution of fishing effort (VMS data), and a set of assessment metrics that considers ecosystem function and fragmentation. In other RFMOs, the assessment of SAI is ongoing work (e.g., NPFC, SIOFA, SEAFO) while in other RFMOs there are no specific criteria or guidelines for assessing SAIs (e.g., GFCM, CECAF and WECAFC).

2.5. Data collection for VME identification and monitoring

Data regarding VMEs is collected in different ways, for example in research surveys (e.g., catches of VME indicators and underwater imagery) or recording bycatch data from fisheries (collected through scientific observers). However, the availability of VME data is very different throughout the RFMOs. For example, NAFO has a regular program of research surveys in its Regulatory Area that supply valuable data regarding VMEs (annual Spanish 3LNO surveys, the EU Flemish Cap Survey, the Canadian DFO NL Multispecies surveys) and other benthic surveys have been carried out to provide underwater imagery and samples (Surveys from the Bedford Institute of Oceanography, Fisheries and Oceans in Canada) and the 2009-2010 NEREIDA surveys carried out by Spain, Canada, the UK and the Russian Federation). It also has 100% observer coverage[8] that provides bycatch data of VME indicators. In other regions data are limited. For example, in the NE region of the NPFC Convention Area, there is limited cold-water coral abundance data available, because most of the data come from fisheries bycatch and research surveys in the NW region of the North Pacific Ocean. Therefore, not all of the RFMOs can apply repeatable, quantitative approaches for VME identification because there are not enough data (e.g., SEAFO, CECAF, NPFC, SIOFA, WECAFC).

Main Issues

- Accurate identification of some VME indicator taxa can be difficult. Identification guides and training of observers are necessary. Some RFMOs have prepared ID Guides (e.g., CCAMLR, NAFO, SEAFO, SIOFA, and SPRFMO) but not all have developed such guides.
- Data for modelling may not have enough quality or resolution. For example, models developed using data with low taxonomic resolution data may mix species with very different life-histories and environmental requirements, resulting in overly broad predicted distributions and potentially increased model uncertainty (Winship et al., 2021).

Good practice

- Developing identification guides for VME indicators for scientific observers. This facilitates accurate identification of VME indicators, increasing the quality of the data.
- Data to improve models for the identification of VMEs:
  - Geange et al. 2020 recommend that comprehensive descriptions of the location (including depth, latitude and longitude), taxonomy (to the highest possible taxonomic resolution achievable), and biomass (ideally the number of individuals as well as weight would be recorded) of deep-sea benthic invertebrates is routinely collected by fisheries observers and research programs.
  - Winship et al. 2021. recommend that VME taxa biological data from fine-scale surveys be recorded to quantify presence-absence, abundance, biomass, or density (abundance or biomass per unit area) with a measure of effort for each sampling unit (e.g., area surveyed). Future sampling programs should record biological data at the highest taxonomic resolution possible. This is because models of functional groups or otherwise reduced taxonomic resolution may be sufficient to address some management applications, but in some cases, models may be needed for specific taxa like species of concern (e.g., endangered species).

2.6. Monitoring, control and surveillance (MCS) frameworks

Recently, Lenel (2020) has carried out a thorough review of the monitoring, control and surveillance of DSF in the high seas (including all of the RFMOs that were reviewed here). The main conclusions and recommendations of that review are presented here.

The deep-sea RFMOs have all exerted considerable effort in the adoption and implementation of comprehensive MCS

[8] Article 30 of NAFO CEM establishes circumstances for when 100% observer coverage may not be necessary.

measures. The MCS implemented by the deep-sea RFMOs have been developed with due consideration of their specific requirements including target species, type of fishing operations, priorities of CPs, fishing fleet capacity, assets available for surveillance and inspection and identified risks.

While all the RFMOs have implemented Conservation and Management Measures (CMMs) that establish MCS measures and provide for compliance and enforcement, there is scope for improvement and harmonization of these measures. The exchange of information and of lessons learnt is an ongoing need, particularly for those RFMO/As that manage similar species, share the same oceans, have overlapping areas of competence or are working on similar activities and projects. There is scope for the harmonization and integration of several MCS measures including records of fishing vessels, IUU vessel lists and port State measures. While the harmonization and integration of MCS can be difficult in an international context, the benefits would be far-reaching. Particularly for the deep-sea RFMO/A that are supported by small secretariats. The need for these MCS measures cannot not be underestimated. CMMs agreed by States and adopted by the deep-sea RFMOs will fail without compliance by those involved in fishing operations and responsible for enforcement. Illegal, Unreported and Unregulated (IUU) fishing remains a constant threat for all of the deep-sea RFMOs and the coordinated, consistent, and rigorous implementation and further development of the MCS and enforcement regimes are essential to address this threat.

While all the deep-sea RFMOs have implemented measures to establish IUU vessel lists that respond to their conservation and management mandates and the recommendations of the FAO International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU), there is scope for improvement and harmonization of these measures. Harmonization is a critical need, particularly for those RFMOs that manage similar species, share the same oceans or have overlapping areas of competence.

Main issues

- IUU fishing remains a constant threat for all of the deep-sea RFMOs

Good practice

- Memorandums of understanding (MoUs) have been established between several of the deep-sea RFMOs but this is not common to all. MoUs provide a formal mechanism for cooperation and information sharing. The implementation of MoUs across the RFMOs is useful to support the harmonization and integration of MCS and facilitate greater cooperation and exchange of information.
- A less formal mechanism for the cooperation and exchange of information between the secretariats of the deep-sea RFMOs may also be very beneficial. Opportunities should be explored for the secretariats to collaborate on activities and projects including those related to data management, capacity building and testing new technologies.

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Annex II

Summary of “By-catch mitigation of vulnerable species in DSF: critical analysis and recommendations”

Bycatch avoidance and mitigation in DSF

3. Background

Deep-sea fisheries (DSF) operate globally throughout the world's oceans, chiefly targeting stocks on the upper and mid-continental slope and offshore seamounts. Major commercial fisheries occur, or have occurred, for species such as orange roughy, oreos, cardinalfish, grenadiers and alfonsino. Fishing in the deep sea not only harvests target species but can also cause unintended environmental harm, mostly from operating heavy bottom trawls and, to a lesser extent, bottom longlines. For this reason, since 2006, the UNGA has adopted provisions to protect vulnerable marine ecosystems from the impacts of bottom fishing in the high seas, while the FAO adopted its International Guidelines for Deep Sea Fisheries in the High Seas in 2008. Bottom trawling over hard seabed (common on seamounts) routinely removes most of the benthic fauna (Clark et al., 2016). In addition to this, many non-target species can be caught incidentally during fishing operations (i.e., bycatch), representing a major concern for sustainable fishing. As part of the impacts of DSF on the ecosystems, the management of bycatch species needs also to be properly addressed.

It is important to note that there is no one-size-fits-all solution to bycatch problems, and that an array of measures is better for addressing bycatch problems. The specific characteristics of each fishery—physical, biological and socio-economic— dictate what combination of measures are most appropriate, and most likely to lead to a successful bycatch minimization outcome. Various combinations have been seen to work in different settings, and the formulae depend not only on issues related to the fishery, but also factors external to this, such as political settings and priorities, and government financing and constraints (Bache, 2003).

4. Critical Assessment of bycatch avoidance/mitigation measures

In this section, the main bycatch avoidance and mitigation measures are discussed for each group (i.e., sharks and rays, marine mammals, seabirds). For each measure, we present an overview, its pros and cons and the available evidence on its effectiveness.

The following RFMOs/Fishing areas have been considered in this study (See Figure below):

- The Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR)
- The General Fisheries Council for the Mediterranean (GFCM)
- The Northwest Atlantic Fisheries Organisation (NAFO)
- The Northeast Atlantic Fisheries Commission (NEAFC)
- The Southeast Atlantic Fisheries Organisation (SEAFO)
- The South Indian Ocean Fisheries Agreement (SIOFA)
- The South Pacific Regional Fisheries Management Organisation (SPRFMO)
- FAO Area 41 (SW Atlantic)

2.1 Summary of measures adopted by RFMOs

Sharks and rays

- Bycatch limits: for sharks, rays and skates (CCAMLR), for only a subgroup of elasmobranchs (NAFO), for single species (NEAFC), in exploratory fisheries (SPRFMO)
- Move-on rule (CCAMLR, SPRFMO)
- Live release (CCAMLR, NAFO, NEAFC)

Marine Mammals

- Exclusion devices (CCAMLR)
- Live release
- Prohibition of offal and discards during net shooting and hauling (CCAMLR)
- Mitigation of depredation: Minimization of net exposure, avoidance of net maintenance in the water (CCAMLR) and Avoidance of hauling longlines in the presence of cetaceans (SIOFA)

Seabirds

- Bycatch limits (CCAMLR)
- Bycatch thresholds to revert to night setting (CCAMLR, SIOFA)
- Live release (CCAMLR, SIOFA, SPRFMO)
- Prohibition of net monitoring cables (trawl gears) (CCAMLR,
- Use of scaring lines and bird exclusion devices (GFCM, SIOFA, SPRFMO)
- Minimization of illumination directed out from the vessel and night setting (CCAMLR, GFCM, SIOFA, SPRFMO)
- Prohibition of offal and discards during net shooting and hauling (CCAMLR, GFCM, SPRFMO)
- Adoption of gear configurations that minimize encounters (CCAMLR, SIOFA, SPRFMO). For example, increasing weighting or decreasing buoyancy, placing colored streamers or other devices.
- Mitigation of depredation: Minimization of net exposure, avoidance of net maintenance in the water (CCAMLR)

General measures

- Limit fishing effort
- Gear prohibition: Gillnet ban (CCAMLR, SEAFO, SPRFMO, NEAFC)
- Depth limitations: e.g., Bottom trawling beyond 1000 m (GFCM) or beyond 1500m (NPFC)

4.2. Measures for sharks and rays

2.2.1 Bycatch limits and move-on rules

CCAMLR has currently in place bycatch limits and move-on rules in toothfish fisheries for skates and rays (CM 33-02, CM 33-03, CM 41-03 and CM 41-09) and a move-on rule also applying to sleeper sharks, Somniosus spp. in CM 33-02. In CCAMLR, bycatch limits for sharks and rays have been set considering historical data and as precautionary limits (e.g., exploratory toothfish fisheries), as advised by the Scientific Committee. Dedicated tagging programs for skates and rays have been and are in place to assess the status of their populations. An example of this is the "Years of the Skate", carried out during fishing seasons 2008/2009 and 2009/2010 in al toothfish fisheries in the CCAMLR Convention area. Bycatch limits for skates and rays are assessed yearly by WGFSA (e.g., CCAMLR 2007 WGFSA Report, para 6.5)

In NAFO bycatch for skates is 2500 kg or 10%, whichever is the greater (listed in annex I.A of NAFO CEM). There is a move-on rule when the bycatch limits exceed the greater of the limits specified above.

In exploratory toothfish fisheries in SPRFMO (CMM 14a-2019, CMM 14d-2020, CMM 14e-2021) bycatch limits and move-on rules have been established. For example, in exploratory fisheries for toothfish by EU vessels, if more than 4 individuals of any of the following families

Somniosidae, Lamnidae, Cetorhinidae, Alopiidae are caught or if more than 2 individuals of any one of these families of sharks are caught in one haul or set, the vessel shall move on for the duration of the trip, and a next line shall not be set closer than 5 nm from the center of the preceding line. These are precautionary bycatch limits. Also, if the retained skate bycatch exceeds 5% of the toothfish catch or reaches a maximum of 100 kg in any one haul or set, the vessel will move-on to another location at least 5 nm distant. These limits were established based on CCAMLR's approach (CM 41-03).

Main Issues

- Many times, the populations affected by bycatch are not well studied, hence it is difficult to determine meaningful bycatch limits. Where information on the bycatch populations is limited, bycatch limits and quotas should be set in accordance with the precautionary approach (FAO, 2011).
- Setting effective bycatch limits requires a good characterization of the fishery and sufficient and accurate bycatch data, which is often not available. For instance, the sample design and data collected requires a consideration of biases, the level of precision, representativeness of samples, observer effects, and other uncertainties (Bache, 2003).
- One of the concerns of using dynamic closures (such as move-on rules) is the potential displacement of effort to other areas, which would reduce or eliminate the supposed benefits of the move-on rule (Dunn et al., 2013). Therefore, bycatch levels and its distribution must be monitored to determine if move-on rules are being effective in reducing bycatch, and not only re-distributing the problem.
- Many of these conservation measures relating to bycatch species in RFMOs may be based on outdated information, or adopted as precautionary measures until information became available, and need to be updated. For example, SPRFMO (2019) has recognized the need to adopt a precautionary approach for shark bycatch until improved assessments and estimates of sustainable yields are available and allow informing the level of reductions in shark bycatch required to mitigate any potential risk for overexploitation, particularly for species assessed to be at high and extreme risk that may be retained as by-product. CCAMLR has also recognized this problem and has encouraged its members to provide updates where new data exists (CCAMLR, 2018b).

Good practice

- To improve effectiveness of move-on rules, an empirical approach could be used. For example, Dunn et al. (2013) developed a data-driven empirical approach to determine the distances and times for effective move-on rules in a New England Multispecies Fishery to reduce discards and maximize profits. In that study, it was determined that the use of empirical move-on rules could reduce catch of juvenile and choke stocks between 27 and 33%, and depredation events (e.g., by sharks and other predators) between 41 and 54%. However, to implement such empirical move-on rules, high-resolution spatio-temporal data (fishing effort and catch) are needed, which may not be available. To our knowledge, this approach has not been used in any of the reviewed RFMOs.

2.2.2. Live release of bycaught sharks/rays

CCAMLR, NAFO and NEAFC consider live release of elasmobranchs in their conservation measures. For example, CCAMLR (CM 32-18 2006) establishes that any bycatch of shark, especially juveniles and gravid females, taken accidentally in other fisheries, shall, as far as possible, be released alive. For skates and rays, CCAMLR has established that skates and rays caught alive and with a high probability of survival should be released alive, by vessels, by cutting snoods, and when practical, removing the hooks, and the number should be recorded and reported to the Secretariat (CCAMLR CM 33/03 2021). In NAFO (Art 12 NAFO Conservation and Enforcement Measures), for example, it is established that vessels shall undertake all reasonable efforts to minimize incidental catch and mortality, and where alive, release Greenland sharks in a manner that causes the least possible harm. Also, in fisheries that are not directed at sharks, Contracting Parties shall encourage every vessel entitled to fly its flag to release sharks alive, and especially juveniles, that are not intended for use as food or subsistence.

Main issues

- Live release is not feasible for many bycaught species of shark and rays. For example, thresher sharks *Alopias* spp., and hammerhead sharks *Sphyrna* spp., are prone to high rates of mortality when caught (Rodríguez-Cabello and Sánchez, 2017 and references therein). For deep-water sharks (e.g., *Somniosus* spp.), even if there is no evident damage upon release, there may be negative effects to their tissues (e.g., gas embolism disease) that result in the eventual death of the released animals (García et al., 2015). CCAMLR has reported that sometimes large caught sharks (e.g. *Somniosus* spp.) are already dead upon hauling, wrapped in the longline so this measure cannot always be applied (CCAMLR, 2018b).
- There is uncertainty of the real benefits of applying this measure for many species of sharks and rays due to a lack of post-release survivorship studies. Tag-recapture or tag-telemetry programs are required to properly estimate post-release mortality for discarded fish (Rodríguez-Cabello and Sánchez, 2017 and references therein).
- The techniques to release bycaught specimens are still under development Actually, several techniques have been tried unsuccessfully for releasing the sharks from the net; the industry is currently testing the use of hooks and lines to fish the sharks out of the net in order to release them (Fowler, 2016).

Good practice

- Best handling practices for safe release of sharks must be followed, which requires the elaboration of guidelines adapted to the shark species bycaught in the fisheries of each RFMO and training of crew members. Many RFMOs managing highly-migratory species, such as the Western and Central Pacific Fisheries Commission and ICCAT have already elaborated such guidelines and integrated minimum handling requirements in their conservation measures (WCPFC, 2018; ICCAT, 2021).
- Several factors need to be taken into account when considering live release as a measure. The most important ones rely on the biological characteristics of the species: gill ventilation, swim bladder condition, metabolic flexibility, liver size and content, body size, reproductive stage, etc. Also important are factors related to the capture process and fishing practice: gear type, hook insertion point and tissue damage, soak time, catch depth, catch weight, handling injuries, time on the deck and others (Fowler, 2016). This knowledge can be obtained by conducting specific research on the biology of candidate species coupled with post-survival studies (e.g., tag-recapture or telemetry studies).

4.3. Measures for marine mammals

2.3.1 Excluder devices

Excluder devices are an additional section of netting or a rigid device placed between the entrance and the cod-end of the net to prevent nontarget species such as cetaceans from entering the net (front-located exclusion device) or cod-end (rear-located exclusion device). The aim of the device is to direct the bycaught animals to an escape panel/hatch in the net. Excluder devices can be rigid or soft depending on the material they are made from. Rigid grids tend to be towards the back of the net and are usually a metal grate made of stainless steel. Cetaceans are prevented from entering the cod-end by the grid and excluded from the net via an escape panel (Read, 2021).

Exclusion devices have been mainly used for small cetaceans such as dolphins and pinnipeds (e.g., fur seals). CCAMLR has established mandatory fitting of marine mammal exclusion devices to all krill vessels (CM 51-01 2010).

Main issues

The main limitations of exclusion devices have been analyzed by Read (2021), as part of a cost-benefit analysis of mitigation measures for the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS). The following list is mainly based on the results of that report and the FAO Guidelines to prevent and reduce bycatch of marine mammals (FAO, 2021).

- The design of exclusion devices requires knowledge of both the target and bycaught species including their size and behavior (spatial and temporal) to ensure that the bycaught animals are excluded whilst ensuring that there is no loss to the quality of the catch or the CPUE.
- Exclusion devices need to be specific to the area, fishery and gear (e.g., pair trawl and single trawl would probably require different types of exclusion devices due to handling difficulties with the much larger net of a pair trawl). The design needs to ensure that the target species (and other similar sized species) will pass through the grid but the large bycaught species are prevented. It can be challenging to design grids for cetaceans to escape in fisheries with large target species (e.g., potential for grids to get blocked).
- Welfare issue for animals unable to escape or getting entangled/injured in the escape panel. Unobservable and unreported cryptic mortality may occur with exclusion devices due to injuries incurred during interactions with devices or because dead animals may fall out escape openings, although scientific evidence has shown that cryptic mortalities from direct interactions with top-opening, hard-grid exclusion devices are unlikely.
- General lack of baseline knowledge required for effective application of exclusion devices, e.g., when are the animals entering the trawl: during deployment, fishing operation or hauling of the gear?
- The type of exclusion device is important. Flexible grids are likely to become distorted during fishing resulting in fish losses, adverse effect on the fisheries target species (e.g. reduction in the quality of the catch) and an increased risk of bycatch.
- Potentially difficult to install, maintain and handle in large trawling nets. For example, in 2017/2018 the CCAMLR Working Group for Fish Stock Assessment (WG-FSA) reported an increased mortality of Antarctic fur seals in the krill fishery. The report stated that an ineffectively attached marine mammal exclusion device may have contributed to the issue and the Working Group encouraged trawl vessels to inspect their exclusion devices in the event of any marine mammal mortality to ensure that it is in structurally good order and correctly attached.
- Expensive video surveillance may be required to determine bycatch rate and effectiveness of the exclusion device(s).

- Development of the exclusion device/grid is likely to be expensive, although once completed, cost to fishery is minimal
- Attaching exclusion devices to the gear may increase drag and, therefore, fuel costs.
- May reduce target catch causing economic losses to fishers.

2.3.2. Live release

This measure refers to releasing bycaught marine mammals, for example, from entanglements in fishing gear. Live release is potentially effective in reducing bycatch mortality of marine mammals.

Main issues

- Bycaught animals are often injured, retain or ingest hooks, or remain entangled in gear (Hamilton and Baker, 2019 and references therein). In general, there is a lack of information on the post-release health and survival of marine mammals that are injured, retain or ingest hooks, or remain entangled in gear (Hamilton and Baker, 2019 and references therein). Thus, the actual effectiveness of this measure is not known and needs to be assessed through research.
- A high level of competence and preparedness (which includes having the right equipment on hand) is required because this has a significant positive impact on post-release survival. In the fishery context, formal, regular and structured training is needed. Fishing crews who are not trained in proper handling and release techniques may also unintentionally cause further harm to animals as they attempt to set them free, or put themselves in danger by engaging in unsafe practices, such as entering the water with the animals (FAO, 2021).

Good practice

- Post-release studies shall be conducted to assess health and survival of released animals. For example, carrying out surveys using photo-identification of tagging studies (e.g., telemetry) could be useful. McHugh et al (2021) recommend using satellite-linked tracking of released animals where direct follow-up observations on individuals post-release are unlikely. This provides short to medium-term information on survival, movements, and behavior allowing for likely outcomes to be identified, and facilitating further interventions if warranted.
- As with sharks and rays, best handling practices for safe release of marine mammals must be followed, which requires the elaboration of guidelines and training of crew members (e.g., Guidelines for the safe and humane handling and release of bycaught small cetaceans from fishing gear by Hamer and Minton, 2020).

2.3.3. Measures to mitigate depredation.

Depredation refers to interactions between marine mammals and fishing operations that to occur when marine mammals actively seek to prey on fish captured in fishing gears. Longline catch and bait can attract species of toothed cetaceans such as sperm whales (*Physeter macrocephalus*), killer whales (*Orcinus orca*), pilot whales (*Globicephala* spp.), and false killer whales (*Pseudorca crassidens*) (FAO, 2021). Associations between cetaceans (e.g., sperm and killer whales) and longline vessels have been recorded in longline fisheries around the world. The relationship is complex and difficult to quantify. Although the highest numbers of associating cetaceans can coincide with very high catch rates, it is generally accepted that the presence of toothed whales has a negative impact on fish catch. For example, CCAMLR WG-FSA-2019/33 presented estimates of Patagonian toothfish (*Dissostichus* *eleginoides*) catches removed by killer whales and sperm whales when depredating on longlines in four CCAMLR areas and two fisheries outside the CCAMLR area in Chile and the southwest Atlantic. Using generalized additive models (GAMs) fitted to the catch-per-unit-effort (CPUE) data, the results indicated that whales removed a total of 6 699 tons of toothfish, equivalent to around 10% of the total catches over the 2009–2016 period.

Some of the RFMOs in this review have implemented some measures to mitigate depredation, such as the minimization of net exposure and avoidance of net maintenance in the water (CCAMLR) and avoidance of hauling longlines in the presence of cetaceans (SIOFA). These measures are also recommended by the Agreement on the Conservation of Albatrosses and Petrels (ACAP), because they are effective for reducing depredation by seabirds (ACAP, 2021a).

One of the most effective measures implemented in the last decade to mitigate depredation in longline fisheries is the Chilean longlining method (trotline with nets). This fishing method was designed to prevent toothed whale depredation of fish (ACAP, 2021a).

2.3.4. Other measures

Spatial closures

Spatial closures can be effective in reducing interactions between marine mammals and fishing gear in areas where they both occur. This applies especially in areas where marine mammals aggregate, such as breeding grounds, areas with seasonal prey abundance, migration corridors, or other critical habitats. Spatial closures ban or restrict fishing within all or a subset of a particular fishing zone, permanently or for a defined period of time (FAO, 2011). The most restrictive are permanent closures, which are applied to all fisheries (e.g., marine protected areas that prohibit fishing and no fishing zones). Temporal closures can restrict fishing activity seasonally (seasonal or rolling closures). Regardless of the type of closure, it needs to be of an appropriate scale to meet management objectives. In other words, it must be located in the right places, or take place at the right times, be effectively managed and enforced to remove the principal threats, avoid introducing new threats, and consider the dynamic nature of the fishery and habitats used by marine mammals over time (FAO, 2021).

Spatial closures for marine mammals have not been implemented in any of the RFMOs reviewed in this document. This measure could be considered by RFMOs, but most of them still lack appropriate knowledge on the abundance and temporal-spatial distribution of marine mammals which is necessary to establish spatial closures.

Gillnet ban

The largest proportion of marine mammal bycatch is undoubtedly the result of accidental encounters, and gillnets are considered the riskiest gear to most species (FAO, 2021 and references therein). In gillnet gear, bycaught cetaceans often experience high mortality, since they cannot reach the surface to breathe. A gillnet ban has been implemented in several RFMOs (CCAMLR, SEAFO, SPRFMO, NEAFC).

Acoustic devices

Acoustic deterrents consist of a range of devices that either emit sounds, using electrical or mechanical means, or acoustically reflect those emitted by echolocating cetaceans. These devices may be deployed on or near fishing gear and include categories referred to as pingers, acoustic harassment devices (including seal-scarer devices), and acoustic alerting devices. Their intended use is to enhance detection of fishing gear by those cetaceans that echolocate for prey detection and other reasons: to do so, they may create an alert or unappealing sound that causes animals to avoid the sound source, or associate it with an obstacle to avoid (FAO, 2021). These acoustic devices are frequently used in gillnet fisheries, which are banned in many of the reviewed RFMOs in this study (CCAMLR, NEAFC, SEAFO and SPRFMO). However, this measure can be considered for other RFMOs, such as GFCM. For example, in the GFCM area of application, it seems that pingers could have a positive effect on reducing the bycatch of Black Sea harbour porpoises (*Phocoena phocoena relicta*) in the Black Sea turbot gillnet fishery and for other cetacean species (Carpentieri et al. 2021).

Evidence shows that acoustic deterrents do not necessarily elicit a behavioural response that reduces bycatch for every marine mammal species. FAO (2021) has compiled a list of the species for which pingers have been shown to be effective in reducing bycatch or causing area avoidance:

- Harbour porpoise
- Striped dolphin (*Stenella coeruleoalba*)
- Franciscana dolphin (*Pontoporia blainvillei*)
- Several beaked whales (Ziphiidae family) – Cuvier's, Hubb's, Stejneger's and Baird's beaked whale

For other species, pingers appear to reduce bycatch but there is not enough evidence yet regarding the effectivity of pingers (e.g., g Burmeister's porpoise—*Phocoena spinipinnis*, North Atlantic right whales and humpback whales —*Megaptera novaeangliae*). Pingers seem to be ineffective for some species that are actually attracted to pinger sounds (e.g., bottlenose dolphin—*Tursiops truncatus*).

2.4 Measures for seabirds

2.4.1. Bycatch limits and bycatch thresholds to revert to night setting

Bycatch limits for seabirds have been only established by CCAMLR. In CCAMLR, a bycatch limit is set for birds in the icefish fishery in Subarea 48.3. Should any vessel catch 20 or more birds in a season it shall cease fishing (CM 41-02).

Bycatch thresholds to revert to night settings have been established in CCAMLR and SIOFA. In both RFMOs, limits are set on the longline fishery in some areas where daylight setting is allowed. Should a vessel catch 3 or more birds it must revert to night setting only (CM 41-04 to 41-11 in CCAMLR and CMM 2019-13 in SIOFA).

No information of the effectiveness of this specific measure was found, because it is applied together with other measures (i.e., CCAMLR CM 25-03 that sets out technical measures to minimize bird bycatch regarding net monitoring cables, vessel lighting, discarding of offal, net cleaning, net sinking and streamer lines). However, in the case the bycatch limits were reached, it would be effective in preventing further damage to the seabird populations.

2.4.2. Minimization of illumination directed out from the vessel and night setting

Seabirds generally detect food at close range by sight. Consequently, they feed mostly during daylight hours and are least active at night. Setting lines at night is therefore a simple but highly effective way of reducing seabird bycatch and bait loss (BirdLife and ACAP, 2019). In longline fisheries incidental mortality occurs mainly during setting, when the birds attempt to feed on the baited hooks, get hooked or entangled and drown as the gear sinks to its fishing depth.

Main issues

- Not equally effective for all seabirds. Less effective for crepuscular/nocturnal foragers such as the white-chinned-petrel. In fact, it increases the bycatch rate of Northern Fulmar (*Fulmarus glacialis*) (ACAP, 2021a and references therein).
- Bright moonlight and deck lights reduce the effectiveness of this mitigation measure (BirdLife and ACAP, 2021).
- Night setting is not a practical option for fisheries operating at high latitudes during summer because the time between nautical dusk and dawn is limited (BirdLife and ACAP, 2019; ACAP, 2021a).
- The effect of night setting on catch rates of target species for different fisheries needs to be assessed.

Good practice

- Setting longlines at night (between the end of nautical twilight and before nautical dawn) is effective at reducing incidental mortality of seabirds because the majority of vulnerable seabirds are diurnal foragers (ACAP 2021a). The effectiveness of night setting is well documented in regional studies and has recently been confirmed on a large and temporal scale in a recent study (Jiménez et al. 2020 and references therein). In their study, Jiménez et al. 2020 analyzed observer data from longline fisheries obtained by scientific observer programs onboard several longline fleets operating in the south Atlantic and southwestern Indian Oceans over a period of 15 years (2002–2016). In this study, night setting was more effective for albatross than for other species, such as petrels, because they have different foraging behaviors. Albatrosses are less active at night, increasing their foraging activity only with a brighter moon, while white-chinned petrels forage during the day and night without the influences of the moon phases (Jiménez et al. 2020). This measure produces the best mitigation scenario in combination with the use of line weighting regimes (in longlines) and bird scaring lines (ACAP, 2021a). Also, to maximize effectiveness, deck lighting should be kept at the minimum level appropriate for crew safety and directed inboard so the line is not illuminated as it leaves the vessel (BirdLife and ACAP, 2021).

2.4.3. Live release

This measure refers to releasing bycaught seabirds, for example, those entangled in fishing gears. This measure has been implemented by some of the RFMOs, like CCAMLR, SIOFA and SPRFMO.

Main issues

- As with elasmobranchs and marine mammals, bycaught animals are often injured, retain or ingest hooks, or remain entangled in gear and this affects their post-release survival.

- Post release survival seems to vary among different species. For example, wandering albatrosses appear to survive less after being released than animals that have never been caught in the general population (Philips and Wood, 2020).
- Studies regarding post-release survival for bycaught seabirds are scarce. This type of studies can be expensive and difficult to carry out. For example, transmitters would need to transmit to the ARGOS satellite system, (or via GSM if network coverage is available), or to a base station if the colony of origin is known. There is a high cost of devices and ARGOS time (limiting sample sizes). Also, it would require the availability of an on-board observer with experience of attaching devices on the infrequent occasions when birds are live-caught during routine fishing operations and the development of methods to avoid the loss of transmitters (Phillips and Wood, 2020).
- Fishing crews who are not trained in proper handling and release techniques may also unintentionally cause further harm to animals as they attempt to set them free.

Good practice

Specific guidelines are available to ensure safe release of seabirds (see Zollett and Swimmer, 2019 and references therein). These guidelines provide recommendations for handling seabirds and maximizing their chance of recovery and survival. For example, a bird that is lightly hooked in the beak, wing, or foot, or has a hook visibly sticking out of its body can have the hook removed with bolt cutters. When this is not feasible, the line should be cut close to the hook. If possible, birds that are injured (e.g., wounds or broken bones) or with swallowed hooks should be brought ashore for treatment. The bird's likelihood of survival is improved if it is given a quiet, dry, and shaded area to recover, while being checked on regularly (Zollett and Swimmer, 2019 and references therein).

2.4.4. Prohibition of net monitoring cables (for trawl gears)

In trawl fisheries, high levels of seabird mortality have been associated with collisions with warp cables and net monitoring cables (also knowns as netsonde or third-wire). The net monitoring cable is an electronic connection between the vessel and the net sounder monitoring system on the headline of the trawl (Løkkeborg, 2011) The use of this equipment is currently banned in several regions (e.g., New Zealand and CCAMLR).

Mortalities caused by cable strikes mainly result from birds being dragged underwater when their wings become entangled around the trawl cable, whereas aerial collisions with cables have little impact on birds (Watkins et al. 2008).

Main issues

- Need to use other methods in the fishing vessel to control depth and gear performance underwater of the trawl.

Good practice

- This measure directly eliminates the risk of birds colliding with these types of cables. Where such a measure cannot be implemented, ACAP (2021b) recommends: i) deploying bird scaring lines specifically positioned to deter birds away from net monitoring cables while fishing; and ii) installing a snatch block at the stern of a vessel to draw the net monitoring cable close to the water to reduce its aerial extent.

2.4.5. Use of scaring lines and bird exclusion devices (brickle curtains)

Streamer line (bird scaring line, tori line). This is a line attached to a high point at the stern and towed behind the vessel while longlines are set. The terminal end of the line has a towed device (e.g., buoys) to create drag and streamers are attached to its aerial portion above the sinking longline. The movements of the streamers deter seabirds from attacking baited hooks (Løkkeborg, 2011).

A Bird Exclusion Device (BED) consists of a horizontal support several meters above the water that encircles the entire hauling bay. Vertical streamers are positioned between the horizontal support and water surface. The BED configuration can also include a line of floats on the water surface connected to the vertical streamers to stabilize movement in strong winds. This configuration is the most effective method to prevent birds entering the area around the hauling bay, either by swimming or by flying. BEDs are retrieved and stowed when not hauling (ACAP, 2021a).

Main issues

- BEDs form a physical and visual barrier around the area where line hauling occurs and prevent seabirds from accessing baited hooks during line hauling.
- The effectiveness of the bird scaring lines is dependent on the design, proper placement, as well as seabird species attending line setting (proficient divers are more difficult to deter than surface feeding birds). It is effective only when streamers are positioned over sinking hooks and the aerial extent matches the distance astern that seabirds can access baited hooks (ACAP, 2021a).
- Streamer lines are likely to be less efficient in reducing bycatch of diving seabirds, particularly in pelagic fisheries, as birds may still reach baited hooks beyond their aerial extent. This deficiency may be significantly reduced by using weighted longlines in combination with streamer lines (Løkkeborg, 2011; ACAP, 2021a).
- Streamer lines can also be less efficient under conditions of strong crosswinds that can blow the streamers to the side of the longline, leaving baited hooks exposed to seabirds.
- There have been a few incidents of birds becoming entangled in bird scaring lines (Otley et al. 2007).
- A practical problem with streamer lines is entanglement with the longline gear

Good practice

- The use of a single bird scaring line has been shown to be an effective mitigation measure in a range of demersal longline fisheries, especially when used properly. Several studies have shown that the use of two or more streamer lines is more effective at deterring birds from baited hooks than one streamer line (ACAP, 2021a and references therein). Effectiveness is higher when used in combination with other measures – e.g., night setting, appropriate weighting of line and offal management.
- The use of bird exclusion devices is effective as mitigation measure when hauling the longlines. BEDs must be used in combination with line setting mitigation measures – bird scaring lines, line weighting, night setting and offal management. The use of a BED can effectively reduce the incidence of birds becoming foul hooked when the line is being hauled (ACAP, 2021a and references therein).

2.4.6. Prohibition of offal and discards during net shooting and hauling

Seabirds (and also marine mammals – e.g., Johnson et al., 2020) are highly attracted to offal discharged from vessels. To prevent large numbers of seabirds attending line setting operations, offal and discards should be retained onboard prior to and during line setting. This is a measure that seeks to reduce general attractiveness of the fishing activities to seabirds (ACAP, 2021a, 2021b). In CCAMLR demersal fisheries, discharge of offal is prohibited during line setting. During line hauling, storage of waste is encouraged, and if discharged must be discharged on the opposite side of the vessel to the hauling bay. A system to remove fish hooks from offal and fish heads prior to discharge is required. Similar requirements are prescribed by other demersal longline fisheries (e.g. Falkland Islands (Islas Malvinas), South Africa and New Zealand (ACAP, 2021a, 2021b).

Main issues

- Fitting of fish waste storage tanks and mealing plants may not be a viable option for existing vessels due to associated space requirements (Munro, 2005).

Good practice

- Discharge of offal and discards is the most important factor attracting seabirds to the stern of trawl vessels, where they are at risk of cable and net interactions. Managing offal discharge and discards while fishing gear is deployed has been shown to reduce seabird attendance of vessels and consequent risk of interactions and bycatch. The following offal and discard management measures, in order of their effectiveness in reducing bird attendance, are recommended by ACAP (2021b):
    1. Retention of waste – No discharge during fishing trips (full retention) should occur. When this is impracticable (e.g., lack of storage space in the vessel), no discharge should occur during fishing activity (when cables or net are in the water);
    2. Mealing waste – Where retention of waste is impracticable, converting offal into fish meal, and retaining all waste material with any discharge restricted to liquid discharge / sump water;
    3. Batching waste – Where meal production and retention of offal and discards are impracticable, waste should be stored temporarily for two hours or longer before strategically discharging it in batches;
    4. Mincing of waste – Where retention, mealing or batching is impracticable, reduce waste to smaller particles (currently only recommended as a mitigation for bycatch of large albatrosses *Diomedea* spp.).

Repeated studies have shown that in the absence of offal discharge/fish discards seabird interactions and mortality levels are negligible (Sullivan et al. 2006; Melvin et al. 2010; Abraham & Thompson 2009, Pierre et al. 2012). Storage of all fish discard and offal, either for processing or for controlled release when cables and net are not in the water, has resulted in significant reductions in the attendance of all groups of seabirds (Abraham et al. 2009). Any discharge is restricted to times when cables and net are out of the water. Management of offal and discharges should be used in combination with additional mitigation methods to mitigate interactions with cables (if birds are still attending the vessel) and net.

2.4.7. Line weighting

In demersal longline fisheries, lines are weighted in order to deliver hooks to the target fishing depth as efficiently as possible and maintain the line on the seabed. Demersal longline gear can be configured in various ways (e.g., autoline system and Spanish system), each with different weighting requirements.

Main issues

- Spanish system longlines are buoyant and weights must be attached to sink gear to fishing depth. Longlines with externally added weights sink unevenly, faster at the weights than at the midpoint between weights. (ACAP, 2021a)
- Weights must be attached and removed for each set-haul cycle, which is onerous and potentially hazardous for crew members. Weights comprised of rocks enclosed in netting bags and concrete blocks deteriorate and require ongoing maintenance/replacement and monitoring to ensure weights are the required mass (Otley et al., 2007); weights made of solid steel are preferred, in terms of mass consistency, handling, maintenance and monitoring compliance (ACAP 2021a and references therein)
- Global minimum standards have not been established. Requirements vary by fishery. For example, CCAMLR minimum requirements for vessels using the Spanish method of longline fishing are 8.5 kg mass at 40 m intervals (if rocks are used), 6 kg mass at 20 m intervals for traditional (concrete) weights, and 5 kg weights at 40 m intervals for solid steel weights. (ACAP, 2021a)
- More research is needed to understand sink rates and sink profiles of line weighting regimes, because these may vary according to vessel type, setting speed and deployment position relative to propeller turbulence. It is important that the sink rate relationships of different line weighting regimes are understood for a particular fishery (or fishery method) and that testing confirms the effectiveness of the line weighting regime and the sink profile in reducing seabird mortality. (ACAP, 2021a)

Good practice

- The Chilean method (trot line with nets) effectively prevents mortality as a sole measure given that hooks sink quickly from the surface, it is prudent to also deploy a bird scaring streamer line (ACAP, 2021a). However, this is a relatively new system, is possibly still in the evolutionary stages, and should be monitored and possibly refined.
- The best practice weighting regimes are intended to take baited hooks beyond the diving range of seabirds while under the protection of a standard streamer line, without compromising catch rates. Specifying a desired sink rate should be an integral part of any performance standard. It is currently recognized that a sink rate of 0.3 m/s is desirable. To achieve this, the prescribed weighting regime will depend on the type and configuration of gear used. CCAMLR specifies two line-weighting options, 8.5 kg at 40 m intervals or 6 kg weights at 20 m intervals, following the aforementioned trials by Robertson et al. (2007). CCAMLR has subsequently adopted a third line weighting option of 5 kg metal weights spaced at 40 m intervals. Achieving a desired sink rate is not just a matter of adding sufficient weight to a line. The way in which gear is handled and deployed also influences the sink rate.

2.4.8. Area and seasonal closure.

As seabird mortality rates are generally higher close to breeding colonies during the breeding seasons, seasonal fishing closure is regarded as a fundamental factor in reducing seabird by catch in CCAMLR fisheries. This measure is applied in some high-risk areas such as South Georgia. There is, however, a risk that area or seasonal closures may displace fishing effort leading to increased mortality in other areas (Løkkeborg, 2011).

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ANNEX 4

D2 Guidelines for improving by-catch management in DSF (Task 3)

TABLE OF CONTENTS

Acronyms

ACAP	Agreement on the Conservation of Albatrosses and Petrels
CCAMLR	The Convention for the Conservation of Antarctic Marine Living Resources
CM	Conservation Measure
CMM	Conservation and management measure
CPCs	Contracting parties and cooperating non-contracting parties
DSCC	Deep Sea Conservation Coalition
DSF	Deep-sea fisheries
FAO	Food and Agriculture Organization of the United Nations
ICCAT	The International Commission for the Conservation of Atlantic Tunas
MoP	Meeting of the Parties (SIOFA)
GFCM	General Fisheries Commission for the Mediterranean
GSAs	Geographical subareas (GFCM)
NAFO	The Northwest Atlantic Fisheries Organisation
NAMMCO	The North Atlantic Marine Mammal Commission
NASCO	The North Atlantic Salmon Conservation Organization
NEAFC	The Northeast Atlantic Fisheries Commission
NPFC	The North Pacific Fisheries Commission
RFBs	Regional Fisheries Bodies
SEAFO	The Southeast Atlantic Fisheries Organisation
SIOFA	The South Indian Ocean Fisheries Agreement
SPRFMO	The South Pacific Regional Fisheries Management Organisation
SSRUs	Small Scale Research Units (CCAMLR)
TAC	Total Allowable Catch
UNFSA	United Nations Fish Stocks Agreement
UNGA	United Nations General Assembly
VME	Vulnerable Marine Ecosystem

Introduction

This deliverable corresponds to Task 3, and its main objective is to conduct an overview and critical analysis of existing by-catch mitigation and management approaches in DSF, and development of recommendations for improving by-catch management in DSF, considering the following RFMOs and Fishing Areas: CCAMLR, GFCM, NAFO, NEAFC, NPFC, SEAFO, SIOFA, SPRFMO and FAO Area 41 (SW Atlantic). Task 3 is divided into three sub-tasks, as follows:

Sub-task 3.1 – Effectiveness of by-catch management

This sub-task is an assessment of the effectiveness of the existing by-catch management approaches: Firstly, by-catch avoidance and management approaches will be identified and described in each of the considered RFMOs/Fishing areas. Once this information has been gathered, an assessment will be carried out considering the existing limitations of each of these approaches, along with their advantages. From this assessment, the effectiveness of the different by-catch management approaches will be determined and the most effective approach(es) will be identified, while remaining challenges/issues will also be highlighted.

Sub-task 3.2 – Areas with gaps/improvements needed

In this task, the areas where knowledge gaps exist or improvements are needed will be identified, especially those related to by-catch of vulnerable species (e.g., corals and sponges, sea birds and marine mammals) and by-catch avoidance or mitigation. If possible, potential solutions to the identified issues will be proposed.

Sub-task 3.3 – Recommendations for by-catch avoidance and management

The purpose of this task is to formulate recommendations for progressing towards better by-catch avoidance and management in DSF. The proposed recommendations will focus on issues such as the establishment of by-catch limits for relevant organisms (such as sharks, crabs, coral, sponges, etc.) of DSF, seabird by-catch mitigation for all gears (with emphasis on trawlers), or depredation issues involving interactions with cetaceans among others.

Background

Deep-sea fisheries operate globally throughout the world's oceans, chiefly targeting stocks on the upper and mid-continental slope and offshore seamounts. Major commercial fisheries occur, or have occurred, for species such as orange roughy, oreos, cardinalfish, grenadiers and alfonsino. Fishing in the deep sea not only harvests target species but can also cause unintended environmental harm, mostly from operating heavy bottom trawls and, to a lesser extent, bottom longlines. For this reason, since 2006, the UNGA has adopted provisions to protect vulnerable marine ecosystems from the impacts of bottom fishing in the high seas, while the FAO adopted its International Guidelines for Deep Sea Fisheries in the High Seas in 2008. Bottom trawling over hard seabed (common on seamounts) routinely removes most of the benthic fauna (Clark et al., 2016). In addition to this, many non-target species can be caught incidentally during fishing operations (i.e., by-catch), representing a major concern for sustainable fishing. As part of the impacts of DSF on the ecosystems, the management of by-catch species needs also to be properly addressed. For example, by-catch limits for relevant organisms (such as sharks, crabs, etc.) of DSF can be set, seabird and VME bycatch mitigation measures can be established or depredation issues involving interactions with cetaceans need to be addressed. In 2018, a study was commissioned by the EC/EASME (Specific Contract No. 8 EASME/EMFF/2016/008) with the purpose of analyzing the different scientific approaches for the management of deep-sea fisheries and ecosystems in RFMOS and RFBs. This study, referred as the "SC08 study" from this point onwards, produced a very useful summary of approaches adopted in various RFMOs and made available information on by-catch management in many DSF. According to it, some RFMOs have been proactive in formulating rules related to deep-sea fisheries exploitation, but the scope and ambition of these measures are often not applied or implemented consistently across all RFMOs (e.g., the scope of implementing fisheries closures to protect VMEs varies greatly between RFMOs). While, in line with the principles of the UNCLOS, RFMOs are given a central place in the management of these fisheries, those responsible for the management of deep-sea fisheries vary widely in scope, authority, participation by fishing nations and especially the robustness of the scientific advice provided. As a consequence, the scientific and management approaches in RFMOs for assessing deep-sea fisheries and ecosystems are broad and variable.

Thus, the present study, building upon the SC08 study results, aimed at producing an overview and critical analysis of existing by-catch mitigation and management approaches in DSF. This allowed us to develop a series of recommendations for improving by-catch management in DSF.

Geographical areas, fisheries and relevant RFMOs.

Under the UNCLOS, fisheries in areas beyond national jurisdiction should be regulated by the Regional Fisheries Management Organizations (RFMOs), although this is not always the case, as in the South West Atlantic (FAO Area 41). Participants in RFMOs include not only the bordering coastal States, but also third countries that are involved in fishing in a given marine region or have a real interest in a fishery. European countries, in turn, are represented in numerous RFMOs by the European Commission. Annual negotiations are held to determine which countries are allowed to catch how much of a species. Almost all commercially relevant fish species are covered by the RFMOs (World Ocean Review, 2021). Thus, the primary competence and responsibility of RFMOs is to manage fisheries in their Convention Areas, typically achieved through legally-binding conservation and management measures (CMMs). The ecosystem approach to fisheries (EAF) is being applied (with various levels of effective implementation) by management bodies responsible for deep-sea fisheries (Fletcher, 2020). The main purpose of applying EAF is to ensure the conservation and sustainable use of all ecological, social and economic systems related to the fishery, not just the targeted species. This means that all ecological 'assets', including all target stocks and other species belonging to the same ecosystem or associated with or dependent on the target stocks, habitats, ecosystems relevant to the fishery and the issues/impacts generated by the fishery that may be affecting these assets should be considered (Fletcher, 2020).

FAO recognizes 61 Regional Fisheries Bodies (RFBs), which have varying mandates and functions (e.g., advisory, coordination, management). According to the FAO, those RFBs which have a management mandate are considered RFMOs (Figure 1). It is important to note that although commonly referred to as an RFMO, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) is a conservation organization with a remit beyond fisheries management, although it does share attributes with RFMOs (Elliott, 2020).

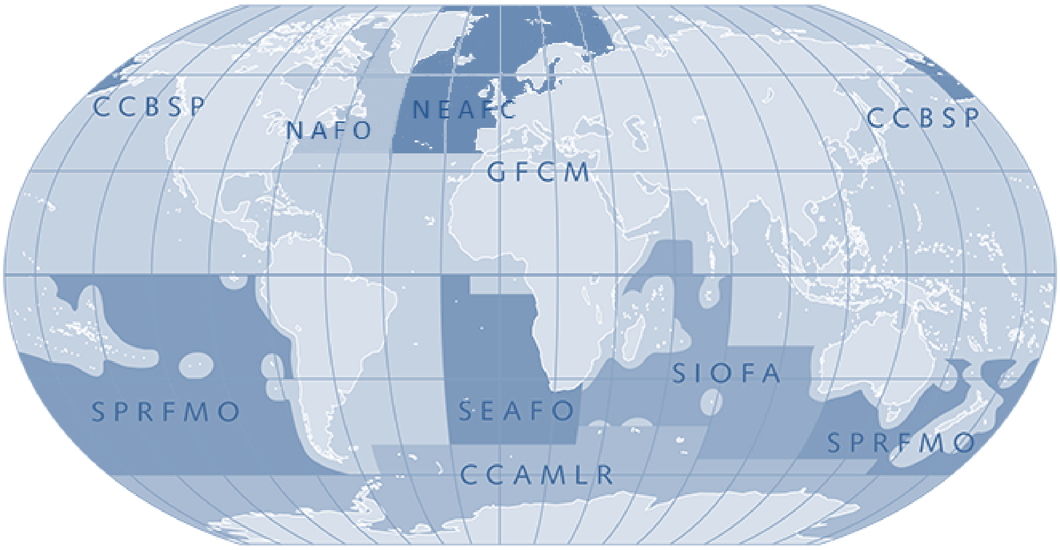

Figure 1. Overview of RFMOS. Source: https://worldoceanreview.com/en/wor-2/fisheries/deep-sea-fishing/catching-fish-in-international-waters/

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) was established by international convention in 1982 with the objective of conserving Antarctic marine life. This was in response to increasing commercial interest in Antarctic krill resources, a keystone component of the Antarctic ecosystem and a history of over-exploitation of several other marine resources in the Southern Ocean (Figure 2). CCAMLR is an international commission with 26 Members, and a further 10 countries have acceded to the Convention. Based on the best available scientific information, the Commission agrees a set of conservation measures that determine the use of marine living resources in the Antarctic. Being responsible for the conservation of Antarctic marine ecosystems, CCAMLR practises an ecosystem-based management approach. This does not exclude harvesting as long as such harvesting is carried out in a sustainable manner and takes account of the effects of fishing on other components of the ecosystem (CCAMLR, 2021). Bottom fishing is permitted by CCAMLR in the high seas areas of the Convention Area using bottom-set longlines of hooks or pots. The main target species are toothfish, primarily Antarctic toothfish (*Dissostichus mawsoni*) near the Antarctic continent, and some Patagonian toothfish (*Dissostichus eleginoides*) in the sub-Antarctic. Pots (traps) are also occasionally used. Total reported catch in the CCAMLR high seas area in 2018-19 was 4097 tonnes of Antarctic toothfish and less than 2 tonnes of Patagonian toothfish. 3 Fishery reports are prepared for each CCAMLR area where a fishery has been undertaken. The majority of the bycatch, by both numbers and weight, consists of species of skates, rays and grenadiers (Macrouridae). A large number of other species are also reported caught in the high seas bottom longline fisheries, including some taken in substantial quantities such as icefish (Channichthyidae), blue antimora (*Antimora rostrata*), rockfish (Nototheniidae) and moray cods (*Muraenolepis* spp). Others are taken in relatively small numbers. The reported bycatch rates are considered low, generally at less than 5% of the catch of the target species (e.g., in sub-area 88.1). However, it is not clear that the 20-tonne limit per small scale research unit (SSRU) of bycatch of all other species combined (excluding skates, rays and grenadiers) is sufficient to ensure the long-term sustainability of these non-target species. Bycatch limits are set for rays and skates, macrourids, and other species. In the Ross Sea region fishery there are bycatch sub-area limits set for three areas, which are used for dividing up the toothfish fishery (DSCC, 2020).

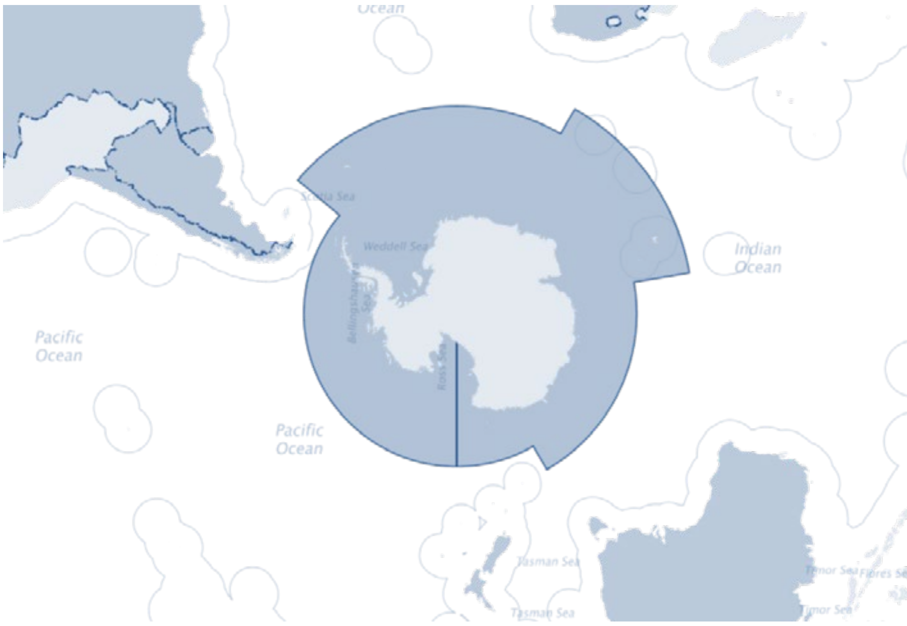

Figure 2. CCAMLR. (Source: FAO Regional Fishery Bodies Map Viewer)

The **General Fisheries Commission for the Mediterranean (GFCM)** is a RFMO established in 1949 under the provisions of Article XIV of the Constitution of the Food and Agriculture Organization of the United Nations (FAO). The GFCM plays a critical role in fisheries governance in its area of application, having the authority to adopt binding recommendations for fisheries conservation and management and for aquaculture development. These recommendations can relate, among others, to the regulation of fishing methods, fishing gear and minimum landing size, as well as the establishment of spatial protection measures, fishing effort control and of multiannual management plans for selected fisheries. The GFCM has competence for all marine waters of the Mediterranean and the Black Sea. The GFCM area of application is divided into five subregions: the Western, Central and Eastern Mediterranean as well as the Adriatic Sea and the Black Sea. These subregions are divided into 30 geographical subareas (GSAs), commonly used in the GFCM as the minimal management unit (Figure 3). The General Fisheries Commission for the Mediterranean is composed of 23 contracting parties: 19 Mediterranean states, 3 Black Sea states and the European Union. The GFCM also counts five cooperating non-contracting parties: Bosnia and Herzegovina, Georgia, Jordan, Republic of Moldova and Ukraine. The main deep-water fisheries are for various types of deep-water shrimp and hake. FAO estimated that the catch from bottom fisheries in 2016 was around 20 000 tonnes of finfish, mostly European hake, and about 25 000 tonnes of shrimp, mostly deep-water rose shrimp, and blue and giant red shrimp. Another 12,000 tonnes of red shrimp were estimated to be caught in the Mediterranean, some of which, like hake, were taken in shallow-water areas. In 2005, GFCM adopted a recommendation on the management of certain fisheries exploiting demersal and deep-water species and the establishment of a fisheries restricted area below 1000 m on (Recommendation GFCM/29/2005/1). This recommendation aimed at protecting deep sea organisms, by prohibiting the use of towed dredges and trawl nets at depths beyond 1000 m.

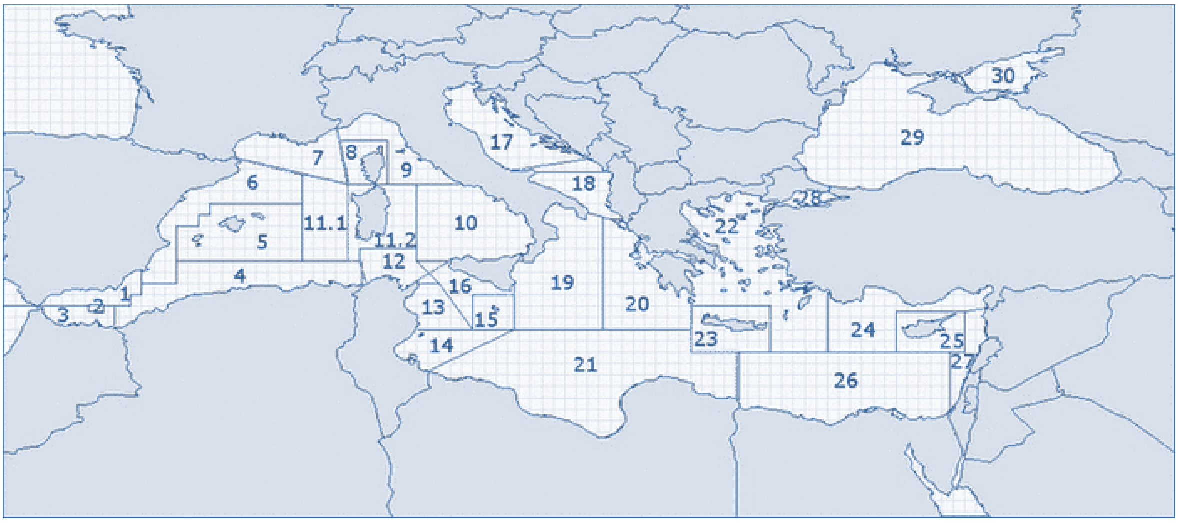

Figure 3. The GFCM. GFCM geographical subareas are shown. Source: FAO

The Northwest Atlantic Fisheries Organization (NAFO) is an intergovernmental fisheries science and management body. It was founded in 1979 as a successor to ICNAF (International Commission of the Northwest Atlantic Fisheries) (1949-1978). Currently, NAFO has 13 Contracting Parties. Its main objective is to ensure long term conservation and sustainable use of the fishery resources in the Convention Area and, in so doing, to safeguard the marine ecosystems in which these resources are found. The NAFO Convention on Cooperation in the Northwest Atlantic Fisheries applies to most fishery resources of the Northwest Atlantic. The NAFO regulated fishery takes place in the NAFO Regulatory Area, which is defined in the NAFO Convention as that part of the Convention Area which lies beyond the areas in which Costal States exercise fisheries jurisdiction (outside of the Exclusive Economic Zones) (Figure 4). The NAFO Regulatory Area, over which it has jurisdiction, is 2 707 895 km^2. The three main fisheries that are regulated in the NAFO Regulatory Area are for groundfish, shrimp and pelagic redfish, however, there is currently a moratorium on the shrimp and pelagic redfish fisheries. The groundfish fishery occurs mainly in NAFO Divisions 3LMNO within the Fishing Footprint and is conducted using mainly bottom trawls. For more specific information on the NAFO Regulated Fisheries, please see the latest Annual Compliance Review[1]. NAFO does not manage sedentary species (e.g. shellfish) and species managed by other fishery bodies, i.e. salmon (NASCO), tunas/marlins (ICCAT), and whales (NAMMCO) (NAFO, 2021).

Figure 4. Map of the Northwest Atlantic Fisheries Organization (NAFO) area. The area of competence is shown in blue, while the regulatory area is shown with a striped pattern. (Source: FAO Regional Fishery Bodies Map Viewer)

[1] NAFO 42nd ANNUAL MEETING – SEPTEMBER 2020 Annual Fisheries and Compliance Review 2020. . Available at: https://www.nafo.int/Portals/0/PDFs/COM/2020/comdoc20-17REV.pdf

The North East Atlantic Fisheries Commission (NEAFC) is the Regional Fisheries Management Organisation (RFMO) for the North East Atlantic, one of the most abundant fishing areas in the world. NEAFC is comprised of Contracting Parties which have signed up to the Convention on Multilateral Cooperation in North East Atlantic Fisheries, which entered into force in November 1982. The area covered by the NEAFC Convention stretches from the southern tip of Greenland, east to the Barents Sea, and south to Portugal. Within the NEAFC regulatory area fishing vessels must abide by both the current management measures and the NEAFC Scheme of Control and Enforcement. The main high seas bottom fishing nations in the NEAFC Regulatory Area are Spain/EU, Norway, and Denmark in respect of the Faroe Islands and Greenland. The main high seas bottom fisheries target roundnose grenadier, Greenland halibut, smoothheads and black scabbardfish. Other species caught commercially include ling, blue ling, red crabs, orange roughy (also targeted) and conger eel. Over the past few years, a bottom pot fishery for snow crabs has developed in the Barents Sea. Some high seas bottom fishing for cod, haddock and redfish also occurs. Bottom fisheries are predominantly bottom trawl fisheries, with some bottom longline fishing also taking place. Targeted fisheries for a number of species – such as deep-sea sharks, rays and chimaeras – have been prohibited by NEAFC, although in some cases they continue to be reported caught as bycatch (NEAFC, 2021 https://www.neafc.org; DSCC, 2020).

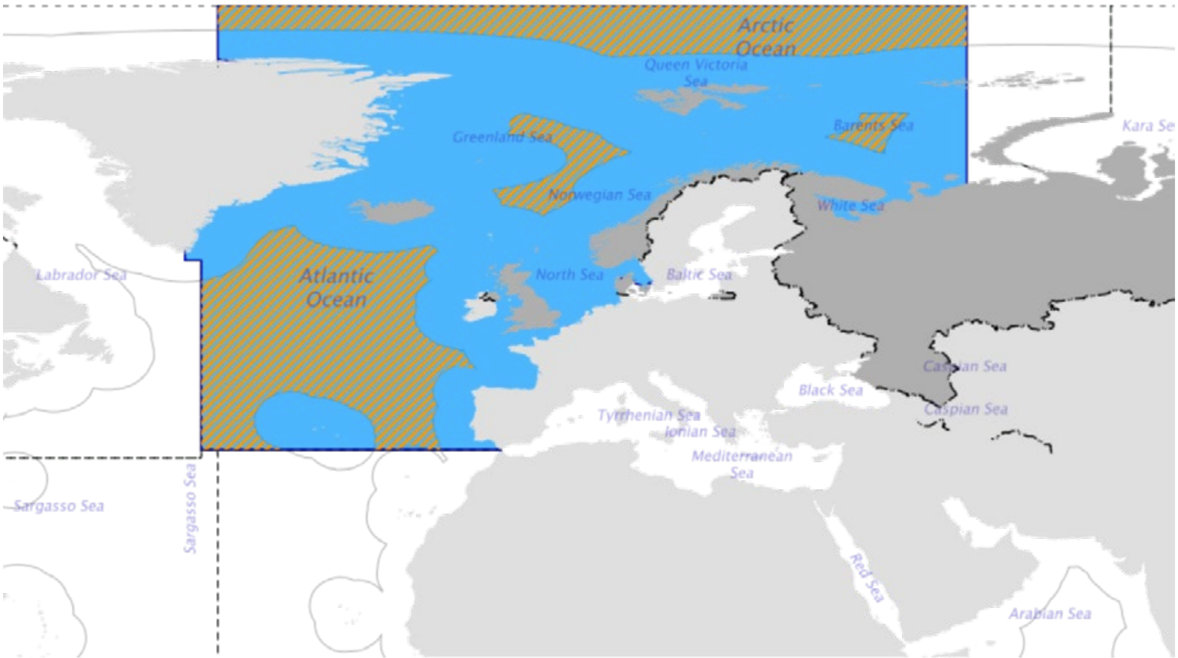

Figure 5. NEAFC Convention Area (in blue) and Regulatory Area (in a striped pattern) Source: FAO Regional Fishery Bodies Map Viewer.

The North Pacific Fisheries Commission (NPFC) is an inter-governmental organization established by the Convention on the Conservation and Management of High Seas Fisheries Resources in the North Pacific Ocean (Figure 6). The objective of the Convention is to ensure the long-term conservation and sustainable use of the fisheries resources in the Convention Area while protecting the marine ecosystems of the North Pacific Ocean in which these resources occur. Current Members include: Canada, China, Japan, the Republic of Korea, the Russian Federation, Chinese Taipei, the United States of America and Vanuatu. Fisheries resources covered by the Convention are all fish, mollusks, crustaceans and other marine species caught by fishing vessels within the Convention Area, excluding: (i) sedentary species insofar as they are subject to the sovereign rights of coastal States; and indicator species of vulnerable marine ecosystems as listed in, or adopted pursuant to the NPFC Convention; (ii) catadromous species; (iii) marine mammals, marine reptiles and seabirds; and (iv) other marine species already covered by pre-existing international fisheries management instruments within the area of competence of such instruments (NPFC, 2021; https://www.npfc.int/).

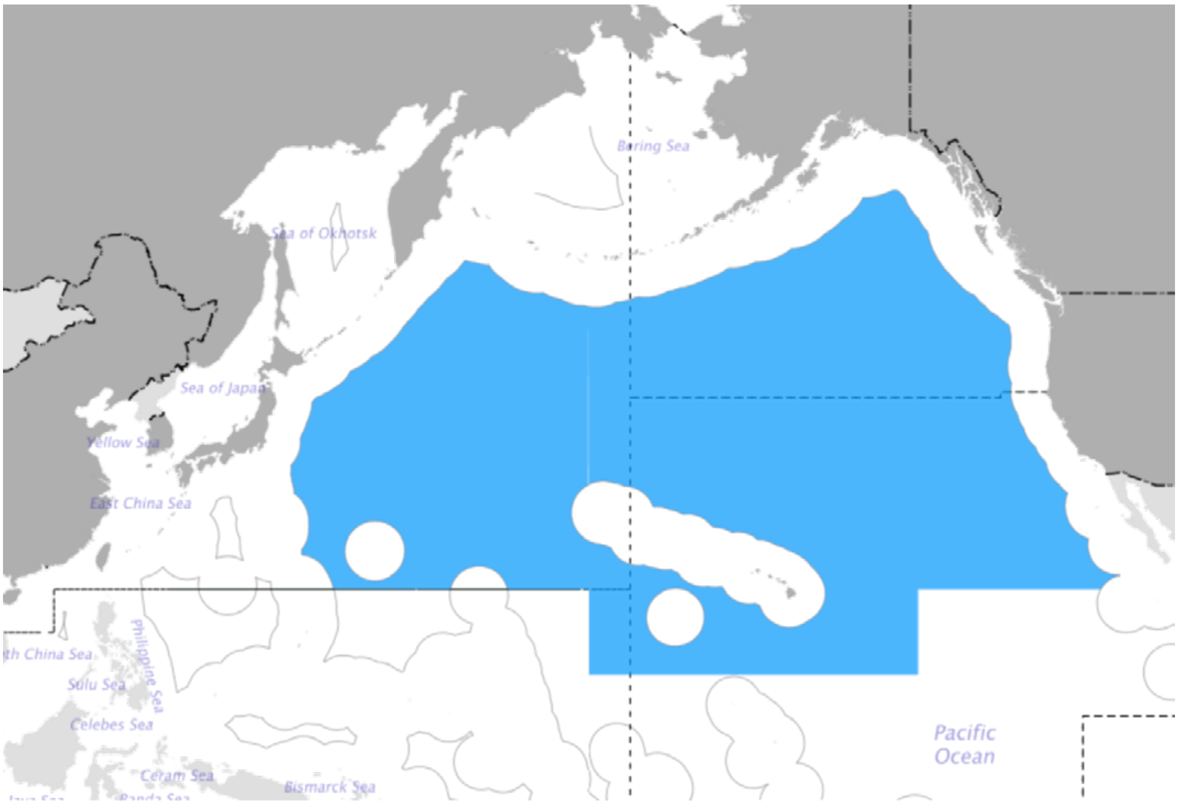

Figure 6. The North Pacific Fisheries Commission. Source: FAO Regional Fishery Bodies Map Viewer.

The South East Atlantic Fisheries Organisation (SEAFO) is a regional fisheries management organisation in South East Atlantic Ocean established in line with the provisions of the United Nations Law of the Sea (Article 118) and United Nations Fish Stocks Agreement. SEAFO's primary purpose is to ensure the long-term conservation and sustainable use of all living marine resources in the South East Atlantic Ocean, and to safeguard the environment and marine ecosystems in which the resources occur. The SEAFO Convention Area covers a sizable part of the high seas of the Southeast Atlantic Ocean, encompassing all the waters beyond areas of national jurisdiction in a region bounded by parallel lines of latitude and meridians of longitude, and the EEZs of West and Southern African States (Figure 8). Economically-important SEAFO fish species in the Convention Area include sedentary / discrete and straddling species such as alfonsino, orange roughy, oreo dories, armourhead, sharks, deepwater hake and red crab. (SEAFO, 2021; http://www.seafo.org/). Currently the only bottom fishery in the SEAFO area is a bottom longline fishery for Patagonian toothfish. However, there are also quotas for deep-sea crab, alfonsino, orange roughy and pelagic armorhead. Contracting Parties have not reported catches using bottom trawl gear since 2005 and the reported bottom trawl catch averaged only slightly over 30 tonnes per year in the previous 11 years (1995-2005). In the past, other commercial species targeted or taken as bycatch have included alfonsino, southern boarfish, oreos, orange roughy, wreckfish and blackbelly rosefish amongst other deep-sea species.

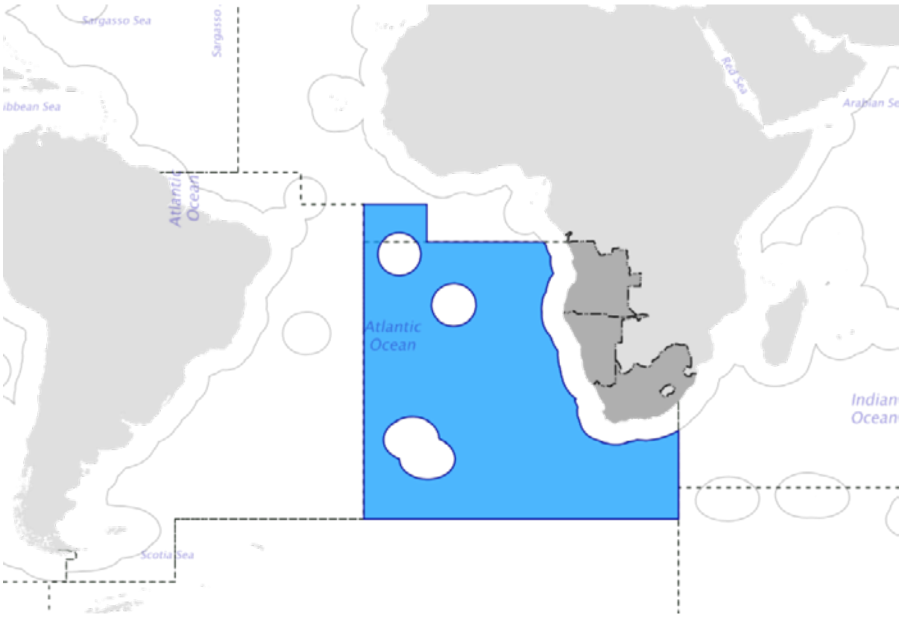

Figure 7. The SEAFO Convention Area (Source: FAO Regional Fishery Bodies Map Viewer)

The South Indian Ocean Fisheries Agreement (SIOFA). SIOFA entered into force in 2012, and the decision-making body known as the "Meeting of the Parties" (MoP) met from 2013, with the scientific committee meeting for the first time in March 2016. To date, there are nine contracting parties: Australia, Cook Islands, European Union, France (on behalf of its Indian Ocean territories), Republic of Korea, Japan, Mauritius, Seychelles and Thailand. The SIOFA Agreement applies to resources of fish, molluscs, crustaceans and other sedentary species, except sedentary species subject to coastal State jurisdiction as well as specified highly migratory species. SIOFA has an area of 35 588 000 km2; of which 98.3% is deeper than 2000 m (Figure 8). The Indian Ocean has no highly productive, current-driven upwelling ecosystems, as in the other large oceans. Deep sea fisheries in SIOFA target mainly orange roughy (*Hoplostethus atlanticus*), alfonsino (*Beryx decadactylus*) and toothfish (*Dissostichus spp*.) (FAO, 2020).

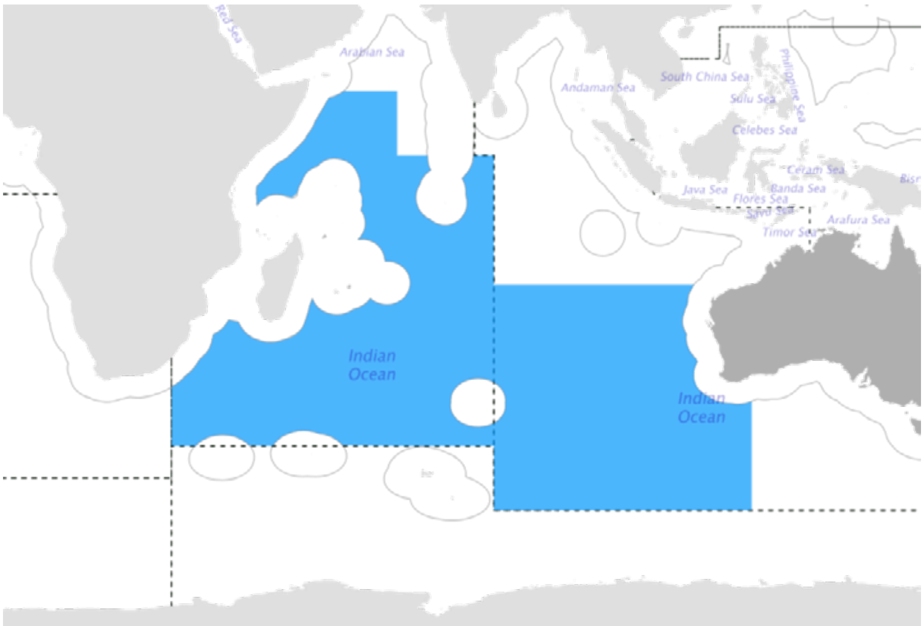

Figure 8. SIOFA (Source: FAO Regional Fishery Bodies Map Viewer)

The **South Pacific Regional Fisheries Management Organisation (SPRFMO)** is an inter-governmental organisation that is committed to the long-term conservation and sustainable use of the fishery resources of the South Pacific Ocean and, in so doing, safeguarding the marine ecosystems in which the resources occur. The SPRFMO Convention applies to the high seas of the South Pacific, covering about a fourth of the Earth's high seas areas (Figure 9). Currently, the main commercial resources fished in the SPRFMO Area are Jack mackerel and jumbo flying squid in the Southeast Pacific and, to a much lesser degree, deep-sea species often associated with seamounts in the Southwest Pacific. The Organisation consists of a Commission and a number of subsidiary bodies. New Zealand is the Depositary for the SPRFMO Convention and hosts the SPRFMO Secretariat in Wellington. The Commission has currently 15 Members from Asia, Europe, the Americas, and Oceania. (SPRFMO, 2021. https://www.sprfmo.int/)

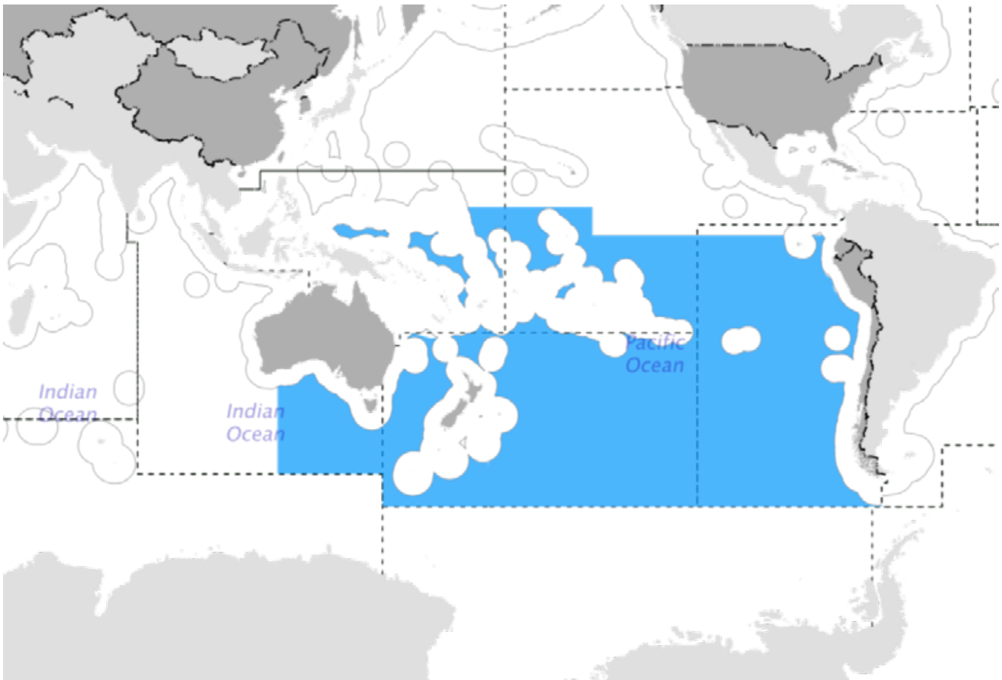

Figure 9. SPRFMO (Source: FAO Regional Fishery Bodies Map Viewer)

FAO Area 41 (Southwest Atlantic). No RFMO or other multilateral interim measures have been established to regulate the high seas bottom fisheries of the Southwest Atlantic, nor are any negotiations currently underway to establish an RFMO in the region (Figure 10). The main high seas bottom fisheries are the bottom trawl fisheries for hake and squid along portions of the Patagonian shelf and upper slope in international waters. Fisheries for Argentine hake and Argentine shortfin squid, the principal target species in the current high seas bottom fisheries in the region developed in the 1960s and 1970s by Argentinian and distant water fleets, primarily from the former Union of Soviet Socialist Republics (USSR), Poland and Japan. In the 1980s, fleets from other distant water nations such as the Republic of Korea, Spain, Taiwan Province of China, Cuba, Germany, began targeting these species in the Southwest Atlantic. The exact numbers and flags of vessels bottom fishing on the high seas of the Southwest Atlantic remain unknown. In November 2019, the Greenpeace vessel Esperanza conducted documentation work in the high seas area adjacent to the EEZ of Argentina, some 500km east of the Gulf of San Jorge, revealing the presence of Spanish, Chinese and Korean vessels engaged in bottom fishing in the area. The Esperanza came across 16 trawlers flagged to China, and Greenpeace campaigners conducted interviews with seven captains aboard the vessels. The interviews confirm that some of these vessels engage in bottom fishing and, in addition to squid, several catch demersal species such as hake, Antarctic icefish, Patagonian toothfish, redfish, and skates, amongst others. Also, the Esperanza came across a bottom longliner flagged to Korea which was documented fishing Patagonian toothfish. A significant unregulated Patagonian toothfish fishery may be taking place in the high seas of the Southwest Atlantic. The Global Atlas of AIS-based fishing activity – Challenges and opportunities, recently published by FAO, identifies substantial fishing activity in the high seas east-south-east of the Falkland/Malvinas, which it believes "is likely to be mostly for Patagonian toothfish longlining using set longlines. In July 2008, in response to the adoption by the UNGA of measures to protect vulnerable marine ecosystems from bottom fishing, the EU adopted Council Regulation (EC) No 734/2008, a framework regulation for the management of high seas bottom fisheries by EU vessels operating in areas of the high seas where no RFMO exists, and where no multilaterally agreed interim measures have been established – including in the Southwest Atlantic. In its report, prepared to the foreseen review of the bottom-fishing measures at the UN General Assembly in 2020 (although it ultimately had to be postponed due to the impacts of the COVID-19 pandemic), the DSCC reported that was not aware of any similar measures adopted by any other flag States whose vessels engage in high seas bottom fisheries in the region, in line with the UNGA provisions. To implement the EU regulation, Spain initially designated a "fisheries footprint", or area where Spanish vessels were permitted to fish, but restricted this to the area of continental shelf and slope on the high seas between 42 and 48 degrees south latitude[2] The EU and Spain are the only ones that have largely implemented the UNGA resolutions in the Southwest Atlantic as far as the DSCC is aware (DSCC, 2020).

[2] See section 5.c. "Definition of spatial footprint for a typical fishing gear deployment event – FAO Area 41 (SW Atlantic)" from Deliverable 3·- "Review of existing and recommended criteria and methodologies for the establishment of historical and cumulative fishing footprints".

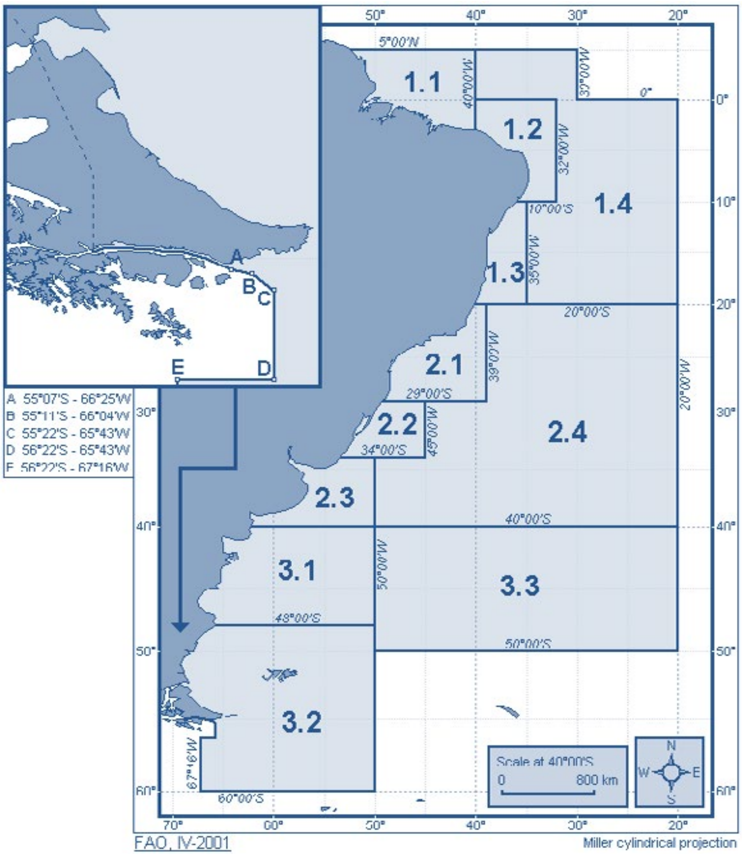

Figure 10. FAO Major Fishing Area 41, Southwest Atlantic. Source: FAO

Methodology

The final purpose of this critical analysis of the current practices and measures implemented to reduce and manage bycatch in DSF is to develop a series of recommendations to improve by-catch avoidance and management. The analysis was focused on the following RFMOs/Fishing areas:

- The Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR)
- The General Fisheries Council for the Mediterranean (GFCM)
- The Northwest Atlantic Fisheries Organisation (NAFO)
- The Northeast Atlantic Fisheries Commission (NEAFC)
- The North Pacific Fisheries Commission (NPFC)
- The Southeast Atlantic Fisheries Organisation (SEAFO)
- The South Indian Ocean Fisheries Agreement (SIOFA)
- The South Pacific Regional Fisheries Management Organisation (SPRFMO)
- FAO Area 41 (SW Atlantic)

The review involved mainly a revision of the information available on each RFMO's website, while available scientific literature, reports and grey literature related to by-catch mitigation and management approaches in DSF were considered as well. Regarding FAO Area 41(SW Atlantic), the absence of a competent RFMO in the area was recognized as a possible challenge to identify current practices and implemented measures because these are determined by individual Flag States and are not easily accessible. Thus, most of the information for FAO Area 41 considered only European fisheries, because no information was available for other countries fishing in the area, such as China, Taiwan and South Korea.

This study was divided into three sections:

1. Effectiveness of by-catch management
2. Areas with gaps or where improvements are needed and
3. Recommendations for by-catch avoidance and management

1. Effectiveness of by-catch management

In this section, an assessment of the existing bycatch management approaches was carried out. Firstly, bycatch avoidance and management approaches were identified and described for each of the considered RFMOs/Fishing areas (Annex 1). Once this information had been gathered, a comparative analysis of the implementation of bycatch mitigation measures across RFMOs was carried out. This facilitated the identification of the main measures taken in the different RFMOs to avoid and mitigate bycatch. In addition, this analysis allowed to evaluate the performance of the different RFMOs considered in this review, by using a modification of the "Bycatch mitigation effort Score" developed by Elliott (2020). Elliott (2020) used this bycatch score to assess the RFMO efforts in addressing cetacean bycatch, but this method was easily extended to other bycatch taxa. For the purpose of this review, RFMOs were assessed for their efforts in addressing bycatch of 4 different groups 1) Sharks and rays, 2) Marine mammals, 3) Seabirds and 4) Benthic organisms related to VMEs.

It is necessary to mention that FAO Area 41 (Southwest Atlantic) was not evaluated using the "Bycatch mitigation effort Score" because there is no RFMO in charge of setting conservation and management measures.

The "Bycatch mitigation effort Score" was calculated for all of the RFMOs, based on six criteria. These criteria were formulated to cover the main aspects of the topics discussed in the 2011 FAO International Guidelines on Bycatch Management and Reduction of Discards, such as a) Bycatch Management and Planning, b) Data collection and Bycatch assessments, c) Research and Development and d) Measures to Manage Bycatch and Reduce Discards (FAO, 2011).

The criteria are then the following:

1. Are there specific conservation and management measures for the bycatch group of concern?
2. Are bycatch limits established (or VME thresholds in the case of benthic organisms)?
3. Are there mitigation measures for bycatch in place (e.g., spatio-temporal closures, technical measures, gear restrictions)?
4. Does the RFMO have an Observer programme that requires data collection on bycatch?
5. Does the RFMO requires that bycatch species reported?
6. Is there ongoing research, or other initiatives related to bycatch, that can improve bycatch mitigation?

Each criterion was assigned a score (i.e., 0, 0,5 or 1) depending on whether the criteria were present (1), met to some extent (0,5) or absent (0) (e.g., the existence of a specific conservation and management measure for the bycatch group of interest received a score of 1 while no conservation measure received a 0) (Table 1). Scores were tallied into a Bycatch mitigation effort Score, with a higher cumulative score indicating better bycatch mitigation effort.

Table 1 The scoring system

Score	Meaning
1	Present
0.5	Present to some extent
0	Absent

Once the main bycatch avoidance/mitigation measures were identified, a critical assessment of these measures was carried out. This assessment included the pros and cons of each measure. Also, if sufficient information was available (e.g., published scientific studies, pilot studies or case studies), the effectiveness of these measures was discussed. Remaining challenges/issues were also highlighted.

2. Areas with gaps/improvements needed

In this section, the areas where knowledge gaps exist or improvements are needed were identified and described, especially those related to bycatch of vulnerable species (e.g., benthic organisms related to VMEs, elasmobranchs, sea birds and cetaceans) and by-catch avoidance or mitigation.

3. Recommendations for by-catch avoidance and management

In this section, recommendations for progressing towards better bycatch avoidance and management in DSF have been formulated. The proposed recommendations are focused on issues such as the establishment of bycatch limits for relevant organisms (such as sharks, crabs, coral, sponges, etc.) of DSF, seabird bycatch mitigation for all gears, or depredation issues involving interactions with cetaceans among others.

Section 1. Effectiveness of management approaches; advantages and limitations

Comparative analysis of the implementation of bycatch mitigation measures in RFMOs

This section presents the results of a comparative analysis of the performance of the various RFMOs using the Bycatch mitigation effort Score described in the previous section. The results are presented for each of the different bycatch groups separately in Tables 2-5. A summary of the results is shown in Table 6.

Table 2. Bycatch mitigation effort Score for sharks and rays

Sharks and rays		**CCAMLR**	**GFCM**	**NAFO**	**NEAFC**	**NPFC**	**SEAFO**	**SIOFA**	**SPRFMO**
Specific conservation and management measures	SCORE	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**0**
	COMMENT	CM 32-18 2006	GFCM/42/2018/2	Art. 12 NAFO CEM. Especially Greenland sharks (*Somniosus microcephalus*)	For sharks, rays and chimaeras Rec. 07 to 10 2020 Rec. 08 2021	No specific conservation and management measures.	CM 04/06	CMM 2019/12	No specific conservation and management measures.
Establishment of bycatch limits	SCORE	**1**	**0**	**0.5**	**0.5**	**0**	**0**	**0**	**0.5**
	COMMENT	For skates, rays and sharks (*Somniosus* spp.) CM 33-02 2020 CM 33-03-2020	No bycatch limits established.	Only for skates 3LNO (Art. 6 NAFO CEM)	For spurdog (*Squalus acanthias*)	No bycatch limits established.	No bycatch limits established.	No bycatch limits established.	Only for exploratory fisheries CMM 14a 2019, CMM 14d-2020
Mitigation measures for bycatch (e.g. spatio-temporal closures, technical measures, gear restrictions)	SCORE	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**
	COMMENT	• Move-on rule CM 33-03 2020 • Gillnet ban CM 22-04 2010 • Restrictions to bottom trawling CM 22-05 2008	Restrictions to bottom trawling (>1000 m)	• Live release of Greenland sharks • Some measures in development according to Art. 12 NAFO CEM.	• Live release • Gillnet ban Rec. 03 2006	Indirect measures such as: Limiting fishing effort in bottom fisheries and not allowing bottom fisheries to conduct fishing operation in areas deeper than 1500m.	Gillnet ban	Some measures in development according to CMM 2019/12	Gillnet ban Some measures in exploratory fisheries, e.g., move-on-rule CMM 14a 2019, CMM 14d-2020,
Scientific observer data collection on bycatch	SCORE	**1**	**0.5**	**1**	**0.5**	**1**	**1**	**1**	**1**
	COMMENT	100% coverage on all vessels. Observers monitor at least 25% of all hooks being hauled and if possible 100% of all hauls for trawl fisheries.	GFCM does not have a dedicated program at present. There are moves toward establishing a regional observer program (e.g., Medbycatch project, FAO/GFCM 2019 Technical Paper No. 640). However, contracting parties carry out fishery-dependent data collection through port sampling (e.g. landings, length/distribution, fishing techniques used and vessels engaged in the fishing activity, value) and through observers on board (e.g. bycatch, days at sea). Data collection for sharks and rays follows GFCM's Data	100% coverage	Observers are required in Exploratory fishing (Rec 10 2021) but focus is on VMEs	All vessels authorized to bottom fishing in the western part of the Convention Area shall carry an observer on board (CMM 2021-05)	100% coverage	CMM 2020/01 For bottom fishing: a. using trawl gear has 100 percent scientific observer coverage b. using any other bottom fishing gear type has 20 percent coverage in any fishing year. 100 % coverage in toothfish fisheries in Del Cano Rise and Williams Ridge.	CMM 16-2021

Sharks and rays		CCAMLR	GFCM	NAFO	NEAFC	NPFC	SEAFO	SIOFA	SPRFMO
			Collection Reference Framework (DCRF).						
Reporting for bycatch species	SCORE	1	1	1	1	1	1	1	1
	COMMENT	Bycatch species are reported by the observer in their logbook and final report, Vessels record and report bycatch data in their standardised CCAMLR logbooks (C1 for trawl, C2 for longline). This if reported to CCAMLR in a five-day summary and in detail on a monthly basis (CM23-01).	GFCM/42/2018/2	Monthly catch reports	Recommendation 08 2021 indicates that Contracting Parties shall submit to ICES all available data on picked dogfish / spurdog (*Squalus acanthias*), including data on discarding, for further evaluation of the state of the resource. Contracting Parties shall submit all data on the relevant fishery to ICES, including catches, bycatches, discards and activity information (e.g., Rec 05 and 06 2021).	Each Member of the Commission shall submit the reports (observer data for target and bycatch species) to the Secretariat. The Secretariat shall compile this information on an annual basis and make it available to the Members of the Commission.	CM 04/06 (Para. 1): Report catches of sharks annually to SEAFO Secretariat. Also, Article 11 of the SEAFO System of Observation, Inspection, Compliance and Enforcement (2019) establishes that a catch report containing the aggregated catch for consecutive 5 days shall be recorded by division, by species and by live weight (Kg), including retained by-catch species and discarded TAC species.	CMM 2019/02 Contracting parties shall ensure that data on fishing activities, including for target, non-target and associated and dependent species such as marine mammals, marine reptiles, seabirds or 'other species of concern', are collected from vessels flying their flag that are fishing in the Agreement Area	CMM 02-2021 Observer data should be provided to the Secretariat of the SPRFMO in a standardised format, Members and CNCPs will provide by 30 September, their previous (January to December) year's data.
Ongoing bycatch research	SCORE	1	1	0	1	0	0	1	1
	COMMENT	Shark bycatch is minimal, very occasionally coming up in trawls. Research into skate/ray bycatch is ongoing with research reviewed at WG-FSA. There is a tagging programme for skate in the Ross Sea.	Medbycatch project	No specific research related to elasmobranchs	Research through ICES Working Group on Elasmobranch fishes (WGEF) and Working Group on Bycatch of Protected Species (WGBYC)	No specific research related to elasmobranchs	No specific research related to elasmobranchs	Research on Deep-water sharks by SIODFA (E.g., Technical Report 21/01; SC-06-INFO-04)	Through its Scientific Committee (e.g., SC7-DW10_rev1)
Total		**5.5**	**4**	**4**	**4.5**	**2.5**	**3.5**	**4.5**	**4**

Table 3. Bycatch mitigation effort Score for marine mammals

Marine mammals		CCAMLR	GFCM	NAFO	NEAFC	NPFC	SEAFO	SIOFA	SPRFMO
Specific conservation and management measures	SCORE	1	1	0	0	0	0	0	0
	COMMENT	CM 25-03-2020	GFCM/43/2019/2 GFCM/36/2012/2 on enhancing the conservation of	No specific conservation and management measures.	No specific conservation and management measures.	No specific conservation and management measures.	There is no evidence of interactions between cetaceans	Some CMMs indirectly refer to cetaceans (e.g.,	No specific conservation and management measures.

			cetaceans in the GFCM area of application				and fisheries, hence no regulations.	CMM 2019/02 and CMM 2020/15).	
Establishment of bycatch limits	SCORE	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	COMMENT	No bycatch limits established.	No bycatch limits established.	No bycatch limits established.	No bycatch limits established.	No bycatch limits established.	No bycatch limits established.	No bycatch limits established.	No bycatch limits established.
Mitigation measures for bycatch (e.g., spatio-temporal closures, technical measures, gear restrictions)	SCORE	**1**	**1**	**0**	**0.5**	**0**	**0.5**	**0.5**	**0.5**
	COMMENT	CM 25-03 2020 Also mandatory fitting of marine mammal exclusion devices to all krill vessels (CM 51-01 2010) Gillnet ban CM 22-04 2010	GFCM/43/2019/2 GFCM/36/2012/2	No mitigation measures for marine mammal bycatch	Rec. 03 2006 bans gillnets in waters over 200 m deep	No mitigation measures for marine mammal bycatch	Rec. 02/2009 Banning of gillnets	Some measures to avoid interactions with cetaceans in Toothfish fisheries in the Del Cano Area. (CMM 2020/15)	Deep-water gillnets are banned Some management measures exist in the case of exploratory toothfish fisheries (e.g., CMM 14 e-2021).
Scientific observer data collection on bycatch	SCORE	**1**	**0.5**	**1**	**0.5**	**1**	**1**	**1**	**1**
	COMMENT	Observers are required to monitor marine mammal interactions with fishing gear in all fisheries	GFCM does not have a dedicated program at present. Contracting parties, however, collect data through observers onboard (e.g. bycatch, days at sea).	100 % coverage But Art. 30 of NAFO CEM establishes circumstances for when 100% observer coverage may not be necessary. Observer coverage <25% on any NAFO fisheries.	No mention regarding observer programme on NEAFC Scheme Observers are required only in Exploratory fishing (Rec 10 2021), but focus is on VMEs.	All vessels authorized to bottom fishing in the western part of the Convention Area shall carry an observer on board. Record of the numbers by species of all marine mammals, seabirds or reptiles caught. (CMM 2021-05)	All vessels are required to have an observer onboard (Section III of Interim Arrangements of the SEAFO Convention Text)	For bottom fishing: a. using trawl gear has 100 percent scientific observer coverage; and b. using any other bottom fishing gear type has 20 percent coverage in any fishing year.	CMM 16 2021 CMM 02 2021
Reporting for bycatch species	SCORE	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	COMMENT	Bycatch species are reported by the observer in their logbook and final report, Vessels record and report bycatch data in their standardised CCAMLR logbooks (C1 for trawl, C2 for longline). This if reported to CCAMLR in a five-day summary and in detail on a monthly basis (CM23-01).	GFCM/43/2019/2 Contracting parties should enhance data reporting information on incidental catch rates of cetaceans in line with the technical manual of the GFCM Data Collection Reference Framework (DCRF).	NAFO CEM Article 30, point 10.	Contracting Parties shall submit all data on the relevant fishery to ICES, including catches, bycatches, discards and activity information (e.g., Recommendation 05 and 06 2021).	Each Member of the Commission shall submit the reports (observer data for target and bycatch species) to the Secretariat. The Secretariat shall compile this information on an annual basis and make it available to the Members of the Commission.	Article 11 of the SEAFO System of Observation, Inspection, Compliance and Enforcement (2019) establishes that a catch report containing the aggregated catch for consecutive 5 days shall be recorded by division, by species and by live weight (Kg), including retained by-catch species and	CMM 2019/02 Contracting parties shall ensure that data on fishing activities, including for target, non-target and associated and dependent species such as marine mammals, marine reptiles, seabirds or 'other species of concern', are collected from vessels flying their flag that are fishing	CMM 02 2021 Observer data should be provided to the Secretariat of the SPRFMO in a standardised format, Members and CNCPs will provide by 30 September, their previous (January to December) year's data.

							discarded TAC species.	in the Agreement Area	
Ongoing bycatch research	SCORE	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0.5**
	COMMENT	Ongoing Research by Working Group on Ecosystem Monitoring and Management	Medbycatch Project	• ICES/NAFO/NAMMCO Working Group on Harp and Hooded Seals. NAFO Working group on ecosystem Science and Assessment	Research through ICES Working Group on Marine Mammal Ecology and Working Group on Bycatch of Protected Species (WGBYC)	No specific research for marine mammals	No specific research for marine mammals	No specific research for marine mammals	SPRFMO is carrying some assessments/ research through their Scientific Committee (e.g., SC8-DW14 from 2020 and SC9-DW13 from 2021).
Total		**5.5**	**4.5**	**3**	**3**	**2**	**2.5**	**2.5**	**3**

Table 4. Bycatch mitigation effort Score for seabirds

Seabirds		CCAMLR	GFCM	NAFO	NEAFC	NPFC	SEAFO	SIOFA	SPRFMO
Specific conservation and management measures	SCORE	**1**	**1**	**0**	**0**	**0**	**1**	**1**	**1**
	COMMENT	CM 25-02 (2018). CM 41-03 (2020) and 41-05 (2020)).	GFCM/35/2011/3	No specific conservation and management measures.	No specific conservation and management measures.	No specific conservation and management measures.	CM 25-12	CMM 2019/13	CMM 09-2017
Establishment of bycatch limits	SCORE	**0.5**	**0**	**0**	**0**		**0**	**0.5**	**0**
	COMMENT	A bycatch limit is set for birds in the icefish fishery in Subarea 48.3. Should any vessel catch 20 or more birds in a season it shall cease fishing (CM 41-02). Limits are also set on the longline fishery in some areas where daylight setting is allowed. Should a vessel catch 3 or more birds it must revert to night setting only (CM 41-04 to 41-11).	No bycatch limits established.	No bycatch limits established.	No bycatch limits established.	No bycatch limits established.	No bycatch limits established.	CMM 2019/13 For longliners, if more than 3 seabirds are caught, the vessel shall change to night setting.	No bycatch limits established.
Mitigation measures for bycatch (e.g. spatio-temporal closures, technical measures, gear restrictions)	SCORE	**1**	**0.5**	**0**	**0**	**0**	**1**	**1**	**1**
	COMMENT	CM 25-02 (2018) Minimisation of the incidental mortality of seabirds in the course of longline fishing CM 24-02 (2014) Longline weighting for seabird conservation	GFCM/35/2011/3 Contracting parties should develop mechanisms to ensure that incidental taking of seabirds in fishing activities is monitored, recorded and kept to the lowest level as possible. However, no specific measures are enforced in GFCM/35/2011/3.	No mitigation measures established for seabirds.	No mitigation measures established for seabirds.	No mitigation measures established for seabirds.	For longliners and trawlers	CMM 2019/13: For demersal longlines and other demersal fishing gears (pots, traps).	For demersal longline and trawls. Also for exploratory fisheries, e.g., CMM 14a-2019, CMM 14d-2020 and CMM 14e-2021 for toothfish fisheries.
Scientific observer data collection on bycatch	SCORE	**1**	**0.5**	**1**	**0.5**	**1**	**1**	**1**	**1**
	COMMENT	100% coverage on all vessels. Observers monitor at least 25% of all hooks being hauled and if possible 100% of all hauls for trawl fisheries.	GFCM does not have a dedicated program at present. Pilot observation schemes are considered in some demersal fisheries (e.g., Rec. GFCM/43/2019/5). Contracting parties,	100 % coverage But Art. 30 establishes circumstances for when 100% observer coverage may not be necessary. Observer coverage is never allowed to drop	No mention regarding observer programme on NEAFC Scheme Observers are required only in Exploratory fishing	Record of the numbers by species of all marine mammals, seabirds or reptiles caught.	All vessels are required to have an observer onboard (Section III of Interim Arrangements of the SEAFO Convention Text)	For bottom fishing: a. using trawl gear has 100 % coverage; and b. using any other bottom fishing gear type has 20 % coverage in any fishing year.	CMM 16 2021 CMM 02 2021

		CCAMLR	GFCM	NAFO	NEAFC	NPFC	SEAFO	SIOFA	SPRFMO
			however, collect data through observers onboard (e.g. bycatch, days at sea).	below 25% on any NAFO fisheries.	(Rec 10 2021), but focus is on VMEs.				
Reporting for bycatch species	SCORE	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	COMMENT	Bycatch species are reported by the observer in their logbook and final report, Vessels record and report bycatch data in their standardised CCAMLR logbooks (C1 for trawl, C2 for longline). This if reported to CCAMLR in a five-day summary and in detail on a monthly basis (CM23-01).	GFCM/35/2011/3 Any event of incidental taking and release shall be recorded by the vessel owner/master in the logbook (or any equivalent document as developed by a Contracting Party to this specific end) and reported to national authorities for notification to GFCM Secretariat.	NAFO CEM Article 30, point 10.	Contracting Parties shall submit all data on the relevant fishery to ICES, including catches, bycatches, discards and activity information (e.g., Recommendation 05 and 06 2021).	Each Member of the Commission shall submit the reports (observer data for target and bycatch species) to the Secretariat. The Secretariat shall compile this information on an annual basis and make it available to the Members of the Commission.	CM 25/12 (Para. 1): Report incidental bycatch of seabirds to SEAFO Secretariat (the report frequency is not specified). Also, Article 11 of the SEAFO System of Observation, Inspection, Compliance and Enforcement (2019) establishes that a catch report containing the aggregated catch for consecutive 5 days shall be recorded by division, by species and by live weight (Kg), including retained by-catch species and discarded TAC species.	CMM 2019/02 Contracting parties shall ensure that data on fishing activities, including for target, non-target and associated and dependent species such as marine mammals, marine reptiles, seabirds or 'other species of concern', are collected from vessels flying their flag that are fishing in the Agreement Area	CMM 02 2021
Ongoing bycatch research	SCORE	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**1**
	COMMENT	Research by WG on Ecosystem Monitoring and Management. Research in cooperation with ACAP MoU between CCAMLR and ACAP from 2018.	Medbycatch project	NAFO Working group on ecosystem Science and Assessment	Research through the ICES Joint OSPAR/HELCOM/ICES Expert Group on Seabirds (JWGBIRD) Working Group on Bycatch of Protected Species (WGBYC)	No specific research for seabirds.	Research in cooperation with ACAP (Memorandum of Understanding between SEAFO and ACAP from 2018.	Research in cooperation with ACAP Research in cooperation with ACAP Memorandum of Understanding between SIOFA and ACAP from 2018.	SPRFMO is carrying some research through their Scientific Committee. Research in cooperation with ACAP. MoU from 2014.
Total		**5**	**4**	**3**	**2.5**	**2**	**5**	**5**	**5.5**

Table 5. Bycatch mitigation effort Score for Benthic organisms related to VMEs

Benthic organisms related to VMEs		**CCAMLR**	**GFCM**	**NAFO**	**NEAFC**	**NPFC**	**SEAFO**	**SIOFA**	**SPRFMO**
	SCORE	**1**	**1**	**1**	**1**	**1**	**1**	**0.5**	**1**

Specific conservation and management measures	COMMENT	CM 22-07 CM 22-09	GFCM/43/2019/6 on the establishment of a set of measures to protect vulnerable marine ecosystems formed by cnidarian (coral) communities in the Mediterranean Sea	Chapter II of the NAFO CEM is dedicated of the protection of the Vulnerable Marine Ecosystems (VMEs)	Rec. 10 2021 to amend Rec.19:2014 on the Protection of Vulnerable Marine Ecosystems in the NEAFC Regulatory Area	CMM 2021-05 and CMM 2019-06	CM 30-15 Conservation Measure on Bottom Fishing Activities and Vulnerable Marine Ecosystems	CMM 2020/011 Only interim measures for Management of Bottom Fishing	CMM 03-2021
Establishment of bycatch limits. In this bycatch group, the criterion refers to VME thresholds.	SCORE	**1**	**0**	**1**	**1**	**0.5**	**1**	**1**	**1**
	COMMENT	CM 22-07 If 10 or more VME indicator units are recorded in one line segment, to complete hauling without delay. Vessel must move away from the area 1nm from the center of the section being hauled and the area will be closed until further notice.	No thresholds have been set, there is no move-on -rule	Exceeding bycatch thresholds triggers move-on-rule. More than 7 kg of sea pens and/or 60 kg of other live coral and/or 300 kg of sponges per set.	Rec. 10 2021 Exceeding bycatch thresholds triggers move-on-rule. For trawls, longlines and other gears. (a) Trawl and other gears: the presence of more than 30 kg of live coral and/or 400 kg of live sponge of VME indicators; and (b) for a longline set: the presence of VME indicators on 10 hooks per caught per 1000 hook segment or per 1200 m section of long line, whichever is the shorter.	CMM 2021-05 and CMM 2019-06 When in the course of fishing operations, cold water corals more than 50Kg are encountered in one gear retrieval, Members of the Commission shall require vessels flying their flag to cease bottom fishing activities in that location. In such cases, the vessel shall not resume fishing activities until it has relocated a sufficient distance, which shall be no less than 2 nautical miles, so that additional encounters with VMEs are unlikely	SEAFO has adopted the approach used by CCAMLR for longline sets, resulting in a threshold of at least 10 VME indicator units in one 1200-meter section of line or 1,000 hooks, whichever is the shorter, in both existing and new fishing areas. For bottom trawls, revised threshold levels of more than 60 kg of live coral and/or 600 kg of live sponge for existing bottom fishing areas, and more than 400 kg of live sponges and/or 60 kg of live coral for new fishing areas, were adopted.	For longlines, the threshold that triggers the encounter protocol for longline gears is the catch/recovery of 10 or more VME-indicator units of species in a single line segment. For trawls, more than 60 kg of live corals and/or 300 Kg of sponges in any tow.	CMM 03-2021 Weight Threshold for Triggering VME Encounter Protocol in Any One Tow for a Single VME Indicator Taxa -Sponges 25kg -Stony corals 60 kg -Black corals 5 kg -Seafan corals 15 kg -Anemones 35 kg -Hexacorals 10 kg Also weight Thresholds for Triggering VME Encounter Protocol in Any One Tow for Three or More Different VME Indicator Taxa.
Mitigation measures for bycatch (e.g., spatio-temporal closures, technical measures, gear restrictions)	SCORE	**1**	**0.5**	**1**	**1**	**0.5**	**1**	**0.5**	**0.5**
	COMMENT	-Move-on-rule (CM 22-07) - Area closures (CM-22-06 and CM 22-07) -Bottom trawling gear prohibitions (CM 22-05 2008) -Assessments of proposed bottom fisheries to determine SAIs on VMEs (CM 22-06, last update 2015).	-Bottom trawling below 1000 m prohibition. -Fisheries restricted areas (FRAs), a specific area-based management tool to protect VMEs in the region. Four areas have been closed to bottom fishing as a result of FRA designations. -**no** move-on-rule or requirement to cease	-Area closures (seamounts, high sponge and coral concentration Areas) -move-on-rule	Rec. 10 2021 -13 Area closures for the protection of VMEs -move-on-rule	Banning of bottom gears Below 1500 m in some areas, and bottom fisheries closure from Nov-Dec (NW). This does not apply for NE. Closure of only very small areas (NW) No (NE). Move-on rule concerning—cold-water corals (Alcyonacea,	-move-on rule; -areas closed to all bottom fishing designed to protect "representative" areas of VMEs; - the remaining areas provisionally closed to bottom fishing; however, fishing can take place provided a prior impact assessment is submitted and	-5 Area closures (though interim measures) -move-on-rule	-move-on-rule and report VME encounter. -No area closures

			fishing where VMEs are encountered.			Antipatharia, Gorgonacea, and Scleractinia) (CMM 2021-05)	reviewed by the SEAFO Scientific Committee, and a permit for exploratory fishing is approved by SEAFO.		
Scientific observer data collection on bycatch	SCORE	**1**	**0.5**	**1**	**0.5**	**1**	**1**	**1**	**1**
	COMMENT	In exploratory fisheries observers undertake the VME sampling protocol. In addition, they record benthic bycatch during their observation period as the line is being hauled.	Same as in the tables above. Also, Resolution GFCM/43/2019/6 states that contracting parties having vessels carrying out deep-sea fisheries activities should endeavour to establish an adequate level of scientific observer programme coverage, in particular if during an exploratory deep-sea fisheries stage.	100 % coverage But Art. 30 establishes circumstances for when 100% observer coverage may not be necessary. Observer coverage is never allowed to drop below 25% on any NAFO fisheries.	No mention regarding observer programme on NEAFC Scheme Observers are required only in Exploratory fishing (Rec 10 2021), focus is on VMEs.	Yes, for all vessels authorized for bottom fishing (NW) Yes (NE)	All vessels are required to have an observer onboard (Section III of Interim Arrangements of the SEAFO Convention Text)	Each CCP shall ensure that any vessel flying its flag and undertaking bottom fishing a. using trawl gear has 100 percent scientific observer coverage for the duration of the trip; and b. using any other bottom fishing gear type has 20 percent coverage in any fishing year.	100 % coverage for bottom trawl and At least 10% observer coverage for bottom line gear (for the fishing gear).
Reporting for bycatch species	SCORE	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	COMMENT	VME species are reported by the vessel on a five-day basis and in more detail on a monthly basis. Benthic species are also recorded and reported by observers at the end of each trip.	GFCM/43/2019/6 VME indicator taxa taken as a bycatch during fishing activities targeting other species should be reported to the competent national authorities, in order to contribute to a better knowledge of VME indicator taxa occurrence.	NAFO CEM Article 30, point 10.	Contracting Parties shall submit all data on the relevant fishery to ICES, including catches, bycatches, discards and activity information (e.g., Recommendation 05 and 06 2021).	Each Member of the Commission shall submit the reports (observer data for target and bycatch species) to the Secretariat. The Secretariat shall compile this information on an annual basis and make it available to the Members of the Commission.	CM 25/12 (Para. 1): Report incidental bycatch of seabirds to SEAFO Secretariat (the report frequency is not specified). Also, Article 11 of the SEAFO System of Observation, Inspection, Compliance and Enforcement (2019) establishes that a catch report containing the aggregated catch for consecutive 5 days shall be recorded by division, by species and by live weight (Kg), including retained by-catch species and discarded TAC species.	CMM 2019/02 Contracting parties shall ensure that data on fishing activities, including for target, non-target are collected from vessels flying their flag that are fishing in the Agreement Area	CMM 02 2021
Ongoing bycatch research	SCORE	**1**	**1**	**1**	**1**	**1**	**0.5**	**1**	**1**

	COMMENT	Research by Working Group on Ecosystem Monitoring and Management (WG-EMM)	(2017) Permanent working group on VMEs through resolution GFCM 41/2017/4 to collect information and map VMEs, advise on new proposals for closed areas and improve collaboration with the scientific bodies of other RFMOs. The GFCM database of sensitive benthic habitats and species was launched in 2020 as a scientific tool to support the work carried out on deep-sea benthic ecosystems. Medbycatch project	NAFO Working group on Ecosystem Science and Assessment ICES/NAFO Joint Working Group on Deep-water Ecology (WG-DEC)	Research through ICES working groups ICES/NAFO Joint Working Group on Deep-water Ecology (WG-DEC)	2018 FAO/NPFC Workshop on Protection of Vulnerable Marine Ecosystems in the North Pacific Fisheries Commission Area: Applying Global Experiences to Regional Assessments	A research survey was conducted in 2019. The objective of the survey was "to collect detailed bathymetric data and to analyze the occurrence and abundance of sessile epibenthos, including indicators of VMEs, benthopelagic fish, and benthic organisms."	A dedicated Protected Areas and Ecosystem Working Group, established in 2017, met for the first time in 2019 to advance the development of maps indicating where VMEs are known or likely to occur.	Through its Scientific Committee, e.g., SPRFMO SC 3RD Deepwater Workshop
Total		**6**	**4**	**6**	**5.5**	**5**	**5.5**	**5**	**5.5**

Table 6. Summary of the Bycatch mitigation effort Score.

	Sharks and rays	Marine mammals	Seabirds	Benthic organisms (VMEs)	TOTAL (out of 24)
CCAMLR	5.5	5	5.5	6	22
GFCM	4	4.5	4	4	16.5
NAFO	4	3	3	6	16
NEAFC	4.5	3	2.5	5.5	15.5
NPFC	2.5	2	2	5	11.5
SEAFO	3.5	2.5	5	5.5	16.5
SIOFA	4.5	2.5	5.5	5	17
SPRFMO	4	3	5	5.5	17.5
Total (out of 48)	**33**	**26**	**33**	**38**	

Results of the comparative analysis

Sharks and rays

CCAMLR had the highest Bycatch mitigation effort Score, while NPFC and SEAFO scored the lowest (Table 2; see Appendix I for full descriptions of RFMO management measures) In general, RFMOs have implemented specific conservation measures to protect sharks and rays, with the exception of SPRFMO. However, only CCAMLR has set bycatch limits for sharks, rays and skates. Other RFMO have only established bycatch limits for only a subgroup of elasmobranchs (e.g., skates in NAFO) or single species (Spurdog, Squalus acanthias, in NEAFC) in regular fisheries, while SPRFMO has set bycatch limits only for exploratory fisheries (e.g., Exploratory Fishing for Toothfish by European Union- and New Zealand-Flagged Vessels in the SPRFMO Convention Area). Regarding the implementation of mitigation measures for bycatch (i.e., spatio-temporal closures, technical measures, gear restrictions or modifications, etc.), most RFMOs have some measures in place, but there is room for improvement. Among the mitigation measures implemented by RFMOs are the prohibition or restrictions to bottom trawling (CCAMLR and GFCM), deep-water gillnet bans (CCAMLR, NEAFC, SEAFO and SPRFMO), move-on rules (CCAMLR and SPRFMO, only for exploratory fisheries), and live-release of caught specimens (NAFO and NEAFC). All RFMO collect elasmobranch bycatch data through scientific observers, although coverage varies among RFMOs. It is worth noting that NEAFC does not mention an Observer Programme in the NEAFC Scheme, and only requires the presence of observers in exploratory fishing activities with a focus on VMEs, not on sharks and rays. A positive aspect is that all of the considered RFMOs are conducting research to improve conservation and management of sharks and rays. For example, GFCM has been carrying research related to elasmobranchs in the area for a decade already. In 2010-2013, GFCM carried out a three-year research programme to improve the knowledge and assess the status of elasmobranchs in the region, and it continues to work in close collaboration with the regional experts to contrast sharks and rays populations' decline (GFCM, 2021). GFCM is currently carrying out the second phase of the Medbycatch project (Understanding Mediterranean multitaxa bycatch of vulnerable species and testing mitigation – a collaborative approach: http://www.fao.org/documents/card/en/c/ca4949en/), focused in some areas of Croatia, Italy, Morocco, Tunisia and Turkey, and with the following objectives: a) Creating knowledge and baseline information on vulnerable marine species affected by multi-taxa bycatch, b) Raising awareness of fishers and other target groups, c) Capacity building of relevant actors for implementing sustainable fishing practices and d) Implementing demonstration projects on sustainable fishing practices. NAFO has requested that the Scientific Council provide information on bycatch of Greenland sharks in NAFO fisheries and, by 2021, provide advice on management measures to reduce the bycatch of this species (DSCC, 2020). NEAFC encourages Contracting Parties to undertake research to identify ways to make fishing gears more selective with the aim to reducing bycatches of sharks and conduct research to on key biological/ ecological parameters, life history and behavioral traits, migration patterns, as well as on the identification of potential mating, pupping and nursery grounds of key shark species (Recommendation 10 2015; NEAFC, 2015). This is important because substantial bycatch of deep-sea sharks has been recorded in the French deep-water trawl fishery in the Northeast Atlantic adjacent to the NEAFC Regulatory Area, including a catch in 2012 of over 120 tonnes of deep-sea sharks now classified as endangered or critically endangered on the IUCN European Red List of Marine Fishes. In this respect, ICES has consistently advised that the bycatch of deep-sea sharks be minimized or avoided in the mixed species deep-water fisheries (DSCC; 2020). NEAFC and OSPAR recently submitted a joint request to ICES for advice on how to achieve this. In response to this request, ICES reviewed the existing information on deep-water sharks, skates and rays and generated 21 distribution maps showing the location of catches in the NEAFC and OSPAR areas of the NE Atlantic3.ICES also presented an overview of approaches which may be applied to mitigate bycatch and to improve stock status. ICES advised that the current mechanisms available to managers (such as prohibition, gear and depth limitations, and TAC) should be maintained despite their limitations and that additional measures, such as electromagnetic exclusion devices, acoustic or light-based deterrents, and spatio-temporal management could be explored. SIOFA is also encouraging contracting parties and other participant entities to undertake research to identify ways to make all relevant fishing gears more selective to minimize deep sea shark by-catch and to identify shark nursery areas in the Agreement Area, in order to

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[3] ICES 2020 - Special Request Advice: https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2020/Special_Requests/neafc_ospar.2020.09.pdf.

provide relevant information to the Scientific Committee (SIOFA, 2019a). In this respect, collaboration with SIODFA has been beneficial to SIOFA. SIODFA has two programmes related to sharks in the South Indian Ocean, namely, the sharks bycatch programme and the NSF Sharks Tree of Life Programme. In this last programme, the expedition allowed to collect approximately 30 different species of sharks, some rare, or possibly new, to science due to a lack of study in this remote location. Results from that expedition have greatly contributed to the knowledge and understanding of the deep-sea fauna in the Southern Indian Ocean and bycatch issues of the fisheries in the area.

Marine mammals

CCAMLR had the highest Bycatch mitigation effort Score, followed by GFCM. NPFC, SEAFO and SIOFA scored the lowest (Table 3; see Appendix I for full descriptions of RFMO management measures). In general, CCAMLR has taken a precautionary and ecosystem-driven approach to bycatch management compared to other RFMOs, as reflected in its score and it has a variety of CMMs directly and indirectly related to cetaceans. CCAMLR has also identified a marine mammal (the Antarctic fur seal - Arctocephalus gazelle) as sentinel species representative of ecosystem change within its Ecosystem Monitoring Programme (CEMP). The utility of using sentinel species has not been otherwise recognized by other RFMOs and is not used elsewhere at present. Actually, many studies laud CCAMLR as the exemplary RFMO-like body for ecosystem-based management (e.g., Elliott (2020) and DSCC (2020)). GFCM also obtained a high score, since it has undertaken several initiatives towards reducing cetacean bycatch in recent years, including the adoption of a marine-mammal focused CMM, participation in a Mediterranean-wide effort to reduce bycatch and voluntary bycatch work with ACCOBAMS and other partners. NAFO, NEAFC, SIOFA and SPRFMO scored similarly (between 2.5 and 3); in general, their Conventions have an objective towards addressing a precautionary approach and they meet minimum criteria with baseline observer coverage and some mitigation measures, but they do not seem proactive on matters specific to marine mammals. Currently research concerning marine mammals is being carried out mainly by NAFO, GFCM, NEAFC. There is ongoing research by CCAMLR Working Group on Ecosystem Monitoring and Management, by GFCM (Medbycatch Project), by NAFO through the ICES/NAFO/NAMMCO Working Group on Harp and Hooded Seals and the NAFO Working group on ecosystem Science and Assessment and by NEAFC through the ICES Working Group on Marine Mammal Ecology and the Working Group on Bycatch of Protected Species (WGBYC). In NAFO, the Commission has requested information on marine mammals (along with turtles and seabirds) that are present in NAFO Regulatory Area (NAFO, 2020). Such research is improving the knowledge of interactions cetaceans with fisheries. For example, there is preliminary information from EU-Spain surveys in Div 3L that shows that most of cetacean sightings occurred during the fishing activities, particularly during the hauling process and that spatial distribution of cetaceans coincided with main fishing grounds (interaction with fishing). A common fail to all RFMO is that bycatch limits have not been set for marine mammals, which puts in evidence that there is still work to be done related to bycatch mitigation of marine mammals.

Seabirds

The highest Bycatch mitigation effort Scores were obtained by CCAMLR, SEAFO, SIOFA and SPRFMO. Their score is related to having set specific conservation and mitigation measures for seabirds along with ongoing research, especially in collaboration with ACAP. Regarding research in the other RFMOs, GFCM is participating in the Medbycatch project and NEAFC is carrying research through the ICES Joint OSPAR/HELCOM/ICES Expert Group on Seabirds (JWGBIRD) and the Working Group on Bycatch of Protected Species (WGBYC). NPFC, NAFO and NEAFC obtained low Bycatch mitigation effort Scores, mainly because they do not have specific conservation and mitigation measures for seabirds.

NAFO has not yet implemented specific measures for mitigation of seabirds bycatch, but it appears to be working towards it. An Action Plan regarding the Management and Minimization of Bycatch and Discards was adopted in 2017. It aims at identifying best practices and possible mitigation measures to avoid by-catch per time, area, depth, fleet and fishery. Moreover, the NAFO Scientific Council has been addressing several requests from NAFO Commission regarding bycatch mitigation of juvenile fish, sharks, seabirds, turtles and marine mammals. In NAFO, research is being carried out in order to provide information to the Commission on seabirds (along with turtles and marine mammals) that are present in NAFO Regulatory Area. Such research is improving the knowledge of interactions seabirds with fisheries (NAFO 2020).

Although **NEAFC** has not implemented specific measures for seabirds yet, it has recently requested ICES to compile and aggregate available data on bird bycatch in the NEAFC regulatory area and to advise upon what is necessary in order to provide recurrent advice on bird bycatch (NEAFC, 2020a).

CCAMLR has developed specific rules to reduce seabird by-catch in long-line fisheries and these are also outlined mainly in CM 25-02 (2018). For example, setting long-lines at night time when vessels catch a certain number of seabirds (e.g., maximum of three seabirds in CM 41-03 (2020) and 41-05 (2020)), Long-lines with weights and Time-Depth Recorders (TDRs), the prohibition of dumping of offal and discards while long-lines are being set and the use of streamer lines during long-line setting to deter birds from approaching the hook-line.

GFCM has a recommendation on reducing incidental bycatch of seabirds in fisheries in the GFCM Competence Area (GFCM/35/2011/3). It includes recommendations that refer to developing mechanisms to ensure that incidental taking of seabirds in fishing activities is monitored, recorded and kept to the lowest level. Also, the GFCM Scientific Advisory Committee (SAC) evaluates on the basis of available information, and in close cooperation with relevant international scientific committees, the risk of seabirds incidental taking and mortality in different types of Mediterranean fisheries, taking into account also areas and seasons, and compare the effects of bycatches among them. It also shall provide advice on the technical details, feasibility, likely effectiveness and side effects of measures for mitigation of seabirds' bycatches in the Mediterranean fisheries such as a) setting of demersal and/or pelagic longlines only at night, b) use of bird-scaring lines and wrap scares, in case of longlines setting during the day, c) setting of a minimum bait weight and using only thawed baits conditioning, d) discards and excess bait shall not be rejected at sea during setting or hauling operations, and e) setting of a minimum distance to set bottom-set nets from sea-birds breeding areas (GFCM, 2011. 'Recommendation on reducing incidental bycatch of seabirds in fisheries in the GFCM Competence Area (GFCM/35/2011/3)'.

SPRFMO has a series of mitigation measures for seabird bycatch in place methods for exploratory fisheries (e.g., in CMM 14a-2019, CMM 14d-2020 and CMM 14e-2021 for toothfish fisheries in the SPRFMO Convention Area). For these fisheries, mitigation measures include:

a) use of integrated weight line as described in the CCAMLR gear library, b) no dumping of offal while lines are being set or while lines being hauled, c) offal or discards shall be macerated by machine prior to discarding, which shall take place only at the end of a haul or while steaming, d) bird exclusion devices (BED) to prevent birds entering the hauling area, and other methods such as water spray, movement, et cetera, shall be used as appropriate to deter aggressive feeders from approaching the line.

SEAFO has established measures for longliners fishing south of the parallel of latitude 30 degrees South and for trawl gears (Conservation Measure 25/12; SEAFO, 2012). For longliners, vessels shall carry and use bird-scaring lines, use the minimum ship's lights necessary for safety at night, avoid the dumping of offal while gear is being shot or set while at hauling shall be avoided and release all birds captured alive during fishing operations.

Trawlers shall deploy a streamer (or tori) line outside of both warp cables, avoid dumping of offal while gear is being shot or set, and, during hauling of gear, clean the nets prior to shooting to remove items that might attract seabirds, adopt shooting and hauling procedures that minimize the time that the net is lying on the surface with the meshes slack.

SIOFA has implemented CMM 2019/13 Conservation and Management Measure on mitigation of seabirds bycatch in demersal longlines and other demersal fishing gears fisheries (Mitigation of Seabirds Bycatch), which requires that demersal longliners apply mitigation measures such as night setting, the use of white color lines to increase visibility, the use of bird scaring lines and bird exclusion devices to prevent birds entering the hauling, no discharging of offal or discards immediately prior to and during the deployment or retrieval of fishing gear, add weights to the hookline or use integrated weight (IW) hooklines while deploying longlines, etc. Vessels using demersal pots or traps to ensure the cleanliness of the traps and pots not to attract birds, and ensure that buoy lines shall not be left floating at the surface.

Benthic organisms related to VMEs

All of the considered RFMOs with competence over bottom fisheries on the high seas have adopted conservation measures for benthic organisms related to VMEs. However, two RFMOs stand out regarding their work towards the conservation and management of VMEs, that is NAFO and CCAMLR. For example, NAFO first closed some seamounts in its Regulatory Area to bottom fishing activity in 2004 marking one of the first ever VME closures by an RFMO. In 2017, based on advice from the Joint Scientific Council and Commission Working Group on the Ecosystem Approach to Fisheries Management (WGEAFM), NAFO agreed to an amended closure of the New England Seamounts to encompass all seamounts at depths above 2,000 meters in the chain. This created a contiguous closure of seamounts within the adjacent EEZ of the United States. CCAMLR began discussing measures to address destructive fishing practices on benthic ecosystems in 2006, and had already adopted a number of measures prior to the adoption of UNGA Resolution 61/105. The Commission adopted nine Conservation Measures between 2008 and 2012 to implement the resolutions (DSCC, 2020).
Regarding the establishment of threshold levels, all RFMO have threshold levels that trigger move-on-rules, except for GFCM, where no thresholds have been set, there is no move-on-rule presently. However, bycatch thresholds for what constitutes an encounter often differ between amongst RFMOs. Nevertheless, the DSCC (2020) has found that while there continues to be significant achievements and progress in some areas and by some RFMOs, some others have slowed in their implementation or done very little to begin with – and, in at least one case, have removed or reversed protective measures for VMEs (e.g., NAFO Area 14 was re-opened in 2019). CCAMLR has arguably done the most to protect benthic organisms related to VMEs by banning the use of bottom trawl and bottom gillnet gears on the high seas and instituting a range of assessment measures. By contrast, SIOFA has made the least progress. Only five SIOFA areas have been closed to bottom trawling to protect VMEs (but they have been opened

to long-line fishing), and the key bottom fishing measure adopted to date together with many of its requirements is only interim (DSCC, 2020).

GFCM has created Fisheries restricted areas (FRAs), a specific area-based management tool to protect VMEs in the region. Four areas have been closed to bottom fishing as a result of FRA designations, including the only seamount extant in the Mediterranean. GFCM has also banned bottom trawling in the Mediterranean Sea below 1000 m. Nevertheless, it has only been in the past few years that the GFCM has begun working towards formally implementing the specific actions called for in the UNGA resolutions, such as mapping VMEs in the Mediterranean, identifying a fisheries footprint, and developing an encounter protocol and move-on rule. A GFCM VME working group was established in 2017; its work is ongoing and the GFCM has begun collecting information on interactions with VMEs (e.g., reported catches of VME indicator species) (GFCM, 2021; DSCC, 2020). In addition, the GFCM database of sensitive benthic habitats and species was developed and launched in 2020 as a scientific tool to support the work carried out on deep-sea benthic ecosystems and EFH. The development of such a database represents one of the steps taken by the GFCM towards improving the management of deep-sea fisheries and preventing any potential adverse impacts that they may have on VME

Still, it appears that improvements need to be made regarding conservation measures, VME thresholds and the move-on-rule. In this regard, the DSCC (2020) has pointed out some issues such as RFMOs not taking into consideration scientific advice (NEAFC has rejected several recommendations from ICES in the past to close areas of VMEs), that thresholds are not working properly or are still too high (NEAFC has adopted a move-on rule but no VME encounters have ever triggered this rule so far) or that the list of VME indicators needs to be revised to include more species (as was the case with SPRFMO).

Regarding FAO Area 41 (SW Atlantic), the absence of an RFMO with a competence over bottom fishing also means that there is no multilateral forum for cooperation between States fishing in the area for the purpose of providing and debating scientific data, in order to prepare advice and agree on relevant regulatory measures. In this case, in line with the responsibilities of Flag States as reflected in the UNCLOS and in line with the UNGA provisions[4], nations should adopt and implement individual regulatory measures for their vessels, similarly to those implemented by the EU and Spain, based on scientific research. However, unilateral measures adopted by a particular flag State are only binding on its vessels, and therefore would not be very effective in protecting VMEs if the other actors of the fishery did not implement similar measures (Durán Muñoz et al., 2012). Only the by-catch of VME indicators (corals and sponges) is regulated for EU

[4] In particular UNGA Resolution 61/105 of 2006

Member States. The VME encounter protocol is similar to the one established for the North Atlantic RFMOs, with the same threshold values. An encounter with VME indicator species is defined as catch per set of more than 7 kg of sea pens and/or 60 kg of other live coral and/or 300 kg of sponges[5].

Summary of bycatch avoidance and mitigation measures implemented in RFMOs

The measures identified in the comparative analysis are shown in the table below.

Sharks and rays	Marine mammals	Seabirds	Benthic organisms related to VMEs
Direct measures:			
Bycatch limits: • for sharks, rays and skates (CCAMLR), • for only a subgroup of elasmobranchs (NAFO) • for single species (NEAFC), • in exploratory fisheries (SPRFMO) **Move-on rule** (CCAMLR, SPRFMO) **Live release** (CCAMLR, NAFO, NEAFC)	**Exclusion devices** (CCAMLR) **Live release** **Prohibition of offal and discards during net shooting and hauling** (CCAMLR) **Mitigation of depredation:** • Minimization of net exposure, avoidance of net maintenance in the water (CCAMLR) • Avoidance of hauling longlines in the presence of cetaceans (SIOFA)	**Bycatch limits** (CCAMLR) **Bycatch thresholds to revert to night setting** (CCAMLR, SIOFA) **Live release** (CCAMLR, SIOFA, SPRFMO) **Prohibition of net monitoring cables** (trawl gears) (CCAMLR, **Use of scaring lines and bird exclusion devices** (GFCM, SIOFA, SPRFMO) **Minimization of illumination directed out from the vessel and night setting** (CCAMLR, GFCM, SIOFA, SPRFMO) **Prohibition of offal and discards during net shooting and hauling** (CCAMLR, GFCM, SPRFMO) **Adoption of gear configurations that minimize encounters** (CCAMLR, SIOFA, SPRFMO) (Increasing weighting or decreasing buoyancy, placing coloured streamers or other devices)	**Area closures** (All RFMOs) **Bycatch thresholds and move-on rule** (All RFMOs except GFCM)

[5] Threshold values indicated in the fishing permit provided by the Spanish fisheries administration. These values are similar to established in the Northwest Atlantic (NAFO, 2021).

		Mitigation of depredation: • Minimization of net exposure, avoidance of net maintenance in the water (CCAMLR)	
Indirect measures:			
Limit fishing effort **Data collection:** Observer Programme **Gear prohibition:** Gillnet ban (CCAMLR, SEAFO, SPRFMO, NEAFC) **Depth limitations** e.g., Bottom trawling beyond 1000 m (GFCM) or beyond 1500m (NPFC) **Research to fill knowledge gaps**			

Critical assessment of identified measures

In this section, the main bycatch avoidance and mitigation measures are discussed for each group (i.e., Sharks and rays, marine mammals, seabirds and benthic organisms related to VMEs). For each measure, we present an overview, its pros and cons and the available evidence on its effectiveness.

It is important to note that there is no one-size-fits-all solution to bycatch problems, and that an array of measures is better for addressing bycatch problems. The specific characteristics of each fishery—physical, biological and socio-economic—dictate what combination of measures are most appropriate, and most likely to lead to a successful bycatch minimization outcome. Various combinations have been seen to work in different settings, and the formulae depend not only on issues related to the fishery, but also factors external to this, such as political settings and priorities, and government financing and constraints (Bache, 2003).

Sharks and rays

Bycatch limits and move-on rules

Overview

Bycatch limits for some species of sharks and rays have been set in CCAMLR, NAFO, NEAFC and SPRFMO. CCAMLR, NAFO and SPRFMO have also adopted move-on rules related to sharks and rays.

CCAMLR has currently in place bycatch limits and move-on rules in toothfish fisheries for skates and rays (CM 33-02, CM 33-03, CM 41-03 and CM 41-09) and a move-on rule also applying to sleeper sharks, *Somniosus* spp. in CM 33-02 (See Annex I – CCAMLR for details). In CCAMLR, bycatch limits for sharks and rays have been set considering historical data and as precautionary limits (e.g., exploratory toothfish fisheries), as advised by the Scientific Committee (Working Group on Fisheries Stock Assessments - WGFSA) (See Appendix I – CCAMLR). Dedicated tagging programmes for skates and rays have been and are in place to assess the status of their populations. An example of this is the "Years of the Skate", carried out during fishing seasons 2008/2009 and 2009/2010 in al toothfish fisheries in the Convention area. (CCAMLR, 2008: Annex 5). Bycatch limits for skates and rays are assessed yearly by WGFSA (e.g., CCAMLR 2007 WGFSA Report, para 6.5)

In **NAFO** bycatch for skates is 2500 kg or 10%, whichever is the greater (listed in annex I.A of NAFO CEM). There is a **move-on rule** when the bycatch limits exceed the greater of the limits specified above (See Annex I – NAFO for more details).

In exploratory toothfish fisheries in **SPRFMO** (CMM 14a-2019, CMM 14d-2020, CMM 14e-2021) bycatch limits and move-on rules have been established. For example, in exploratory fisheries for toothfish by EU vessels, if more than 4 individuals of any of the following families Somniosidae, Lamnidae, Cetorhinidae, Alopiidae are caught or if more than 2 individuals of any one of these families of sharks are caught in one haul or set, the vessel shall move on for the duration of the trip, and a next line shall not be set closer than 5 nm from the centre of the preceding line. These are precautionary bycatch limits. Also, if the retained skate bycatch exceeds 5% of the toothfish catch or reaches a maximum of 100 kg in any one haul or set, the vessel will move-on to another location at least 5 nm distant. These limits were established based on CCAMLR approach (CM 41-03).

Pros

- Bycatch limits are widely used as bycatch mitigation measure. These limits allow for the regulation of a range of impacts upon a threatened species such that they do not endanger the continued survival of the species or population (Bache, 2003).
- This measure is part of the main tools recommended for bycatch management in the FAO International Guidelines on Bycatch management and Reduction of Discards (FAO, 2011), especially in fisheries where bycatch is unavoidable.
- When bycatch limits are set, then once the limit is reached some form of action will be triggered (e.g., closure of fishery, altering fishing methods, penalty applied, etc.). This approach places pressure on fishers to avoid bycatch and encourages them to improve their fishing operations and methods (Bache, 2003).

Cons

- In setting effective bycatch limits, a good knowledge of population being affected by bycatch is needed. Important factors that need to be considered are:
  - the relative health of the population under consideration (e.g., stable population, declining population, vulnerable of threatened population, etc.
  - the reproductive rate or rate of replenishment of the bycatch population; and
  - the impact of the target operation on the bycaught population.

  Many times, the populations affected by bycatch are not well studied, hence it is difficult to determine meaningful bycatch limits. Where information on the bycatch populations is limited, bycatch limits and quotas should be set in accordance with the precautionary approach (FAO, 2011).

- Setting effective bycatch limits requires a good characterization of the fishery and sufficient and accurate bycatch data, which is often not available. For instance, the sample design and data collected requires a consideration of biases, the level of precision, representativeness of samples, observer effects, and other uncertainties (Bache, 2003).
- One of the concerns of using dynamic closures (such as move-on rules) is the potential displacement of effort to other areas, which would reduce or eliminate the supposed benefits of the move-on rule (Dunn et al., 2013). Therefore, bycatch levels and its distribution must be monitored to determine if move-on rules are being effective in reducing bycatch, and not only re-distributing the problem.
- Many of these conservation measures relating to bycatch species in RFMOs may be based on outdated information, or adopted as precautionary measures until information became available, and need to be updated. For example, SPRFMO (2019c) has recognized the need to adopt a precautionary approach for shark bycatch until improved assessments and estimates of sustainable yields are available and allow informing the level of reductions in shark bycatch required to mitigate any potential risk for overexploitation, particularly for species assessed to be at high and extreme risk that may be retained as by-product. CCAMLR has also recognized this problem and has encouraged its members to provide updates where new data exists (WGFSA 2018 WG-FSA-18/63 – CCAMLR, 2018b).

Evidence of effectiveness

In 2018, the WGFSA (CCAMLR, 2018b) reviewed the implementation of the bycatch move-on rules in fisheries between 2010 and 2018. WGFSA considered whether the current system of bycatch and move-on rules was achieving its objectives of protecting bycatch species and avoiding local depletion. It was noted that the move-on rule was an effective means of moving a vessel with high bycatch rates away from an area without affecting those vessels that had low bycatch rates. Move-on rules were also likely to move effort away from local regions of high bycatch density. However., the SC (CCAMLR, 2018b) has acknowledged that catch limits for bycatch within the exploratory fisheries are based on a ratio of bycatch to target species which was derived from historical *D. eleginoides* catch to bycatch ratio. It was noted that it was unclear whether bycatch limits that are based on a ratio of bycatch to target species are still the best option and alternative methods for setting bycatch limits may need to be developed and evaluated. Suggested additional measures include using region-specific bycatch limits and spatial management measures to reduce the impact on bycatch species in areas where they aggregate.

To improve effectiveness of move-on rules, an empirical approach could be used. For example, Dunn et al. 2013 developed a data-driven empirical approach to determine the distances and times for effective move-on rules in a New England Multispecies Fishery to reduce discards and maximize profits. In that study, it was determined that the use of empirical move-on rules could reduce catch of juvenile and choke stocks between 27 and 33%, and depredation events (e.g., by sharks and other predators) between 41 and 54%. However, to implement such empirical move-on rules, high-resolution spatio-temporal data (fishing effort and catch) are needed, which may not be available. To our knowledge, this approach has not been used in any of the reviewed RFMOs.

Live release

Overview

CCAMLR, NAFO and NEAFC consider live release of elasmobranchs in their conservation measures. For example, CCAMLR (CM 32-18 2006) establishes that any bycatch of shark, especially juveniles and gravid females, taken accidentally in other fisheries, shall, as far as possible, be released alive. For skates and rays, CCAMLR has established that skates and rays caught alive and with a high probability of survival should be released alive, by vessels, by cutting snoods, and when practical, removing the hooks, and the number should be recorded and reported to the Secretariat (CCAMLR CM 33/03 2021). In NAFO (Art 12 NAFO CEM), for example, it is established that vessels shall undertake all reasonable efforts to minimize incidental catch and mortality, and where alive, release Greenland sharks in a manner that causes the least possible harm. Also, in fisheries that are not directed at sharks, Contracting Parties shall encourage every vessel entitled to fly its flag to release sharks alive, and especially juveniles, that are not intended for use as food or subsistence.

Pros

- This measure is potentially effective in reducing the impacts of bycatch on many sharks and rays' species by reducing mortality.
- Some elasmobranchs are considered to have high survival rates, for practically any capture process, including lesser-spotted dogfish *Scyliorhinus canicula*, thornback ray *Raja clavata* and blue shark *Prionace glauca*. (Rodríguez-Cabello and Sánchez, 2017). Some studies have determined that survival rates for skates are high, for example, in CCAMLR there was a study conducted by the French-flagged autoline vessel Saint André (WG-FSA-14/05), and concluded that post-release skate survival was high.

Cons

- Live release is not feasible for many bycaught species of shark and rays. For example, thresher sharks *Alopias* spp., and hammerhead sharks *Sphyrna* spp., are prone to high rates of mortality when caught (Rodríguez-Cabello and Sánchez, 2017 and references therein). For deep-water sharks (e.g., *Somniosus* spp.), even if there is no evident damage upon release, there may be negative effects to their tissues (e.g., gas embolism disease) that result in the eventual death of the released animals (García et al., 2015). CCAMLR has reported that sometimes large caught sharks (e.g. *Somniosus* spp.) are already dead upon hauling, wrapped in the longline so this measure cannot always be applied (CCAMLR, 2018).
- There is uncertainty of the real benefits of applying this measure for many species of sharks and rays due to a lack of post-release survivorship studies. Tag-recapture or tag-telemetry programmes are required to properly estimate post-release mortality for discarded fish (Rodríguez-Cabello and Sánchez, 2017 and references therein).
- The techniques to release bycaught specimens are still under development Actually, several techniques have been tried unsuccessfully for releasing the sharks from the net; the industry is currently testing the use of hooks and lines to fish the sharks out of the net in order to release them (Fowler, 2016).
- Best handling practices for safe release of sharks must be followed, which requires the elaboration of guidelines adapted to the shark species bycaught in the fisheries of each RFMO and training of crew members. Many RFMOs managing highly-migratory species, such as the Western and Central Pacific Fisheries Commission and ICCAT have already elaborated such guidelines and integrated minimum handling requirements in their conservation measures (WCPFC, 2018; WCPFC, 2017; ICCAT, 2021).

Evidence of effectiveness

For species with high survival rates such as lesser-spotted dogfish, thornback ray, blue sharks, and some species of skates studies have shown that this measure is potentially effective in reducing the impacts of bycatch on their populations (e.g., Rodríguez-Cabello and Sánchez, 2017; CCAMLR 2014). Nevertheless, for deep-water sharks, the likelihood of survival of released specimens is very low given the great depths at which they are caught (ICES, 2020), which limits the effectiveness of this measure.

Several factors need to be taken into account when considering live release as a measure. The most important ones rely on the biological characteristics of the species: gill ventilation, swim bladder condition, metabolic flexibility, liver size and content, body size, reproductive stage, etc. Also important are factors related to the capture process and fishing practice: gear type, hook insertion point and tissue damage, soak time, catch depth, catch weight, handling injuries, time on the deck and others (e.g., Fowler, 2016). This knowledge can be obtained by conducting specific research on the biology of candidate species coupled with post-survival studies (e.g., tag-recapture or telemetry studies).

Marine mammals

Exclusion devices

Overview

Excluder devices are an additional section of netting or a rigid device placed between the entrance and the cod-end of the net to prevent nontarget species such as cetaceans from entering the net (front-located exclusion device) or cod-end (rear-located exclusion device). The aim of the device is to direct the bycaught animals to an escape panel/hatch in the net. Exclusion devices can be rigid or soft depending on the material they are made from. Rigid grids tend to be towards the back of the net and are usually a metal grate made of stainless steel. Cetaceans are prevented from entering the cod-end by the grid and excluded from the net via an escape panel (Read, 2021).

Exclusion devices have been mainly used for small cetaceans such as dolphins and pinnipeds (e.g., fur seals). The pros and cons for excluder devices have been determined by Read (2021), as part of a cost-benefit analysis of mitigation measures for the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS). The following list is mainly based on the results of that report and the FAP Guidelines to prevent and reduce bycatch of marine mammals (FAO, 2021).

Pros

- This measure is potentially effective in reducing bycatch mortality of cetaceans (mainly small cetaceans such as dolphins and pinnipeds), as animals are able to escape the fishing net. When properly designed for the concerned species, they tend to function adequately, at least in bottom trawls.
- Survival rate of dolphins able to escape is likely to be very high but there may be cryptic or unobserved mortalities)
- Once the design has been finalized and tested, there is very low additional costs to the fishery.
- These devices are integrated into the gear, so the easy to store

Cons

- The design of exclusion devices requires knowledge of both the target and bycaught species including their size and behavior (spatial and temporal) to ensure that the bycaught animals are excluded whilst ensuring that there is no loss to the quality of the catch or the CPUE.

- Exclusion devices need to be specific to the area, fishery and gear (e.g. pair trawl and single trawl would probably require different types of exclusion devices due to handling difficulties with the much larger net of a pair trawl). The design needs to ensure that the target species (and other similar sized species) will pass through the grid but the large bycaught species are prevented. It can be challenging to design grids for cetaceans to escape in fisheries with large target species (e.g. potential for grids to get blocked).
- Welfare issue for animals unable to escape or getting entangled/injured in the escape panel. Unobservable and unreported cryptic mortality may occur with exclusion devices due to injuries incurred during interactions with devices or because dead animals may fall out escape openings, although scientific evidence has shown that cryptic mortalities from direct interactions with top-opening, hard-grid exclusion devices are unlikely.
- General lack of baseline knowledge required for effective application of exclusion devices, e.g., when are the animals entering the trawl: during deployment, fishing operation or hauling of the gear?
- The type of exclusion device is important. Flexible grids are likely to become distorted during fishing resulting in fish losses, adverse effect on the fisheries target species (e.g. reduction in the quality of the catch) and an increased risk of bycatch.
- Potentially difficult to install, maintain and handle in large trawling nets. For example, in 2017/2018 the CCAMLR WGFSA reported an increased mortality of Antarctic fur seals in the krill fishery. The report stated that an ineffectively attached marine mammal exclusion device (MMED) may have contributed to the issue the Working Group encouraged trawl vessels to inspect their MMED in the event of any marine mammal mortality to ensure that it is in structurally good order and correctly attached.
- Expensive video surveillance may be required to determine bycatch rate and effectiveness of the exclusion device(s).
- Development of the exclusion device/grid is likely to be expensive, although once completed, cost to fishery is minimal
- Attaching exclusion devices to the gear may increase drag and, therefore, fuel costs.
- May reduce target catch causing economic losses to fishers.

Evidence of effectiveness

It is widely accepted that appropriately designed exclusion devices successfully prevent mortalities of a range of non-target marine species in nets without significantly impacting target catch (Hamilton and Baker 2019 and references therein), although there are differing outcomes for pinnipeds and cetaceans. For example, top-opening, hard-grid exclusion devices have effectively reduced pinniped bycatch in a number of trawl fisheries (CCAMLR 2017; Hamilton and Baker 2015, Hamilton and Baker, 2019 and references therein). However, this measure has shown limited success in reducing cetacean bycatch (Hamilton and Baker, 2019).

In CCAMLR, three Antarctic fur seal were killed in the krill fishery in 2017/18. This was likely caused by an ineffectively attached marine mammal exclusion device. Since exclusion devices have been highly effective in reducing marine mammal mortalities (pinnipeds), the CCAMLR WGFSA encouraged trawl vessels to inspect their exclusion devices in the event of any marine mammal mortality to ensure that it is in structurally good order and correctly attached (CCAMLR, 2019).

Live release

Overview

This measure refers to releasing bycaught marine mammals, for example, from entanglements in fishing gear.

Pros

- This measure is potentially effective in reducing bycatch mortality of marine mammals

Cons

- Bycaught animals are often injured, retain or ingest hooks, or remain entangled in gear (Hamilton and Baker, 2019 and references therein). Post-release survival requires more documentation.
- A high level of competence and preparedness (which includes having the right equipment on hand) is required because this has a significant positive impact on post-release survival. In the fishery context, formal, regular and structured training is needed.
- Fishing crews who are not trained in proper handling and release techniques may also unintentionally cause further harm to animals as they attempt to set them free, or put themselves in danger by engaging in unsafe practices, such as entering the water with the animals (FAO, 2021). As with sharks and rays, best handling practices for safe release of marine mammals must be followed, which requires the elaboration of guidelines and training of crew members (e.g., Guidelines for the safe and humane handling and release of bycaught small cetaceans from fishing gear by Hamer and Minton,2020).

Evidence of effectiveness

In general, there is a lack of information on the post-release health and survival of marine mammals that are injured, retain or ingest hooks, or remain entangled in gear (Hamilton and Baker, 2019 and references therein). Thus, the actual effectiveness of this measure is not known and needs to be assessed through research. For example, carrying out surveys using photo-identification of tagging studies (e.g., telemetry) could be useful. McHugh et al (2021) recommend using satellite-linked tracking of released animals where direct follow-up observations on individuals post-release are unlikely. This provides short to medium-term information on survival, movements, and behavior allowing for likely outcomes to be identified, and facilitating further interventions if warranted. In gillnet gear, bycaught cetaceans often experience high mortality, since they cannot reach the surface to breathe, so this measure cannot be applied.

<u>Measures to mitigate depredation</u>

Overview

Depredation refers to interactions between marine mammals and fishing operations that to occur when marine mammals actively seek to prey on fish captured in fishing gears. Longline catch and bait can attract species of toothed cetaceans such as sperm whales (*Physeter macrocephalus*), killer whales (*Orcinus orca*), pilot whales (*Globicephala* spp.), and false killer whales (*Pseudorca crassidens*) (FAO, 2021). Associations between cetaceans (e.g., sperm and killer whales) and longline vessels have been recorded in longline fisheries around the world. The relationship is complex and difficult to quantify. Although the highest numbers of associating cetaceans can coincide with very high catch rates, it is generally accepted that the presence of toothed whales has a negative impact on fish catch. For example, CCAMLR WG-FSA-2019/33 presented estimates of *D. eleginoides* catches removed by killer whales and sperm whales when depredating on longlines in four CCAMLR areas (Subareas 58.6 and 58.7 and Divisions 58.5.1 and 58.5.2) and two fisheries outside the CCAMLR area in Chile and the southwest Atlantic. Using generalized additive models (GAMs) fitted to the catch-per-unit-effort (CPUE) data, the results indicated that whales removed a total of 6 699 tons of toothfish, equivalent to around 10% of the total catches over the 2009–2016 period.

Some of the RFMOs in this review have implemented some measures to mitigate depredation, such as the minimization of net exposure and avoidance of net maintenance in the water (CCAMLR) and avoidance of hauling longlines in the presence of cetaceans (SIOFA). These measures are also recommended by ACAP, because they are effective for reducing depredation by seabirds (ACAP, 2021a)

One of the most effective measures implemented in the last decade to mitigate depredation in longline fisheries is the Chilean longlining method (trotline with nets). This is a variant of the traditional Spanish double line method of longlining and was developed in Chile to minimize depredation of Patagonian toothfish by toothed whales. This system makes use of net sleeves or 'cachaloteras' which envelop captured fish during hauling. Because of its effectiveness in reducing impacts of toothed whales, this method is currently used in many longline fleets operating in South American waters (Moreno et al. 2008) and in the south west Atlantic (ACAP, 2021b). Vessels participating in Patagonian toothfish fisheries in CCAMLR also use this method. The driving force behind the development of the Chilean System was depredation by cetaceans. Trials indicate that this system successfully deters whales from taking fish from the lines. The following pros and cons refer mostly to this measure (Chilean longlining method), according to FAO (2021).

Pros

- Some evidence shows reduced depredation rates.
- The cost of new equipment may be at least partially offset by an increase of retained catch (neither removed nor partially eaten through depredation).
- Continued and persistent use of these devices possibly alters depredation. behavior in marine mammal populations.
- Better catch quality and higher catch retention rate.

Cons

- Over time, cetaceans could become habituated to the net shrouds and resume fish depredation.
- Units can sometimes fail to release components that encapsulate target catch, or become tangled.
- The Chilean System requires a considerable restructuring of the fishing gear. Once adopted, the mitigating effect of the gear is integral to the day-to-day fishing operations.
- Deployment takes additional time and results in increased labor time and operating costs.

Evidence of effectiveness

At present, the Chilean longlining system has shown great potential as a deterrent to cetacean depredation of target catch and as a means of seabird bycatch mitigation (FAO, 2021). Continued monitoring is required to observe the interactions between the Chilean System gear and cetaceans.

Other measures

Spatial closures can be effective in reducing interactions between marine mammals and fishing gear in areas where they both occur. This applies especially in areas where marine mammals aggregate, such as breeding grounds, areas with seasonal prey abundance, migration corridors, or other critical habitats. Spatial closures ban or restrict fishing within all or a subset of a particular fishing zone, permanently or for a defined period of time (FAO, 2011). The most restrictive are permanent closures, which are applied to all fisheries (e.g., marine protected areas that prohibit fishing and no fishing zones). Temporal closures can restrict fishing activity seasonally (seasonal or rolling closures). Regardless of the type of closure, it needs to be of an appropriate scale to meet management objectives. In other words, it must be located in the right places, or take place at the right times, be effectively managed and enforced to remove the principal threats, avoid introducing new threats, and consider the dynamic nature of the fishery and habitats used by marine mammals over time (FAO, 2018). Spatial closures for marine mammals have not been implemented in any of the RFMOs reviewed in this document. This measure could be considered by RFMOs, but many of them still lack appropriate knowledge on the abundance and temporal-spatial distribution of marine mammals which is necessary to establish spatial closures. Some of the pros and cons of this measure, as listed by FAO (2021), are:

Pros

- Eliminates all or nearly all bycatch within the designated area (when effectively enforced).
- May have other ecosystem benefits during the period the closure is in effect, such as avoiding environmental consequences from fishing or helping to rebuild fish populations.

Cons

- Does not always achieve the ultimate conservation benefit of population recovery.
- Requires reliable information on marine mammals (such as foraging areas) and fisheries activity, as well as effective management, monitoring and enforcement.
- Benefits limited to the designated area(s) Can concentrate fishing effort outside the boundary in a small area, which can increase bycatch.
- Generally unpopular with fishers, who become excluded from their preferred fishing grounds.

Acoustic devices. Acoustic deterrents consist of a range of devices that either emit sounds, using electrical or mechanical means, or acoustically reflect those emitted by echolocating cetaceans. These devices may be deployed on or near fishing gear and include categories referred to as pingers, acoustic harassment devices (including seal-scarer devices), and acoustic alerting devices. Their intended use is to enhance detection of fishing gear by those cetaceans that echolocate for prey detection and other reasons: to do so, they may create an alert or unappealing sound that causes animals to avoid the sound source, or associate it with an obstacle to avoid (FAO, 2021).

These acoustic devices are mainly used in gillnet fisheries, which are banned in many of the reviewed RFMOs in this document (CCAMLR, NEAFC, SEAFO and SPRFMO). However, this measure can be considered for other RFMOs, such as GFCM. For example, in the GFCM area of application, it seems pingers could have a positive effect on reducing the bycatch of Black Sea harbour porpoises (*Phocoena phocoena relicta*) in the Black Sea turbot gillnet fishery and for other cetacean species (Carpentieri et al. 2021).

Some of the pros and cons of this measure, as listed by FAO (2021), are:

Pros

- Have demonstrated reduction in marine mammal bycatch for some species, and in some cases over many fishing seasons.
- Do not tend to affect target catch.
- Supported by a range of studies involving field trials, behavioural responses, and fisheries monitoring.
- Produced by a number of manufacturers with different models, some of which continue to receive upgrades to battery life, LED indicators that confirm proper function, modified duty cycles, and other features.
- Help reduce depredation by pinnipeds with increased sound frequency.

Cons

- Do not work for all species.
- Effect may be nullified or reduced depending on where they are deployed.
- In a few cases, species or populations may habituate, in which case the deterrent effect no longer works without adjustments (e.g. change in sound frequency).
- May overly ensonify an environment and exclude some marine mammals from critical habitats when used at a large scale.
- Requires units that are functioning properly and spaced correctly to avoid the risk of increased bycatch.
- Some units emit high power outputs that can cause hearing impairment and other adverse health effects to marine mammals.

- When implemented, the level of bycatch reduction generally tends to be lower than that recorded in scientific trials; the use of acoustic deterrents is therefore a less suitable option for highly endangered species.
- When implemented, the level of bycatch reduction generally tends to be lower than that recorded in scientific trials; the use of acoustic deterrents is therefore a less suitable option for highly endangered species.
- There are reports that pingers can pose risks to fishermen, as devices have been known to explode during hauling, owing to increased gear weight.
- At certain frequencies, pingers may lead to increased depredation and bycatch through the "dinner bell effect".

Evidence of effectiveness

According to FAO (2021) the most critical consideration is whether or not these deterrents elicit a behavioural response in a particular species such that bycatch is prevented or substantially reduced. Evidence shows that acoustic deterrents do not necessarily elicit a behavioural response that reduces bycatch for every marine mammal species. FAO (2021) has compiled a list of the species for which pingers have been shown to be effective in reducing bycatch or causing area avoidance:

- harbour porpoise
- striped dolphin (Stenella coeruleoalba)
- franciscana dolphin (Pontoporia blainvillei)
- several beaked whales (Ziphiidae family) – Cuvier's, Hubb's, Stejneger's and Baird's beaked whale

For other species, pingers appear to reduce bycatch but there is not enough evidence yet regarding the effectivity of pingers (e.g., g Burmeister's porpoise—*Phocoena spinipinnis*, North Atlantic right whales and humpback whales —*Megaptera novaeangliae*). Pingers seem to be ineffective forsome species that are actually attracted to pinger sounds (e.g., bottlenose dolphin—*Tursiops truncatus*).

Seabirds

Bycatch limits and bycatch thresholds to revert to night setting

Overview

Bycatch limits for seabirds have been only established by CCAMLR. In CCAMLR, a bycatch limit is set for birds in the icefish fishery in Subarea 48.3. Should any vessel catch 20 or more birds in a season it shall cease fishing (CM 41-02).

Bycatch thresholds to revert to night settings have been established in CCAMLR and SIOFA. In both RFMOs, limits are set on the longline fishery in some areas where daylight setting is allowed. Should a vessel catch 3 or more birds it must revert to night setting only (CM 41-04 to 41-11 in CCAMLR and CMM 2019-13 in SIOFA).

Pros and cons

See above (Bycatch limits for sharks and rays)

Evidence of effectiveness

No information of the effectiveness of this specific measure was found, because it is applied together with other measures in this fishery (CM 25-03 that sets out technical measures to minimize bird bycatch regarding net monitoring cables, vessel lighting, discarding of offal, net cleaning, net sinking and streamer lines). However, in the case the bycatch limits were reached, it would be effective in preventing further damage to the seabird populations.

<u>Minimization of illumination directed out from the vessel and night setting;</u>

Overview

Seabirds generally detect food at close range by sight. Consequently, they feed mostly during daylight hours and are least active at night. Setting lines at night is therefore a simple but highly effective way of reducing seabird bycatch and bait loss (BirdLife and ACAP, 2019). In longline fisheries incidental mortality occurs mainly during setting, when the birds attempt to feed on the baited hooks, get hooked or entangled and drown as the gear sinks to its fishing depth.

Pros

- Reduces incidental mortality of birds that forage during the day (e.g., albatross) and in combination with other measures (e.g., scaring lines and weighted lines), it also reduces bycatch of seabirds with different foraging behavior.

Cons

- Not equally effective for all seabirds. Less effective for crepuscular/nocturnal forgers such as the white-chinned-petrel. In fact, it increases the bycatch rate of Northern Fulmar (*Fulmarus glacialis*) (ACAP, 2021 and references therein).
- Bright moonlight and deck lights reduce the effectiveness of this mitigation measure (BirdLife and ACAP, 2021).
- Night setting is not a practical option for fisheries operating at high latitudes during summer because the time between nautical dusk and dawn is limited (BirdLife and ACAP, 2019; ACAP, 2021).
- The effect of night setting on catch rates of target species for different fisheries needs to be assessed.

Evidence of effectiveness

- Setting longlines at night (between the end of nautical twilight and before nautical dawn) is effective at reducing incidental mortality of seabirds because the majority of vulnerable seabirds are diurnal foragers (ACAP 2021). The effectiveness of night setting is well documented in regional studies and has recently been confirmed on a large and temporal scale in a recent study (Jiménez et al. 2020 and references therein). In their study, Jiménez et al. 2020 analyzed observer data from longline fisheries obtained by scientific observer programs onboard several longline fleets operating in the south Atlantic and southwestern Indian Oceans over a period of 15 years (2002–2016). In this study, night setting was more effective for albatross than for other species, such as petrels, because they have different foraging behaviors. Albatrosses are less active at night, increasing their foraging activity only with a brighter moon, while white-chinned petrels forage during the day and night without the influences of the moon phases (Jiménez et al. 2020). This measure produces the best mitigation scenario in combination with the use of line weighting regimes (in longlines) and bird scaring lines (ACAP, 2021). Also, to maximize effectiveness, deck lighting should be kept at the minimum level appropriate for crew safety and directed inboard so the line is not illuminated as it leaves the vessel (BirdLife and ACAP, 2021).

<u>Live release</u>

Overview

This measure refers to releasing bycaught seabirds, for example, those entangled in fishing gears. This measure has been implemented by some of the RFMOs, like CCAMLR, SIOFA and SPRFMO.

Pros

- Live release may reduce incidental mortality of seabirds and lessen the negative impacts of fishing on their populations.

Cons

- As with elasmobranchs and marine mammals, bycaught animals are often injured, retain or ingest hooks, or remain entangled in gear and this affects their post-release survival.
- Post release survival seems to vary among different species. For example, wandering albatrosses appear to survive less after being released (Philips and Wood, 2020).

- Fishing crews who are not trained in proper handling and release techniques may also unintentionally cause further harm to animals as they attempt to set them free

Evidence of effectiveness

Studies regarding post-release survival for bycaught seabirds are scarce. A recent study by Philips and Wood (2020) has examined live captures reports of albatrosses and petrels ringed at South Georgia that were caught during fishing operations and released alive, together with their ringing and resighting histories, and; observations of birds seen at the breeding colony with embedded hooks or entangled in line. In this study, subsequent survival rate of live-caught birds relative to the wider population were determined. Their results indicate that subsequent survival of live-caught and released wandering albatrosses was around 40% of that expected for the wider population.
Studies using tracking devices would be useful for determining survival in weeks or months following release. However, these types of studies can be expensive and difficult to carry out. For example, transmitters would need to transmit to the ARGOS satellite system, (or via GSM if network coverage is available), or to a base station if the colony of origin is known. There is a high cost of devices and ARGOS time (limiting sample sizes). Also, it would require the availability of an on-board observer with experience of attaching devices on the infrequent occasions when birds are live-caught during routine fishing operations and the development of methods to avoid the loss of transmitters (Phillips and Wood, 2020).

<u>Prohibition of net monitoring cables (for trawl gears)</u>

Overview

In trawl fisheries, high levels of seabird mortality have been associated with collisions with warp cables and net monitoring cables (also knowns as netsonde or third-wire). The net monitoring cable is an electronic connection between the vessel and the net sounder monitoring system on the headline of the trawl (Løkkeborg, 2011) The use of this equipment is currently banned in several regions (e.g., New Zealand and CCAMLR). Mortalities caused by cable strikes mainly result from birds being dragged underwater when their wings become entangled around the trawl cable, whereas aerial collisions with cables have little impact on birds (Watkins et al. 2008).

Pros

- Helps reducing incidental mortality of seabirds in trawl fisheries.

Cons

- Need to use other methods in the fishing vessel to control depth and gear performance underwater of the trawl.

Evidence of effectiveness

This measure directly eliminates the risk of birds colliding with these types of cables. Where such a measure cannot be implemented, ACAP (2021) recommends: i) deploying bird scaring lines specifically positioned to deter birds away from net monitoring cables while fishing; and ii) installing a snatch block at the stern of a vessel to draw the net monitoring cable close to the water to reduce its aerial extent.

Use of scaring lines and bird exclusion devices (brickle curtains)

Overview

Streamer line (bird scaring line, tori line). This is a line attached to a high point at the stern and towed behind the vessel while longlines are set. The terminal end of the line has a towed device (e.g., buoys) to create drag and streamers are attached to its aerial portion above the sinking longline. The movements of the streamers deter seabirds from attacking baited hooks (Løkkeborg, 2011).

A Bird Exclusion Device (BED) consists of a horizontal support several metres above the water that encircles the entire hauling bay. Vertical streamers are positioned between the horizontal support and water surface. The BED configuration can also include a line of floats on the water surface connected to the vertical streamers to stabilize movement in strong winds. This configuration is the most effective method to prevent birds entering the area around the hauling bay, either by swimming or by flying. BEDs are retrieved and stowed when not hauling (ACAP, 2021).

Pros

- Scaring lines and bird exclusion devices are a proven and recommended method to reduce interactions of seabirds with fishing gears (ACAP 2021 and references therein).
- The use and specifications/performance standards of scaring lines are fairly well established in demersal longline fisheries.
- BEDs form a physical and visual barrier around the area where line hauling occurs and prevent seabirds from accessing baited hooks during line hauling.

Cons

- The effectiveness of the bird scaring lines is dependent on the design, proper placement, as well as seabird species attending line setting (proficient divers are more difficult to deter than surface feeding birds). It is effective only when streamers are positioned over sinking hooks and the aerial extent matches the distance astern that seabirds can access baited hooks (ACAP, 2021).
- Streamer lines are likely to be less efficient in reducing bycatch of diving seabirds, particularly in pelagic fisheries, as birds may still reach baited hooks

beyond their aerial extent. This deficiency may be significantly reduced by using weighted longlines in combination with streamer lines (Løkkeborg, 2011; ACAP, 2021).

- Streamer lines can also be less efficient under conditions of strong crosswinds that can blow the streamers to the side of the longline, leaving baited hooks exposed to seabirds.
- There have been a few incidents of birds becoming entangled in bird scaring lines (Otley et al. 2007).
- A practical problem with streamer lines is entanglement with the longline gear

Evidence of effectiveness

The use of a single bird scaring line has been shown to be an effective mitigation measure in a range of demersal longline fisheries, especially when used properly. Several studies have shown that the use of two or more streamer lines is more effective at deterring birds from baited hooks than one streamer line (ACAP, 2021 and references therein). Effectiveness is when used in combination with other measures – e.g., night setting, appropriate weighting of line and offal management.

The use of bird exclusion devices is effective as mitigation measure when hauling the longlines. BEDs must be used in combination with line setting mitigation measures – bird scaring lines, line weighting, night setting and offal management. The use of a BED can effectively reduce the incidence of birds becoming foul hooked when the line is being hauled (ACAP, 2021 and references therein).

<u>Prohibition of offal and discards during net shooting and hauling</u>

Overview

Seabirds (and also marine mammals – e.g., Johnson et al., 2020) are highly attracted to offal discharged from vessels. To prevent large numbers of seabirds attending line setting operations, offal and discards should be retained onboard prior to and during line setting. This is a measure that seeks to reduce general attractiveness of the fishing activities to seabirds (ACAP, 2021). In CCAMLR demersal fisheries, discharge of offal is prohibited during line setting. During line hauling, storage of waste is encouraged, and if discharged must be discharged on the opposite side of the vessel to the hauling bay. A system to remove fish hooks from offal and fish heads prior to discharge is required. Similar requirements are prescribed by other demersal longline fisheries (e.g. Falkland Islands (Islas Malvinas), South Africa and New Zealand (ACAP, 2021).

Pros

- This is a proven measure and it is considered as the most effective measure to reduce attractiveness of the fishing activities to seabirds. There is also good evidence from a number of fisheries that fish meal processing and reducing discharge to sump water is highly effective in reducing seabird bycatch. (ACAP 2021 and references therein).

Cons

Retrofitting of fish waste storage tanks and mealing plants may not be a viable option for existing vessels due to associated space requirements (Munro 2005).

Evidence of effectiveness

Discharge of offal and discards is the most important factor attracting seabirds to the stern of trawl vessels, where they are at risk of cable and net interactions. Managing offal discharge and discards while fishing gear is deployed has been shown to reduce seabird attendance of vessels and consequent risk of interactions and bycatch. The following offal and discard management measures, in order of their effectiveness in reducing bird attendance, are recommended by ACAP (2021):

1. Retention of waste – No discharge during fishing trips (full retention) should occur. When this is impracticable (e.g., lack of storage space in the vessel), no discharge should occur during fishing activity (when cables or net are in the water);
2. Mealing waste – Where retention of waste is impracticable, converting offal into fish meal, and retaining all waste material with any discharge restricted to liquid discharge / sump water;
3. Batching waste – Where meal production and retention of offal and discards are impracticable, waste should be stored temporarily for two hours or longer before strategically discharging it in batches;
4. Mincing of waste – Where retention, mealing or batching is impracticable, reduce waste to smaller particles (currently only recommended as a mitigation for bycatch of large albatrosses *Diomedea* spp.).

Repeated studies have shown that in the absence of offal discharge/fish discards seabird interactions and mortality levels are negligible (Sullivan et al. 2006; Melvin et al. 2010; Abraham & Thompson 2009, Pierre et al. 2012). Storage of all fish discard and offal, either for processing or for controlled release when cables and net are not in the water, has resulted in significant reductions in the attendance of all groups of seabirds (Abraham et al. 2009). Any discharge is restricted to times when cables and net are out of the water. Management of offal and discharges should be used in combination with additional mitigation methods to mitigate interactions with cables (if birds are still attending the vessel) and net.

<u>Line weighting</u>

Overview

In demersal longline fisheries, lines are weighted in order to deliver hooks to the target fishing depth as efficiently as possible and maintain the line on the seabed. Demersal longline gear can be configured in various ways (e.g., autoline system and Spanish system), each with different weighting requirements.

Pros

- Line weighting is an essential component of seabird bycatch mitigation strategies, being one of the more effective known mitigation measures (a primary measure) (BirdLife and ACAP, 2014). Best practice weighting regimes should result in rapid initial line sink rates that will reduce the likelihood of seabird bycatch.

Cons

- Spanish system longlines are buoyant and weights must be attached to sink gear to fishing depth. Longlines with externally added weights sink unevenly, faster at the weights than at the midpoint between weights. (ACAP, 2021)
- Weights must be attached and removed for each set-haul cycle, which is onerous and potentially hazardous for crew members. Weights comprised of rocks enclosed in netting bags and concrete blocks deteriorate and require ongoing maintenance/replacement and monitoring to ensure weights are the required mass (Otley et al., 2007); weights made of solid steel are preferred, in terms of mass consistency, handling, maintenance and monitoring compliance (ACAP 2021 and references therein)
- Global minimum standards have not been established. Requirements vary by fishery. For example, CCAMLR minimum requirements for vessels using the Spanish method of longline fishing are 8.5 kg mass at 40 m intervals (if rocks are used), 6 kg mass at 20 m intervals for traditional (concrete) weights, and 5 kg weights at 40 m intervals for solid steel weights. (ACAP, 2021)
- More research is needed to understand sink rates and sink profiles of line weighting regimes, because these may vary according to vessel type, setting speed and deployment position relative to propeller turbulence. It is important that the sink rate relationships of different line weighting regimes are understood for a particular fishery (or fishery method) and that testing confirms the effectiveness of the line weighting regime and the sink profile in reducing seabird mortality. (ACAP, 2021)

Evidence of effectiveness

The Chilean method (trot line with nets) effectively prevents mortality as a sole measure given that hooks sink quickly from the surface, it is prudent to also deploy a bird scaring streamer line (ACAP, 2021). However, this is a relatively new system, is possibly still in the evolutionary stages, and should be monitored and possibly refined. Concern has been raised about the excessive discarding of fish bycatch (e.g. grenadiers) with embedded hooks and the ingestion of these hooks by albatrosses especially with this gear type (Phillips et al. 2010). The solution to this problem is to stop hooks from being discarded. This is best achieved by banning the discarding of hooks as part of the licence conditions, as is already done in many fisheries, and also increasing awareness amongst fishers, observers, and operators to facilitate compliance with such a ban (ACAP, 2021).

The best practice weighting regimes are intended to take baited hooks beyond the diving range of seabirds while under the protection of a standard streamer line, without compromising catch rates. Specifying a desired sink rate should be an integral part of any performance standard. It is currently recognised that a sink rate of 0.3 m/s is desirable. To achieve this, the prescribed weighting regime will depend on the type and configuration of gear used. CCAMLR specify two line weighting options, 8.5 kg at 40 m intervals or 6 kg weights at 20 m intervals, following the aforementioned trials by Robertson et al. (2007). CCAMLR subsequently adopted a third line weighting option of 5 kg metal weights spaced at 40 m intervals. Achieving a desired sink rate is not just a matter of adding sufficient weight to a line. The way in which gear is handled and deployed influences the sink rate.

<u>Mitigation of depredation: Minimization of net exposure, avoidance of net maintenance in the water</u>

Overview

Pros and cons

Evidence of effectiveness

WG-FSA-2019/31 presented a final report on fishing effort and seabird interactions during three season extension trials (1–14 April, 1–14 November and 15–30 November) in the longline fishery for *D. eleginoides* in Division 58.5.2. Due to the application of effective seabird by-catch mitigation by participating fishing vessels, the overall risk of seabird mortality in this fishery was low with 20 mortalities in total reported between 2003 and 2018. The rate of seabird mortality in the core fishing season and the existing post-season extension from 15 September to 31 October was less than 0.0001 birds per 1 000 hooks (or less than 0.1 birds per million hooks). The rates of seabird mortality for the pre-season and two post-season extension trials were comparable to that during the existing pre-season extension from 15 to 30 April

Other measures

Area and seasonal closure.

As seabird mortality rates are generally higher close to breeding colonies during the breeding seasons, seasonal fishing closure is regarded as a fundamental factor in reducing seabird by catch in CCAMLR fisheries. This measure is applied in some high-risk areas such as South Georgia. There is, however, a risk that area or seasonal closures may displace fishing effort leading to increased mortality in other areas (Løkkeborg, 2011).

Area closures

Overview

VME area closures are typically designated based on known VME presence (VME as defined by the FAO guidelines) or seabed geomorphological characteristics typically associated with VME (e.g., seamounts and canyons). Ideally, VMEs would be identified by fishery-independent means (e.g., direct observations). In many cases, however, the only information available comes from VME indicator taxa that are landed on deck as bycatch in the course of fishing (Ardron et al. 2014).

Pros

- Closing areas to bottom contact gear is the only certain method for avoiding significant adverse impacts on VMEs (Wright et al. 2015 and references therein). This is a well-establish measure to protect VMEs and such closures are used by all of the reviewed RFMOs as the main measure to protect VMEs.

Cons

- The identification and delineation of the area closures is not a straightforward process. The FAO criteria for identifying VMEs are a useful starting point. However, they may need to be elaborated to be relevant to the specific taxa, habitats and fisheries in a given region.
- There is still a lack of empirical data on the distribution of VMEs within the high seas, which means that spatial management is often informed by model predictions of the spatial distribution of VME indicator taxa. Models, however, have a level of uncertainty associated.
- The VME closures typically represent only a proportion of the full extent (where known) of the VME present, especially where such areas coincide with a defined fishing footprint (e.g. NAFO, NEAFC) (Bell et al., 2018).
- In most cases, it is likely impossible to directly assess whether these areas are meeting their conservation objectives, since they usually lack the requisite baseline data to determine the effectiveness of management decisions (Bell et al., 2018).
- While area closures can offer protection from direct impacts of bottom-contact fishing gears, the long-term viability of the protected populations will depend on identifying and protecting sources of recruitment and connectivity pathways (Wang et al. 2020 and references therein)
- Area closures are likely to have negative impacts on fisheries. An ideal closure scenario protects all potential VMEs while having a minimal impact on fishing activities. In the designation process of area closures, the socio-economic trade-

offs between protecting VMEs and impacting fishing activities must be considered.

Evidence of effectiveness

Area closures are used by RFMOs as the main measure to protect VMEs. The value and effectiveness of "no-take" marine reserves is well-evidenced by the literature on marine protected areas, and studies have confirmed these benefits in the context of bottom fisheries closures in the high seas (Wright et al. 2015 and references therein). However, this measure's effectiveness depends on the correct identification and definition of the area occupied by a VME. As was mentioned above, there is still a lack of empirical data (e.g., from research surveys) on the distribution of VMEs and identification of VMEs relies many times in the results of distribution models.

The effectiveness of area closures can be improved by using explicit buffer zones. In the context of the protection of VMEs from significant adverse impacts of bottom-contact fishing gears, a buffer zone is considered to be "a spatial margin of assurance around the VME to avoid adverse impact" (ICES, 2013). For example, Grant et al., (2019) showed that sediment clouds produced during bottom trawling activities taking place outside of a conservation area in British Columbia (Pacific Canada) had an impact on glass sponges found at >2 km from the source, inside the conservation area. Such buffer zones have been used by ICES, for example, to ensure the protection of VME habitats distributed along the edge of the C-squares [6]containing VMEs in EU waters (ICES, 2020). To this regard, NAFO has recently applied a modified version of the ICES approach to creating buffer zones to the NAFO closed areas to explore whether that method could be used by NAFO to provide additional protection to the VMEs of SAI of fishing (NAFO, 2020).

Another important aspect to be considered for the effectiveness of closures is determining the connectivity among the areas closed to protect VMEs. Population connectivity refers to the exchange of individuals among populations: it affects gene flow, regulates population size and function, and mitigates recovery from natural or anthropogenic disturbances. Many populations in the deep sea are spatially fragmented, and will become more so with increasing resource exploitation. Thus, understanding population connectivity is critical for spatial management (Hilário et al. 2015). Benthic invertebrates under protection, are all sessile as adults but rely on larval transport for dispersal and persistence. In this context, there are source and sink populations: for a given species, good quality habitats yield a demographic excess (natality greater than mortality), and are designated as 'source'. Lower quality habitats yield a demographic

[6] C-square is a grid system. ICES uses a C-square resolution of 0.05° longitude by 0.05° latitude (about 15 km² (3km x 5km) at 60°N latitude). This resolution is a practical scale to collate, explore and assess data relating to fishing activities in the marine environment. Furthermore, it is the acceptable scale in terms of the confidentiality of data with respect to individual fishing vessels.

deficit (mortality greater than natality) and are designated as 'sink' (Dias, 1996). Larval retention in sink populations becomes very important to their persistence at least in the short-term, although such populations are susceptible to negative genetic consequences over generations (reduced fitness, inbreeding etc.). For this reason, effective area closures for the long-term conservation of VME must take into account connectivity. For example, NAFO has already started evaluating connectivity among areas closed to protect large-sized sponges, large gorgonian corals and sea pens (NAFO, 2020)

DSCC (2020) recently advised that the UNGA should recommend that sites where VMEs have occurred or were likely to have occurred in the past, but which may have been damaged or destroyed by bottom fishing, be placed off limits, at least to bottom trawling, and provided an opportunity to regenerate and potentially recover. To put this recommendation into practice, the first step would be to identify VMEs that existed and were damaged or destroyed and this may not be straightforward, because it would require the analysis of historical data (bycatch data or other records) that may not be available. To this regard, recent studies are exploring the use of habitat suitability models (HSM) to provide estimates for a pre-fishing baseline of the distribution and biomass of VME indicator taxa (Downie et al., 2021). In that study, it was possible to identify areas of suitable *Geodia* sponges habitat that are currently impacted by fishing, suggesting that past sponge habitats have been impacted by bottom trawling activities. Another aspect to consider with regards to this recommendation is the potential conflicts with the fishing sector that would see their fishing grounds diminish when new areas of closure are increasingly proposed.

<u>Encounter thresholds and move-on rules</u>:

Overview

Move-on rules, also referred to as encounter protocols, were initially instituted in the early 1990s in Canadian snow crab fishery and groundfish fisheries to reduce wastage of unmarketable catches of target species (Kenchington, 2011). In response to the UNGA requirements to 'prevent significant adverse impacts' to areas where VMEs are 'known or likely to occur', numerous RFMOs have adopted move-on rules as a first measure to prevent ongoing fishing in areas where 'evidence' of VMEs is encountered during fishing operations. These move-on rules require fishing vessels to move a predetermined minimum distance from locations where some pre-determined quantity of species indicative of VMEs are captured in fishing gear (i.e., encounter threshold) (Hansen et al. 2013). In the event that a fishing vessel exceeds this threshold (weight, volume and/or biodiversity) of VME indicator species, the general procedure followed by vessels (as established in most RFMOs) is to report the encounter, move away a certain distance (e.g., 1 nm in CCAMLR and SPRFMO, 2 nm in NAFO and NEAFC). Then the

RFMO usually closes the area temporarily, and then the relevant scientific body assesses the available information to provide advice whether further action is needed (e.g., permanent closure).

Pros

- Move-on rules provide an immediate response that prevents further damage to possible VMEs encountered during fishing operations.
- Move-on rules can serve as “back stops” or “insurance” to the main management measures (e.g., area closures) in case these turn out to be deeply flawed. For instance, a move-on rule can put a quick stop to fishing in a place where large amounts of sensitive and structural benthic fauna are recovered when none or little was predicted by the VME habitat suitability models used to design the spatial management regime (Cryer et al. 2018)

Cons

- When the move-on rule is triggered, damage to the (potential) VME has already been done.
- Encounter thresholds should ideally be specific to area, gear type and taxon, and based on historic bycatch levels and catchability estimates (Ardron et al., 2014). However, in many occasions the historic data of bycatch levels are not available and catchability has not been estimated, so the set encounter thresholds may not be appropriate. Because of this, there is a need of revising encounter thresholds as new bycatch data becomes available. Most RFMOs have established thresholds using data-informed approaches (e.g., using cumulative catch rate curves in SPRFMO, GIS Modelling approaches in NAFO, etc.). Other RFMOs have set arbitrary encounter thresholds or have used thresholds derived for other regions. For example, SEAFO also established the threshold following the example of NAFO, and an adapted version of the CCAMLR encounter protocols is applied in the SEAFO area for non-trawl gear in both existing and new fishing areas. This is also the case of SIOFA, that has adopted CCAMLR’s encounter protocol for longline gears and NAFO’s thresholds for trawl gears.
- VME indicators bycatch is assumed to be an indicator of *in situ* VME biomass and composition, however, the limited studies that have evaluated this assumption indicate that bottom-fishing gear (which is designed to catch fish) is very inefficient at sampling/retaining VMEs, such that large quantities of VMEs might be destroyed on the seabed before an amount exceeding encounter thresholds is brought to the surface (Auster et al., 2010). For instance, with an encounter threshold set at 30 kg, a catch efficiency of 5% could potentially mean 600 kg of stony corals on the seafloor had been impacted (SPRFMO, 2017).

- Sub-threshold encounters are not reported in many RFMOs/RFBs, which limits the information collected regarding VMEs.
- There is the issue of re-opening areas that have been temporarily closed after the move-on rule has been triggered (but also for areas closed on the basis of other evidence, such as data from surveys). Re-opening a closed area where a VME is suspected requires an assessment of the available evidence by a relevant scientific advisory body, which may not be enough to make a definite decision (re-opening *vs* remaining closed). Thus, the process may not straightforward, as was the case of NAFO area 14 (see Box below).

Evidence of effectiveness

In general, there are concerns about the effectiveness of encounter protocols, and it is generally agreed that spatial restrictions and closures are more effective at protecting VMEs. However, encounter protocols still play an important role in areas that have not been fully mapped for the presence of VMEs. Because of this, move-on rules should be considered to be temporary measures: they can provide precautionary protection for areas showing evidence of VMEs and serve as an imperfect interim data collection measure, until objectively planned spatial closures can be implemented to protect known and highly bio-diverse VME areas (Hansen et al. 2013, Cryer et al 2018).

Revising area closures – some examples

NAFO Area 14. As part of its commitment to safeguard the marine ecosystem, in 2016, the NAFO Fisheries Commission agreed to create a new area (number 14 in Figure 1) closure on the Eastern Flemish Cap to protect significant concentrations of sea pens. This area (239 km^2) remained closed to bottom trawling activities until 31 December 2018.

To help inform the Commission in deciding on management measures after 2018, the Scientific Council (SC) conducted an updated analysis with additional sea pen biomass records (2014-2017) to re-evaluate the status of this area. The SC concluded that there was very little change in the overall distribution of sea pen VME found on the eastern area of the Flemish Cap (NAFO, 2018; pp. 86-87).

There was no clear consensus regarding the status of Area 14 closure beyond December 31, 2018. Some members of the Working Group on Ecosystem Approach Framework to Fisheries Management suggested extending the closure through 2020 to align with the other NAFO closed areas and reflecting the precautionary approach. Several Contracting Parties (CPs) noted the need for additional information from the SC on the status on the resilience of sea pens, as part of the Article 18 criteria of the FAO Guidelines for the Management of Deep

Sea Fisheries in the High Seas. Finally, reference to Area 14 closure in the 2019 NAFO Conservation and Enforcement Measures (NAFO CEM) was deleted and therefore, this area was re-opened to fishing in January 2019 (NAFO, 2019). Moreover, it was agreed that Area 14 closure would be included in the scheduled review of the current closures in 2020.

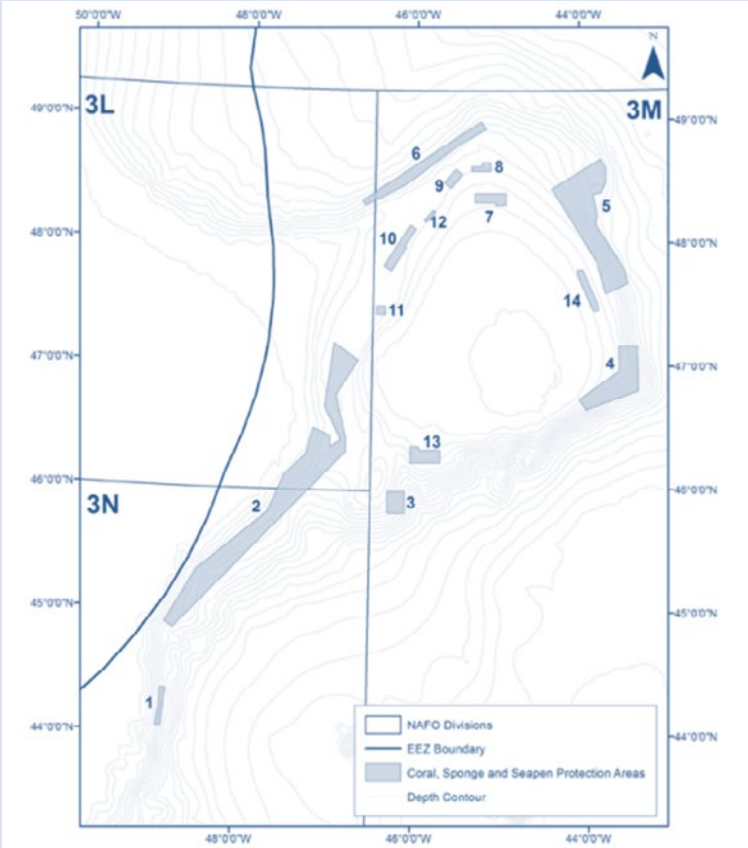

Figure 1. Polygons Delineating Areas of High Sponge and Coral Concentrations Referenced in NAFO CEM Article 17.3. (Source: NAFO, 2017)

The SC conducted the re-assessment of VME closures by 2020, including Area 14. The assessment of the adequacy of the closures involved the same general criteria used in the first review conducted by NAFO in 2014 (NAFO, 2014), but improved on it by incorporating connectivity into the evaluation, and by developing a structured approach to the assessment criteria based on coverage and connectivity which is consistent with the approach being used for the next assessment of Significant Adverse Impacts in 2021. The principal data source used for the assessment was the scientific research vessel trawl catches in the NRA, including an additional 2394 trawl catch samples since the last assessment was conducted in 2014. In that assessment, the adequacy of closures themselves was mainly evaluated based on coverage, while a broader set of criteria was used to help define priorities for management actions, e.g.:

1. The proportion of the VME area/biomass that is protected.
2. Areas with no current protection.
3. Multiple VME presence, e.g., overlapping VMEs.
4. Proximity to an existing closed area as this may imply continuity of the habitats.
5. Proximity to high fishing activity which could endanger the VME (increased risk of impact).

Overall, the SC did not recommend the removal or reduction of any of the currently closed areas. The result of the overall assessment for Area 14 was that the sea pen biomass protection was poor with "essential" Management Action recommended.

Given the challenging circumstances due to constraints caused by Covid-19 pandemic, NAFO adopted a number of decisions related to the further development of its ecosystem approach framework to fisheries management and the upcoming review of its measures to protect VMEs from bottom fishing activities. These decisions included a rollover of the current VME closures in the NAFO Regulatory Area for an additional year (i.e., until December 2021), pending a more comprehensive review in 2021.

Based upon the outcome of the SAI analysis, the SC considered a number of options to improve VME protection, including move-on rules and buffer zones, however it was considered that these would have limited efficacy, and consequently an expert group was assembled to evaluate the benefits and consequences of extending existing closures as well as considering the addition of new closures. This group included fisheries specialists as well as experts in benthic ecology. The analysis considered both VME area and biomass values, connectivity between VMEs, distribution of fishing effort and inter-year fishing stability over a ten-year period. The overall aim was to improve the protection of VMEs, while limiting the impact and/or consequences in terms of access to fishing locations and overall catches.

This work was further developed by the SC at its June 2021 meeting, allowing input from a wider range of experts. Changes to current VME protection (as recommended by NAFO SC) included, among others, the re-establishment of a modified Area Closure 14 (Areas 14a & 14b), over areas of high sea pen concentrations in the eastern portion of the Flemish Cap (Figure 2). This recommendation was adopted in 2021 by NAFO Commission on an interim period of two years (i.e., until 31 December 2023, no vessel shall engage in bottom fishing activities).

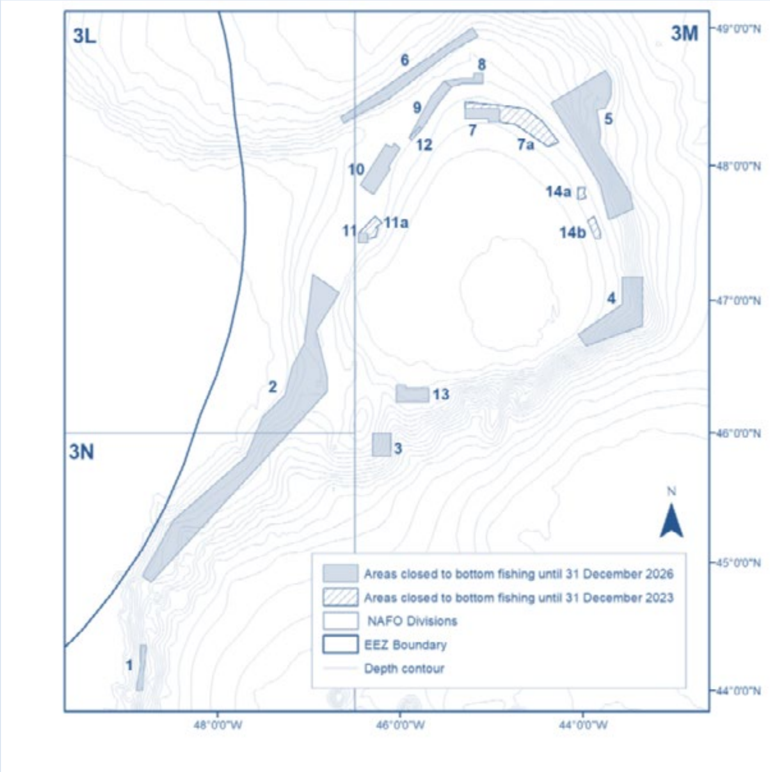

Figure 2. Polygons Delineating Vulnerable Marine Ecosystem Area Closures Referenced in NAFO CEM Article 17.3 and Article 17.3 bis. (Source: NAFO, 2022)

SEAFO. Another example that illustrates the complexity of making the decision to re-open closures or maintaining them can be seen in SEAFO. In SEAFO, a set of potential fishing areas that represented the range of features likely to have VMEs (e.g., seamounts) within the major biogeographical and surface productivity zones of the region were closed (Figure 3). However, the scientific basis for selecting these areas to close to fishing was recognized as rather weak. The FAO is funding some research surveys to explore these areas to document presence/absence of VME indicators and to describe distribution patterns. These surveys would help to analyze the appropriateness of VME closures currently implemented solely based on feature characteristics and biogeographical patterns. The general procedure established by SEAFO to take the decision to reopen a temporarily closed area can be found in Conservation Measure 30/15 on Bottom Fishing Activities and Vulnerable Marine Ecosystems in the SEAFO Convention Area:

> In order to assess accurately the position and the extent of the possible VME encountered in terms of paragraph 1 of this article, sea bed mapping should be carried out using echo-sounders, and if practicable, multi-beam sounders. The result of any mapping shall be submitted to the Scientific Committee for its evaluation and advice.

This advice shall be forwarded to the Commission and contribute to the basis for a decision by the Commission to reopen the temporary closure or add the temporary closure to the SEAFO fishing closures.

If the Scientific Committee advises that the area has sufficient evidence of a VME, the Executive Secretary shall request Contracting Parties to maintain the temporary closure until such time that the Commission has acted upon the advice from the Scientific Committee. If the Scientific Committee evaluation does not conclude that the temporary closed area has sufficient evidence of a VME, the Executive Secretary shall inform Contracting Parties which may re-open the area to their fishing vessels.

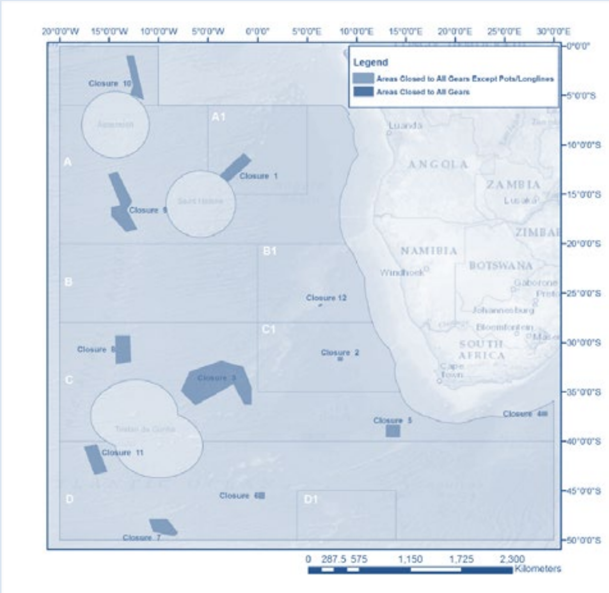

Figure 3. Polygons Delineating Vulnerable Marine Ecosystem Area Closures in SEAFO, Referenced in CM 30/15. (Source: SEAFO, 2015)

Other measures

Non-destructive sampling for the protection of VMEs

Recently, the DSCC (2020) has recommended that bottom trawl fisheries research surveys should avoid all areas where VMEs are known or are likely to occur and non-destructive sampling should be employed, particularly in areas where bottom fishing is prohibited. There are a few options that could be considered to carry out non-destructive sampling. For example, underwater imagery can be used to obtain information on the location and characteristics of potential VMEs, as has been done in surveys using remote operated vehicles (ROVs) or towed cameras (e.g., Dinn et al., 2020, Beazley and Kenchington, 2015; McINtyre, 2016). However, video surveys do have their limitations with respect to species identification and complementary methods are often needed (e.g., an Agassiz trawl to obtain specimens) to cover a representative area and acquire some degree of taxonomic certainty (McIntyre, 2016).

Another promising method to survey potential VMEs is environmental DNA (eDNA). The term eDNA refers to any DNA that is collected from an environmental sample (such as water or sediments) rather than directly from an organism. eDNA originates from body cells or waste products of organisms and remains suspended in the water column or in the sediment (Ficetola et al. 2008; Taberlet et al. 2012). This technique could be used, at least in theory, to determine: a) the diversity and species composition in potential or established VMEs, and ii) the abundance and biomass of indicator species. Such an approach has been already tested to map the distribution of cold-water coral reefs in Norwegian fjords by Kutti et al. 2020. In that study, a great potential was demonstrated for eDNA measurements as a cost-efficient tool for a rapid screening of the distribution cold-water coral vertical reefs that cannot be imaged using traditional multibeam echo-sounders and difficult to detect using ROVs alone. An earlier study by Everett and Park (2017) tested an eDNA protocol for identification of deep-sea octocorals from water samples collected in a research survey along the west coast of USA. They were able to sequence eDNA from octocorals using water samples, and use these data along with image data collected during the cruise to identify taxa to the species level in a variety of habitats. They concluded that eDNA sampling has the potential to complement traditional deep-sea coral surveys by overcoming the difficulty in visually identifying deep-sea octocorals and characterizing their diversity.

Although non-destructive sampling appears to be promising for detection and monitoring of VMEs, its implementation in the short-term does not seem probable. There are still few studies using eDNA to detect VME species and specific pilot studies in different areas with diverse bathymetry and hydrographic conditions must be carried out to test the utility of eDNA for these purposes. Other considerations for the implementation of eDNA for detecting VME species are:

- A better understanding of how eDNA in the marine environment is originated, its state, how it is transported and how it is degraded is needed. The concentration of eDNA is dependent also on intrinsic factors of the organisms (e.g., physiology and life history) and other factors, like biomass and use of space of organisms. This information is still scarce for many VME species.
- eDNA is a sensitive method, and there are many potential sources of error. Some of these errors are associated to collection, laboratory and bioinformatics procedures and include contamination, inhibition, amplification and sequencing errors, computational artifacts and inaccurate taxonomic assignment. From these errors, the most serious is probably the risk of contamination and hence the possibility of false positive results, but also the misassignments of species due to incompleteness or errors in public genomic databases. These sources of error must be considered when developing and fine-tuning protocols

- The sequences available in public databases are far from being complete and may not contain sufficient reference sequences for VME indicator species, therefore, a previous assessment of the species inhabiting the area of study is highly desirable, in order to build *ad hoc* databases. This also dedicated surveys to collect samples and expert taxonomists to identify the species.
- Taxonomy itself can be problematic for many VME species and needs further research. For example, in the SPRFMO area, bamboo corals that grow as unbranched colonies have generally been assumed to belong to the genus *Lepidisis*. However, recent genetic and morphological data from approximately 400 bamboo coral specimens, show that whip bamboos are found in 6 different molecular clades on the bamboo evolutionary tree. It is likely that at least 6 different genera and an untold number of species are involved. Sponge taxonomy in the Pacific is still lacking, as there has been very little work on the molecular genetics of that evolutionary group and the morphological studies are just beginning (SPRFMO, 2020).

- In the literature, diverse approaches for sampling and interpreting DNA data that result in a variety of protocols (lack of standards). There is no single universal processing workflow that provides a unified and streamlined manner for satisfactorily treating eDNA data from raw sequences to taxonomic identification and diversity analysis. An ongoing project[7], where the feasibility of using eDNA to monitor biodiversity in the context of bottom trawl research surveys is being studied, has highlighted the difficulties in optimizing and reproducing eDNA protocols (i.e., published protocols). Even extraordinarily detailed step-by-step protocols produce strikingly different results when carried out at different laboratories, emphasizing the complexity of a broad adoption of the technique for regular monitoring.

7 FishGenome. "Improving cost-efficiency of fisheries research surveys and fish stocks assessments using next-generation genetic sequencing methods" Contract – EASME/EMFF/2017/1.3.2.10/ SI2.790889.

Section 2. Areas with gaps/improvements needed

The following areas with gaps, or that require improvements have been identified and are described for the different bycatch groups and RFMOs below:

- **Sharks and rays:**

In general, there is a lack of knowledge about the biology, ecology and status of deep-water sharks and other elasmobranchs in the areas covered by the different RFMOs. In addition, ICES (2020) has noted that bycatch mitigation measures are difficult to implement for chondrichthyans since many species occur in a similar size range as the target species in mixed fisheries (exemptions include the Greenland shark, *Somniosus microcephalus*).

Within **CCAMLR** sharks are very rarely caught, occasionally porbeagles (*Lamna nasus*) come up in trawls but are of little commercial value and discarded. Despite this, it has not been possible to adopt a proposal amending CM 32-18 (on the prohibition of targeted fishing for sharks), banning shark finning in line with UN FAO and other RFMO requirements. Work on skates and rays is ongoing, although bycatch limits have been set in the various Subareas and Divisions (normally based on a proportion of the target species) there have been no assessments on the stock status of the various species that occur in the Convention Area. A tagging programme in the Ross Sea is ongoing to gather data for this as well as information on growth parameters and movement.

In the specific case of **CCAMLR**, bycatch limits are focused on rays and skates mainly, leaving sharks aside. Sharks may instead be covered by the 16% catch limit for 'all other species.' Therefore, the CM could be improved by either explicitly including sharks under the 5% catch limit, or explicitly stating them to be 'other species.' This may be relevant since shark bycatch, although still a relatively small proportion of overall bycatch, has increased in the last decade and that that quality of shark bycatch data is probably low (WGFSA 2018 WG-FSA-18/63).

In **GFCM**, one of the biggest challenges regarding elasmobranch bycatch is species identification. According to Carpentieri et al. 2021, easy tools should be provided to fishers to help them recognize Mediterranean species and distinguish protected species from commercial ones, as well as to record catches. They also point out that the precautionary approach becomes very important for these species with limited data available to assess their conservation status. For this reason, Carpentieri et al. 2021 remark that it is crucial to gather information systematically from all fisheries data collection framework programmes in place and to enforce current management measures. Also, information campaigns for fishers and stakeholders are required in order to raise awareness of the current legal framework and the ecological roles played by these vulnerable animals in sustaining the health of marine ecosystems

In **NAFO**, it is necessary to identify areas and times where bycatch and discards of Greenland sharks have a higher rate of occurrence. Because of this, several requests were made by the NAFO Commission to the Scientific Committee, which will provide information on this regard in the near future. Also, the NAFO Commission Ad hoc Working Group to Reflect on the Rules Governing Bycatches, Discards and Selectivity (WG-BDS) is working to identify areas and times where bycatch and discards of Greenland sharks have a higher rate of occurrence.

NEAFC and OSPAR have requested ICES advice on deep sea sharks, rays and chimaeras (Documents PECMAS 2020-01-13 and PECMAS 2020-01-23) in order to protect these species and implement effective conservation measures (NEAFC, 2020a). The advice covered 21 species of deep water (deeper than 500m) sharks and rays, subject to available data. However, ICES noted that other data may become available over a longer time scale and that since 2005, only 4 of these shark species have had specific advice from ICES. ICES has also noted that current legislation aimed at deterring targeted catch and high bycatch areas is limited in terms of mitigation of bycatch of these species (NEAFC, 2020a). ICES noted that particular gear types such as longlines and certain trawls at particular depths presented the main risks of bycatch. Options for reduction of bycatch included potential deterrents and spatio-temporal management, but both needed further research/development. Several issues such as the impact of particular long-line fisheries or spatio-temporal measures need further elaboration by ICES. Moreover, EU considers that NEAFC should adopt a more active role for the conservation of deep-sea sharks, which are covered by the ICES advice (NEAFC, 2020a). It is still necessary to establish the level of protection in NEAFC in line with the scientific advice.

In **SEAFO**, there is a specific conservation measure for sharks caught in association with fisheries managed by this RFMO. However, the protection level of deep-sea shark is low, because there is only a recommendation that places a voluntary ban on the catch of deep-sea sharks, namely Rec 1/2008 about “banning deep-water shark catches”. This recommendation intends to ban deep-water shark directed fisheries in the SEAFO Convention Area until additional information becomes available to identify sustainable harvesting levels. Therefore, it is necessary that SEAFO directs more efforts toward the conservation of deep-sea sharks.

SIOFA is still working towards setting appropriate bycatch limits for relevant deep-sea shark species, which would be a significant improvement.

In **SPRFMO**, there are no specific conservation measures for **sharks and rays** (chondrichthyans). Some management measures exist in the case of exploratory fisheries (e.g., CMM 14a 2019, CMM 14d-2020, CMM 14b 2021, CMM 14 e-2021). Thus, more work is needed to advance in the protection of sharks and rays in this RFMO.

- **Marine mammals:**

In order to effectively tackle cetacean bycatch, improving knowledge of cetacean bycatch levels and population-level impacts within RFMOs is vital. RFMOs must first understand baseline information of cetacean distribution, abundance, and bycatch levels in their fisheries; this is vital to properly understanding bycatch risk and working towards effective management and policy response (Elliott, 2020). Many RFMOs still lack appropriate knowledge on this regard, which is preventing the establishment of conservation measures for marine mammals.

CCAMLR have been running the CCAMLR Ecosystem Monitoring Programme (CEMP) since 1989 which was set up to provide information on the effects of fishing on dependent species, including marine mammals (specifically Antarctic fur seals). It monitors the population life history and size in response to fishing pressure and as such provides a valuable time series of data. These data are becoming increasingly important with the development of the feedback management scheme for the krill fishery which allows (near) real time management of the fishery in response to changes in the [8]ecosystem, for this to be effective it is likely that more monitoring will need to be carried out. Marine mammal mortalities as a result of direct interactions with the fishery are low as result of mitigation measures, such as the marine mammal exclusion device, being introduced in the krill fishery.

The recent review of incidental catch of vulnerable species within the **GFCM** area (Carpentieri et al., 2021) has shown that cetacean bycatch in Mediterranean fisheries is decreasing with respect to the past. However, interactions (i.e., incidental catch and/or depredation) between marine mammals and fishing activities still occur (e.g., in purse seine fisheries in Tunisia and Morocco and other small-scale fisheries in Spain, Italy and Malta [9]), and in some areas (for example, the Black Sea), still need to be carefully addressed in order to better understand and prevent any kind of conflict.Solid and

[9] The MAVA Depredation project «Towards solutions to interactions between fisheries and cetaceans in Moroccan and Tunisian waters» (https://mava-foundation.org/fr/grants/mitigating-dolphin-depradation-in-mediterranean-fisheries-joining-efforts-to-strengthen-cetacean-conservation-and-sustainable-fisheries-2/) and the MAVA Depredation 2 project «Mitigating dolphin depredation in Mediterranean fisheries – Joining efforts for strengthening cetacean conservation and sustainable fisheries».

standardized monitoring programmes would facilitate the application of emergency measures in areas where negative interactions continue to occur.

In **SIOFA**, the Members report no observed marine mammal bycatch, but there does not appear to be analysis of marine mammal bycatch currently being undertaken. While some Members are reporting no observed marine mammal interactions in their national reports, cetacean bycatch remains a possibility with bottom trawl, longlines, and gillnets being used in the Convention Area. Thus, research is needed in this regard.

Elliot et al. 2020 have noted that **SEAFO**, **NPFC** and **NEAFC**, were not directly addressing cetacean bycatch; some have minimum bycatch reporting requirements or minimum observer requirements, but are not engaged directly with addressing fishery interactions with cetaceans. This could partially be due to how recent some of them are (e.g., NPFC), coupled with low levels of fishing in recent years (e.g., SEAFO) (Elliot, 2020; SEAFO, 2020a). Apart from the general principles of the article 3 of the Convention text applying the provisions of the SEAFO Convention relating to fishery resources (SEAFO, 2001), taking due account of the impact of fishing operations on ecologically related species such as seabirds, cetaceans, seals --and marine turtles, there is no evidence of interaction of fisheries with cetaceans in the SEAFO CA, so there are no regulations. In any case, these RFMOs should be working to obtain baseline information about fishery interactions with cetaceans and establish measures if necessary.

- **Seabirds:**

The reduction in bird mortalities within the **CCAMLR** Convention Area has been primarily due to the introduction and enforcement of a number of mitigation measures through the Conservation Measures and introduction of observers. Recent proposals by some Member States to reintroduce net monitoring cables (banned in the early 1990s over concerns of potential bird mortalities) has led to CCAMLR reassessing the levels of coverage using at sea observers alone. Work is underway, using a combination of at sea observers and Remote Electronic Monitoring (REM) to increase coverage level and get closer to the true mortality / strike interaction level. An online group has been developed to discuss this and develop protocols for future monitoring[10]

In **GFCM**, most of the data available on seabird bycatch in fisheries of the Mediterranean and the Black Sea are scarce and unequally distributed, with data mainly gathered in the western Mediterranean. These data are mostly obtained from opportunistic and

[10] https://www.ccamlr.org/en/system/files/e-sc-39-rep.pdf

irregular surveys or from interview-based studies and self-reporting questionnaires, which has impeded the assessment of data reliability and comparability between studies (Carpentieri et al. 2021). Thus, more robust monitoring methods (for example, standardized onboard observations and questionnaires, including for small-scale fisheries) are required to correctly estimate seabird bycatch. Also, the use of remote electronic monitoring by cameras – already used in some parts of the world to monitor bycatch – can be especially relevant for studies concerning small-scale fisheries, where systematic onboard observations are often not feasible (Carpentieri et al., 2021)

In **NAFO**, information on seabirds that are present in NAFO Regulatory Area has been requested to its scientific committee by the NAFO Commission. It is expected that this year, updated information regarding seabirds is made available to NAFO Commission in order to combine it with existing text on marine mammals and turtles.

NEAFC needs information regarding bird bycatch in the NEAFC regulatory area in order to address the calls and commitments set out on bird bycatch under the UNGA fisheries resolutions (NEAFC, 2020a; 2020g). According to anecdotal information bird bycatch is considered low in the fisheries conducted in the NEAFC regulatory area. NEAFC requested ICES to compile and aggregate available data on bird bycatch in the NEAFC regulatory area, i.e., spatially and temporally distributed, as well as per gear. However, only a few EU countries reported any monitoring effort data within the NEAFC RA and the data was incomplete (e.g., no data on fishing effort) or lacking enough details (ICES, 2021) In the incomplete data reported to ICES, no bycatch of seabirds was reported in any fishery in the NEAFC RA. However, it is clear from the monitoring data that not all states reported their data. In addition, it was not possible to deduce from the reported data whether monitoring had actually taken place in the NEAFC RA. Therefore, ICES could not deduce that no bycatch of seabirds occurs in fisheries in the NEAFC RA. Considering this, ICES has recommended that a systematic collection and reporting of data on seabird bycatch should be established as soon as possible, because this is essential for tackling seabird bycatch. ICES would need data on total fishing effort from VMS and logbook data for all gears and data on bycatch incidents would need to be by haul (i.e., higher detail than the current supplied data) and at the species level. Using a standard reporting format for recording seabird bycatch and to compile this as soon as possible in one place, e.g., in a database of seabird bycatch, would facilitate the analysis by relevant experts.

ICES is requested to advise upon what is necessary in order to provide recurrent advice on bird bycatch as well. To compile and aggregate available data on bird bycatch, spatially and temporally by fishery in general ICES would need access to detailed data not currently provided which do imply a long timeline to respond to the request. Also, ICES would need data on total fishing effort from VMS and logbook data for all gears and data on bycatch incidents would need to be by haul (i.e., higher detail than the current supplied data). The current data available, (i.e., aggregating data over several hauls) would most likely not be sufficient to provide a robust advice.

In the **SIOFA** area, ACAP recommends that assessment and monitoring of seabird bycatch levels over time should include estimates of a) bycatch rates (i.e., number of birds killed per a given unit effort, for example birds per 1000 hooks set for longline fisheries) and b) the total number of birds killed per unit effort. The reason it is important to include both of these metrics as indicators is that although bycatch rates are suitable for direct comparisons over time or across strata or fisheries, they do not account for differences in fishing effort. Even if bycatch rates decline, impacts on seabird populations could increase if fishing effort increases. In some cases, changes in bycatch rates might also reflect declining/increasing seabird populations or shifts in fishing areas and seasons. Consequently, bycatch rates should be used in combination with estimates of the total number of birds killed per fleet as an overall indicator to monitor bycatch trends over time. These two indicators are recognized by the FAO as the primary approaches for monitoring seabird bycatch reduction goals.

In **SPRFMO**, monitoring of the implementation and effectiveness of mitigation approaches should continue, including periodic review of mitigation measures applied by other RFMOs and CCAMLR or advised by ACAP, to ensure best practice and consistent or complementary arrangements.

- **Benthic organisms related to VME**

In general, there is a need for improving the effectiveness of encounter protocols and the move-on rule in the different RFMOs. Currently, research is being carried out within the different RFMOs to improve encounter protocols and develop more effective (and science-based) thresholds. For example, Rowden et al. 2020 have developed density thresholds that can be used to objectively identify structurally complex coral reef VMEs (e.g., stony coral reefs of *Solenosmilia variabilis*) in the SPRFMO Convention Area. This methodology operationalizes one of the criteria for identifying VMEs by determining the "significant concentrations" of a structure forming organism that supports a "high diversity" of associated fauna that are dependent on this structuring organism. Furthermore, specific threshold density metrics for particular species and regions, such as the one derived for number of live coral heads of S. variabilis for the South Pacific, can be used to threshold abundance-based habitat suitability model predictions to make maps that can be used by RFMOs to design spatial management measures to prevent significant adverse impacts to VMEs (Rowden et al. 2020). SEAFO is examining the use of scientific data (video footage & survey counts) in the determination of threshold limits of VME encounters in relation to guidelines in other RFMOs and scientific bodies (SEAFO, 2020).

Specific areas of improvement for the different RFMOs are presented below:

Bottom fishing within **CCAMLR** is mainly restricted to longlining, with a small amount of trawling occurring in one of the divisions. Although pots are also permitted, they have not been in use since 2012. It has been acknowledged that benthic species being recovered on longlines do not necessarily represent what is present on the seafloor, with longlines most likely overrepresenting light species over heavy ones. Work is underway to make more use of remote underwater cameras to ground-truth what is being recovered on the longlines. All the work done on benthic impacts has been based on autolines, with little research into the impacts by Spanish lines, trotlines or pots.

In **GFCM**, information about the incidental catch of VME indicator taxa from many commercial fisheries is still scarce (e.g., small-scale fisheries and fisheries using longlines, traps and pots) or only refer to a few specific areas (Carpentieri et al. 2021). An increasing amount of information exists about VME occurrences throughout the Mediterranean basin, based on non-destructive visual surveys, but the eastern basin and the Black Sea are certainly less covered by scientific studies. It is essential to continue with efforts for mapping VMEs in the Mediterranean, so that spatial management measures are defined to protect VMEs (e.g., area closures). Until such solutions are put in place, the adoption of the precautionary approach is necessary to preserve vulnerable habitats and species. Establishing VME thresholds and encounter protocols for deep-sea fisheries using bottom-contact gear would be desirable and could also provide new information on the distribution of VME indicators, but these measures should be complementary to adequate VME spatial closures. .

NAFO is one of the RFMOs that is at the vanguard of VMEs protection. This has often led to conflicts with the fishing sector that see their fishing grounds diminish when new areas of closure are increasingly proposed. However, other industries, namely gas and oil exploration, are increasing without any restrictions on exploration in areas closed to bottom fisheries to protect VMEs. This is an issue that needs to be addressed as soon as possible.

NEAFC. In 2020, the quality of the vessel monitoring system (VMS) data provided to ICES for determining the impact of fishing on VMEs has significantly improved compared to previous years. However, a large proportion of the vessels still have no gear specified, which is an important element for the assessment (ICES, 2020). In its last advice to NEAFC (ICES, 2020) ICES noted that fishing activity is taking place at low intensities outside of the existing NEAFC bottom-fishing areas in the Mid-Atlantic Ridge, the Josephine Seamount area, and the Reykjanes Ridge and this is being examined by NEAFC. So far, they appear to be “false positives” of vessels fishing for ICCAT species but reporting their positions to NEAFC (NEACF, 2021e). Five new VME habitat records of coral gardens, tube-dwelling anemone aggregations, and deep-sea sponge aggregations, occurring outside of all existing closure areas, were submitted to ICES. Although they represent rare occurrences of habitat-forming species, these data are preliminary and further work is required before they can be fully incorporated into the ICES VME database. This work will take place in 2021 and will be incorporated into subsequent advice. Thus, NEAFC will need to act on this new information, once ICES provides specific advice in 2021, to protect these habitats as soon as possible.

SEAFO is currently carrying out a series of tasks aimed at improving VMEs protection, such as 1) preparing a draft of guidelines for using scientific data (video footage & survey counts) in the determination of threshold limits of VME encounters in relation to guidelines in other RFMOs and scientific bodies and 2) Reviewing the spatial distribution of reported catches of benthic organisms (corals, sponges, etc.): SEAFO's Science Committee (SC) reviewed the updated data on incidental catches of VME species for fishing data received from 1 October 2019 to 31 September 2020 from the bottom longline fishery. The SC reviewed the spatial distribution maps provided by the Secretariat. Glass sponges were added to the list of VME indicators and should be discussed at the next SC meeting for consideration. (14th Annual Scientific Committee Meeting Report (2020) http://www.seafo.org/Documents)

In **SPRFMO**, much work needs to be done to protect VMEs. For example, developing a multi-taxonomic level list of VME indicator taxa for the SPRFMO Convention Area that will provide an important resource for the Scientific Committee (SC) work. This has been noted by the SPRFMO and it has requested Members and CNCPs to begin compiling information they hold on VME groups that can contribute to updates to the list (SPRFMO, 2020a). Also, there is need for further research in many areas of SPRFMO regarding the potential impact of fisheries on the benthic environment. For example, the Cook Islands have carried out a study to estimate encounter rates with VME Indicator species at Kopernik Seamount in the South Pacific Ocean for trap fishing targeting lobsters and crabs. This study has provided a first glance at the potential impact of this fishery on the benthic environment. However, additional work is still required to gain a more complete picture of the total impact (SPRFMO, 2021d).

General comments regarding improvements needed for by-catch avoidance and management

In **GFCM**, there was an urgent need for establishing a baseline for bycatch in the region and identifying existing gaps. GFCM has taken a huge step forward with regards to monitoring and mitigating bycatch through its MedBycatch project. The Medbycatch project (Understanding Mediterranean multitaxa bycatch of vulnerable species and testing mitigation – a collaborative approach) is an ongoing project in which five countries (Croatia, Italy, Morocco, Tunisia and Turkey) are involved. The scope of the project is to monitor and mitigate incidental catches of vulnerable species and reduce fishing impacts and pressures on marine habitats and species. The general objective of the project is building on complementarities of partners' respective mandates, while joining resources and expertise and striving for best practices and replicability. More specifically, the project aims to: i) Address knowledge gaps regarding the bycatch of vulnerable species occurring during fishing operations in the Mediterranean through a more systematic and standardized approach to data collection and capacity-building; ii) identify, and support the testing of, mitigation measures to reduce incidental catches and/or mortality of vulnerable species and iii) raise awareness on the issue of bycatch and provide bases for the formulation of national/regional strategies to reduce incidental catches, preserve vulnerable species and support the sustainability of fisheries.

In **NAFO**, some clarity on the by-catch definition is needed because some confusion exists when reading some official NAFO papers. Also, some lack of reporting is noted and this needs to be improved. Though being a minor issue (that can be considered insignificant), the rules for reporting bycatches of seabirds, turtles and marine mammals are not well-defined. Nevertheless, there is a risk that the more restrictive the rules are (especially on insignificant issues that can be considered insignificant), the more reporting of existing bycatch events will be avoided by fishermen. Other issues that are currently being addressed by NAFO are: 1) a review of submitted protocols for a survey methodology to inform the assessment of splendid alfonsino, 2) obtaining information on sea turtles, sea birds, and marine mammals that are present in NAFO Regulatory Area, 3) continuing the evaluation of scientific trawl surveys in VME closed areas and 4) identifying discard species/stocks with high survivability rates.

NEAFC is working on formulating requests for advice from ICES regarding the following topics related to bycatch as stated in the PECMAS 2020-02 Report (NEAFC 2020a): a) Advice for bird bycatch in the NEAFC Regulatory Area; b) Advice on vulnerable marine ecosystems in the NEAFC Regulatory Area, not acted on so far and c) Advice and past NEAFC closures not acted on.

In the **NPFC** area, the lack of available data provided by certain fisheries and members impedes accurate implementation of the bycatch management measures in the **NPFC** convention area. For example, data limitations make it difficult to interpret any bycatch trends and provide a robust analysis of the status of bycatch resources (e.g., all USA fisheries in NPFC area). Another point of concern is that, at present, NPFC seems to be only focused on bycatch of benthic organism related to VMEs, neglecting bycatch of sharks and rays, seabirds, marine mammals and reptiles. Thus, it is desirable that NPFC also directs its efforts at assessing bycatch of these groups and adopts measures for their conservation and management. With regard to VMEs, it seems that NPFC is actively pursuing improvements for their conservation and management. In the last meeting of the Small Scientific Committee on Bottom Fish and Marine Ecosystems (NPFC, 2020), several aspects regarding the assessment of VMEs were discussed with the objective of improving their management. For example, the member's research activities related to VMEs were reviewed, a VME indicator taxa identification course was planned for 2021, new potential VME sites were identified, improvements for reporting an encounter of VME indicator taxa were suggested, etc.

In **SPRFMO**, information about fishery interactions for all categories of marine mammals, seabirds, reptiles, and other species of concern is currently lacking, and there are no formal estimates of the total number of interactions for either bottom line fisheries or trawl fisheries within the SPRFMO Area. In addition, the numbers of interactions reported cannot be interpreted as the total number of interactions or fatalities because only 10% observer coverage is required in line fisheries and fishers may not report all interactions (SPRFMO, 2020a). There is a relatively high proportion of differences between SPRFMO and Members' data holdings and records on bottom fisheries interactions with marine mammals, seabirds, reptiles or other species of concern. This suggests that processes for verification of records and updating of databases need to be strengthened.

Section 3. Recommendations to improve bycatch management in DSF

Sharks and rays

- The establishment of bycatch limits for sharks and rays shall be considered by RFMOs. If possible, a data-informed approach shall be followed to define acceptable limits taking into account the biological and ecological characteristics of bycaught species.
- Live release of bycaught animals shall be considered for species with high survival rates such as the lesser-spotted dogfish and several species of rays and skates. This measure could be implemented in the RFMOs that have not explicitly incorporated live release in their conservation measures. If implemented, this measure must be accompanied by guidelines of best handling practices for safe release of sharks and appropriate training of crew members to ensure their safety as well.
- It is recommended that the technical effectiveness of mitigation measures for elasmobranch bycatch is investigated by RFMOs, considering the particular characteristics in each of the fisheries. Some of the measures to be considered are:
    1) Spatio-temporal closures, such as avoidance of some fishing grounds or periods of the year where the spatial overlap between the target species of the fisheries and deep-water shark species.
    2) Net restrictions;
    3) Gear-based technical measures can be applied to improve the selectivity for sharks. For example, use of hooks at different depths, alternative hooks and/or deployment of magnets on hooks, alternative mesh sizes and shapes, new materials, grids and escape windows to reduce bycatch
    4) Bycatch exclusion devices such as novel grid panels designed to facilitate flatfishes (e.g. 'Freshwind' https://vimeo.com/channels/801304) may have potential to reduce some skates bycatches with similar body morphology
    5) Use of shark deterrents (e.g., use of deterrent measures "triggering" electromagnetic senses of elasmobranchs such as hook or net material, as well as acoustics and light-based technologies.

  Because these measures should always be subjected to proper scientific evaluation before they can be implemented, trials or pilot studies can be carried out to determine the effectiveness of a certain measure in a particular fishery.

- Recommendations from international organizations, such as the Memorandum of Understanding on the Conservation of Migratory Sharks (CMS Sharks MoU) or the ICES Working Group on Elasmobranch Fishes (WGEF), can serve as a guide to develop and implement such measures in RFMOs. Socio-economic feasibility of implementing such measures shall be considered as well.

Marine mammals

- RFMOs should explore mitigation measures taking into account the characteristics of their fisheries. Due to the variability between species, populations, fisheries and local conditions, each fishery must consider the appropriateness of different techniques before their full implementation in a fishery, often through trials (FAO, 2021). The following measures can be considered:
    1) spatial closures (including dynamic or real-time closures): spatial closures can be effective in reducing interactions between marine mammals and fishing gear in areas where they both occur. This applies especially in areas where marine mammals aggregate, such as breeding grounds, areas with seasonal prey abundance, migration corridors, or other critical habitats.
    2) modifications to fishing gear: fishing gear may be modified to reduce interactions with marine mammals or to facilitate animals to self-release when they become hooked or entrapped. For example, excluder devices with escape openings (holes) can be used in trawling nets. Excluder devices have shown to be especially effective for pinnipeds and can be considered for other small cetaceans. There are also modifications to logline gears that have shown to be effective for reducing depredation by marine mammals, such as the Chilean longline system (trotline with nets).
    3) acoustic deterrents or alerting devices (e.g., pingers) for certain species cetaceans (e.g., harbor porpoises, striped dolphins, franciscana dolphins and several beaked whales).
    4) changes in fishing operations (e.g., prohibition of offal and discards during net shooting and hauling)

- In general, a lack of data of the interactions of marine mammals and the fisheries in the RFMOs was identified in this review. It is recommended that further research is carried out to determine the distribution of marine mammals in the RFMOs, their biology and ecology, the fisheries that interact with them and bycatch rates. This is crucial to de able to implement conservation measures for marine mammals, for example, for establishing, monitoring and enforcing spatial closures.

- Recently, FAO has elaborated Guidelines to prevent and reduce bycatch of marine mammals in capture fisheries (FAO, 2021). It is recommended that RFMOs take advantage of the Guidelines to improve their conservation and management measures accordingly. Moreover, the adoption of the Guidelines by the RFMOs will help to develop ecosystem management and conservation frameworks and plans that apply across large areas of the world's oceans.

Seabirds

- *Trawl fisheries*. The best practice measures for reducing seabird net entanglements are effective fish waste management combined with operational measures such as cleaning the net prior to shooting and reducing the time the net is on the surface at shooting and hauling. Available evidence suggest that a no-discharge policy would virtually eliminate seabird mortality, and that strategic management of offal discharge is probably the most critical mitigation measure. Therefore, these measures shall be considered by those RFMOs that have not implemented them.
- *Longline fisheries.* It is recommended that RFMOs consider the following measures, because available evidence has shown that they are the most effective measures to reduce incidental catch of seabirds in demersal longline fisheries, (especially if used in combination):
    1) Use of an appropriate line weighting regime to sink baited hooks as close to the vessel as possible to reduce their availability to seabirds.
    2) Actively deterring birds from baited hooks by means of bird scaring lines, and,
    3) Setting longlines at night. In cases where line weighting is integral to fishing gear, it has the advantage of consistent implementation, and compared to bird scaring lines and night setting, facilitates compliance and port monitoring.
- Regarding seabirds, there are several published guidelines and recommendations that can be used as a basis to improve seabird bycatch and conservation measures. These guidelines have been elaborated by FAO and various organisations dedicated to seabird conservation, for example the Agreement on the Conservation of Albatrosses and Petrels (ACAP). It is recommended that RFMO dedicate attention to these publications in order to improve their mitigation strategies for seabirds bycatch. Some of the available publications are:
    a) FAO. 2009. Fishing operations. 2. Best practices to reduce incidental catch of seabirds in capture fisheries. FAO Technical Guidelines for Responsible Fisheries. No. 1, Suppl. 2. Rome. Available at: http://www.fao.org/3/i1145e/i1145e00.pdf

b) ACAP, 2021. ACAP Review of Mitigation Measures and Best Practice Advice for Reducing the Impact of Pelagic and Demersal Trawl Fisheries on Seabirds.

c) ACAP, 2021. ACAP Review of mitigation measures and Best Practice Advice for Reducing the Impact of Demersal Longline Fisheries on Seabirds. In: ACAP - Twelfth Meeting of the Advisory Committee. Online

Benthic organisms related to VMEs

- Closing areas to bottom contact gear is the only certain method for avoiding significant adverse impacts on VMEs (Wright et al. 2015 and references therein). This is a well-establish measure to protect VMEs and such closures are used by all of the reviewed RFMOs as the main measure to protect VMEs. Therefore, it is recommended that efforts should continue to identify areas were VMEs are present or al likely to occur.
- For areas closures already established, the possibility of improving the effectiveness of these closures shall be explored. For example, by determining buffer zones and taking into account the connectivity of the populations among different closures.
- In general, there are concerns about the effectiveness of encounter protocols, and the "robustness" of the established thresholds is not homogeneous. RFMOs should refine the current thresholds on the basis of new scientific information, including bycatch levels and catchability estimates, and use taxon-specific and gear-specific thresholds. The use of data-informed approaches (such as using cumulative catch rate curves or GIS modelling) shall be promoted as more data becomes available in the different RFMOs.
- In the GFCM, no thresholds have been yet established and there is ongoing work to identify VME. In this particular case, involving fishers in the collection of data on macrobenthic invertebrate bycatch could represent an appropriate solution to help to fill knowledge gaps regarding the incidental catch of VME indicator taxa in areas not covered by scientific surveys. The implementation of data collection programs onboard commercial vessels would also provide a useful means to quantify the magnitude of fishing impacts on VMEs (Carpentieri, et al. 2021).
- Non-destructive sampling using eDNA appears to be promising for detection and monitoring of VMEs and shall be considered as a possibility for the future. There are still few studies using eDNA to detect VME species and specific pilot studies in different areas with diverse bathymetry and hydrographic conditions must be carried out to test the utility of eDNA for these purposes. It is recommended that further research is carried out in this regard.

Other recommendations

- A general issue that is evident from this review is the lack of data that still exists in many RFMOs on the interactions of vulnerable species with fisheries, that can end up as bycatch. This is especially evident for elasmobranchs, marine mammals and seabirds (e.g, NAFO, NEAFC, NPFC, etc.). As GFCM acknowledges, the lack of data on the occurrence and level of bycatch hinders the ability to manage and apply rules on fishing vessel activities. Even where data exists, the lack of statistically robust and harmonized sampling designs limits its value and, for example, prevents comparisons between different fishing fleets and areas (GFCM, 2021). Therefore, adequate monitoring programs and frameworks that can provide sound bycatch data collection are therefore urgently required. It is recommended that RFMOs establish such monitoring programs in order to obtain the necessary information to manage adequately the bycatch of vulnerable species. For example, to facilitate this, the General Fisheries Commission for the Mediterranean (GFCM) and its partners in the Mediterranean have jointly developed a framework for the collection of data on bycatch. Although developed for use in the Mediterranean and Black Sea, the approach is applicable to fisheries outside the GFCM area of application.

Summary of recommendations

- **Sharks and rays**. it is recommended that the technical effectiveness of mitigation measures for elasmobranch bycatch is investigated by RFMOs, considering the particular characteristics in each of the fisheries. Some of the measures to be considered are: (1) spatio-temporal closures; (2) net restrictions; (3) bycatch exclusion devices; (4) use of shark deterrents and (4) live release of specimens on board or from the net.
- **Marine mammals**. It is recommended that further research is carried out to determine the distribution of marine mammals in the RFMOs (including at different periods in the year), their biology and ecology, the fisheries that interact with them and bycatch rates. This is crucial to de able to implement conservation measures for marine mammals. Recently, FAO has elaborated Guidelines to prevent and reduce bycatch of marine mammals in capture fisheries (FAO, 2021). It is recommended that RFMOs take advantage of the Guidelines to improve their conservation and management measures accordingly.
- **Seabirds.** There are several published guidelines and recommendations that can be used as a basis to improve seabird bycatch and conservation measures. These guidelines have been elaborated by FAO and various organisms dedicated to seabird conservation, for example the Agreement on the Conservation of Albatrosses and Petrels (ACAP). It is recommended that RFMO dedicate attention to these publications.
- **Benthic organisms related to VMEs.** Area closures are a well-establish measure to protect VMEs. Therefore, efforts should continue to identify areas were VMEs are present or al likely to occur. For areas closures already established, the possibility of improving the effectiveness of these closures shall be explored. For example, by determining buffer zones and taking into account the connectivity of the populations among different closures. Encounter thresholds still play an important role in areas that have not been fully mapped for the presence of VMEs and it is recommended that at least, a data-informed approach should be used for establishing such thresholds. Non-destructive sampling using eDNA seems to be a promising method for detecting and monitoring VMEs, and it is recommended to carry out specific research on this methodology.

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ANNEX I Description of by-catch management approaches

The Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR)

The majority of the bycatch, by both numbers and weight, consists of species of skates, rays and grenadiers (Macrouridae). A large number of other species are also reported caught in the high seas bottom longline fisheries, including some taken in substantial quantities such as icefish (Channichthyidae), blue antimora (*Antimora rostrata*), rockfish (Nototheniidae) and moray cods (*Muraenolepis* spp). Others are taken in relatively small numbers (CCAMLR, 2015).

Bycatch limits are set out under Conservation Measures (CMs) 33-01 – 33-03, (summarised below) Bycatch limits for individual Subareas or Divisions are also set out in the CM for that area. They follow a proportion of the overall catch of the target species for a particular area (e.g., 5% and 16% of the total catch), but are also done on a line-by-line basis and are defined as a move-on rule if more than a certain amount of particular species is caught on one line. This also applies to VME species, where more than a certain number of 'units' (defined by weight or volume) caught on a single section of line are defined as a risk area and are subsequently closed off from future fishing. Within CCAMLR, the only fisheries that have an impact on the seafloor, or can be considered deep-sea fisheries (DSFs) are longline fisheries, although Australia does have a bottom trawl fishery that operates within their EEZ (Heard and McDaonald Islands). The following CMs relate mainly to longline fishing and outline the current catch limits (for the 2021/22 season).

<u>Limitation of by-catch in Subarea 48.3 (CM 33-01)</u>

There are catch limits in place for particular bycatch species, mainly introduced to prohibit directed fishing for these species but now established for anything landed in any directed fishery and fishing season: humped rockcod *Gobionotothen gibberifrons* (1,470 tonnes), blackfin icefish *Chaenocephalus aceratus* (2,200 tonnes), South Georgia icefish *Pseudochaenichthys georgianus*, marbled rockcod *Notothenia rossii* and grey rockcod *Lepidonotothen squamifrons* (300 tonnes each). These limits have not been updated since 1995, but are kept under review by the Commission taking in to account advice of the Scientific Committee (CM 33-01, 1995).

<u>Limitation of by-catch in Division 58.5.2 (CM 33-02)</u>

By-catch limits are in place for unicorn icefish *Channichthys rhinoceratus* (1,663 tonnes), grey rockcod *Lepidonotothen squamifrons* (80 tonnes), rattails *Macrourus caml* and *Macrourus whitsoni* (409 tonnes combined), *Macrourus holotrachys* and *Macrourus* *carinatus* (360 tonnes combined). **Skates and rays** by-catch will not exceed 120 tonnes. The **by-catch of any other fish species** not mentioned above, and for which there is no other catch limit in force, **shall not exceed 50 tonnes**.

The CM goes on to define the move-on rule, where if the catch of any by-catch species outlined above as well as by catch of **sharks** (*Somniosus* spp.) exceeds the threshold limit, then fishing is prohibited for 5 days within 5 nm of the locality (point at which fishing gear is deployed and subsequently retrieved) (CM 33-02, 2020). The 5-day prohibition is based around the 5-day reporting period, as defined in CM 23-01, rather than on any scientific basis. The wording states '…pending the adoption of a more appropriate period by the Commission.', however this has not been revised since the introduction of the move on rule in 1996.

<u>Limitation of by-catch in new and exploratory fisheries in 2021/21 season (CM 33-03)</u>

Conservation Measure 33-03 applies to all new and exploratory fisheries, except where specific by-catch limits apply, with the catch limits outlined in the CM. These are based on the proportion of catch compared to the total catch of the target species for ***Macrourus* spp**. and **skate and rays**. As with CM 33-02, it brings the move-on rule but also by-catch limits within 10-day periods per month (if they are exceeded within two 10-day periods then the move-on rule will apply. It goes on to define the by-catch limits for each area and are reiterated in individual CMs for each area (e.g., see 41-09).

<u>By-catch limits are also set out in **individual CM for DSFs**:</u>

- CM 41-02 (2019) sets out by-catch limits for the *Dissostichus eleginoides* fishery in Subarea 48.3, which equates to 5% of the Total Allowable Catch (TAC). It also includes the move-on rule mentioned in 33-03 (if the by-catch is equal to or is greater than 1 tonne in one haul or set). Any **crabs** caught as by-catch should be released alive where possible.
- CM 41-03 (2020) sets out by-catch limits for the *Dissostichus* spp. fishery in Subarea 48.4. The move-on rule is also applied if the catch of **skates and rays** exceeds 5% of TAC, or if the catch of *Macrourus* spp. exceeds 16% of the TAC (or reached 150 kg).
- CM 41-04 (2020) sets out the catch limits for *D. eleginoides* in Subarea 48.6 as those set out in CM 33-03.
- CM 41-05 sets out the catch limits for *D. eleginoides* in Division 58.4.2 as those set out in CM 33-03.
- CM 41-06 sets out the catch limits for *D. eleginoides* in Division 58.4.3a as those set out in CM 33-03.
- CM 41-07 sets out the catch limits for *D. eleginoides* in Division 58.4.3b as those set out in CM 33-03.

- CM 41-08 sets out the catch limits for *D. eleginoides* in Division 58.5.2 as those set out in CM 33-02.
- CM 41-09 sets out bycatch rules for the exploratory fishery for *Dissostichus mawsoni* in Subarea 88.1. By-catch limits here apply to individual Small Scale Research Units (SSRUs) and set limits for each SSRU for skates and macrourids.
- CM 41-10 sets out bycatch rules for the exploratory fishery for *Dissostichus mawsoni* in Subarea 88.2. By-catch limits here apply to individual Small Scale Research Units (SSRUs) and set limits for each SSRU for skates and macrourids.

CCAMLR have developed specific rules to reduce **seabird by-catch** in long-line fisheries and these are also outlined mainly in CM 25-02 (2018).

CM 22-04 (2010) details an interim **prohibition on deep-sea gillnetting** (except for scientific purposes) until the Scientific Committee has investigated and reported the potential impacts of gillnets (CM 24-04, 2010).

Vulnerable Marine Ecosystems

Compared to many ocean areas where bottom fishing occurs, the Southern Ocean is characterized by extremely limited data on both the prevailing bottom topography and associated benthic marine ecosystems. This is exemplified by the proportion of new species discovered by recent focused research efforts to study the marine benthic fauna of the region. Furthermore, in the Antarctic, where growth rates of benthic taxa are typically slower than in more temperate regions, the impacts of fishing gear on vulnerable taxa may be magnified because of the much longer time taken to recover. Work continues to improve the mapping of the bottom topography with increased research being put in place provide data that will meet the objectives for the establishment of MPAs under CM 91-04.

CCAMLR has adopted a suite of measures (see Table 1) that restrict the distribution of bottom fisheries by closing areas to fishing, as well as those measures that have been specifically introduced to protect benthic communities. For example, finfish fishing is prohibited around the Antarctic Peninsula and the South Orkney Islands to protect finfish stocks that were depleted prior to the establishment of CCAMLR, although, pot fishing for crabs is permitted following a scientific research program.

Bottom trawling in all high seas areas within the Convention Area has been prohibited along with a complete prohibition on the use of gillnets. The only current CCAMLR high-seas fisheries are pelagic trawling for krill, demersal longlines, and pots for crabs and finfish. For the latter gears, in order to protect shelf-based benthic systems, bottom fishing is prohibited in water shallower than 550 m around the entire Antarctic continent. (CCAMLR, 2021 https://www.ccamlr.org/en/compliance/vulnerable-marine-ecosystems-vmes).

Encounters with potential VMEs

Fishing gear such as longlines and pots are not designed to sample benthic organisms, however, the incidental take of VME-indicator taxa does provide information on the distribution of VMEs. This does also mean that the absence of VME-indicator taxa in the catch may not necessarily represent the absence of a VME, or the impacts of these gears on such VME, in the area being fished. Examples of this have been seen as far back as 2008, where video evidence showed benthic bycatch being lost from lines, in this case stalked crinoids (WG-FSA-08/58). More recently it has suggested that detection thresholds for VME indicator species should be revised based on the characteristics of the species being encountered, specifically the size/weight ratio (WG-EMM_2019/52) CCAMLR's approach has therefore been to balance the acquisition of information on VMEs with the need to implement precautionary measures aimed at avoiding significant adverse impacts to VMEs.

The procedures to be followed by vessels to **monitor and report encounters** with potential VMEs during the course of bottom fishing are described in CM 22-07. These require fishing vessels to collect and report all catches of a suite of "VME-indicator taxa" that are described in CCAMLR's VME Taxa Classification Guide.

Bottom fishing and encounters with VMEs are covered under CM 22-06. This includes the requirement for contracting parties to submit an assessment of their fishing gear on VMEs. There is a pro forma under Annex A for submitting preliminary assessments of the potential for bottom fishing activities to have significant adverse impacts on VMEs (CM 22-06, 2019). See Sharp (2009) paper for a New Zealand case study, which provides an impact assessment framework for THE 2008/09 toothfish longline fishery in the CCAMLR Convention Area.

CM 22-07 outlines the methodology for **reporting on VME encounters**. This is the vessel's responsibility and it needs to notify CCAMLR and its flag State if more than 10 'VME' units are recovered in a given section of line (kg or litre) and it is designated as a risk area and fishing in the area is banned within 1 nm. In addition, it also needs to notify CCAMLR and its flag state if five or more VME units are recovered in a line segment, if more than five of these notifications are received within a fine scale rectangle[11] then all vessels fishing in in that area are warned of the potential of VME encounters. The application of a trigger level of 10 VME indicator units to be used as evidence of a potential VME was based on historical data and experience from both the

[11] An area 0.5° latitude by 1° longitude.

Ross Sea and the Indian Ocean, assessing what would be above an acceptable level compared to normal (SC-CAMLR XXVII).

Also, observers are asked to randomly sample 30% of the line segments or non-randomly sampled buckets that contain ≥ 5 VME units and information entered in to a VME logbook form (CCAMLR, 2020), these data are not used to define VME areas.

Seabirds

Category: 25 - Minimisation of incidental mortality:

CM 25-02 2018. Minimisation of the incidental mortality of seabirds in the course of longline fishing or longline fishing research in the Convention Area (https://www.ccamlr.org/en/measure-25-02-2018)

CM 25-03 2020 Minimisation of the incidental mortality of seabirds and marine mammals in the course of trawl fishing in the Convention Area (https://www.ccamlr.org/en/measure-25-03-2020). This prohibits the use of net monitor cables, prohibits discharge of offal and discards during shooting and hauling of trawl gear, slack time on the water should be minimized, and other gear configuration requirements specific to birds. It does not establish any data reporting requirements.

CCAMLR also has several binding measures related to bycatch and general environmental protections (Elliott, 2020)

Observers are required to monitor marine mammal and seabird interactions with fishing gear in all fisheries. Observations are conducted with the following objectives: (i) to document and quantify seabird and marine mammal catch rates and determine the specific identity, age and sex of all seabirds caught (ii) assess the relative vulnerability of different seabird and marine mammal species (iii) monitor the mortality of seabirds and marine mammals per unit of fishing effort (iv) document all aspects of a vessel's fishing strategy, methods and equipment which have an impact on seabirds and marine mammals (v) assess the effectiveness of CCAMLR measures aimed at reducing the incidental mortality of seabirds and marine mammals (vi) ascertain what, in terms of a vessel's fishing operations, contributes to the seabird and marine mammal by-catch rates observed, and to collect data relevant to factors that influence seabird by-catch rates (vii) to collect and retain biological samples. For collection of seabirds and marine mammal data, the highest priorities for a single scientific observer are as follows: (i) Record mortality, injury and entanglement of seabirds and marine mammals. The level of observation will vary between fisheries, and on the tasking of the observer. In all situations, observers should attempt to maximise the level of coverage of trawl hauls and longline hooks hauled. It is essential that the proportion of fishing effort observed is recorded to allow estimation of total incidental mortality. (ii) Trawl warp strikes. Conduct at least one warp-strike observation per 24-hour period. 27 (iii) Record interaction of marine mammals with fishing vessels and gear. During each haul or trawl observation period, record any interactions with the vessel that do not result in mortality, injury or entanglement. (iv) Verify that mitigation measures used by vessels comply with CCAMLR requirements, and describe any additional measures, or measures that differ from CCAMLR requirements. The CCAMLR website has extensive resources on seabird identification, a self-training tool to assist observers to identify seabirds and marine mammals, and several posters in multiple languages for educating crew and vessels on reducing impacts on marine species (www.ccamlr.org/node/77322).

CCAMLR Conservation Measure **CM 32-18 2006** prohibited directed fishing for **sharks** has in the CCAMLR Area, other than for scientific research. Any accidental bycatch of sharks shall, as far as possible, be released alive. CCAMLR has also adopted guidelines for releasing skates to minimize damage, quotas for skate and ray bycatch, and measures to minimize incidental mortality of non-target species, including sharks (CM 33-02, 2012; 33-03, 2015). CM 33-03 (2015) on the "Limitation of by-catch in new and exploratory fisheries in the 2015/16 season" specifies that, recaptured tagged skates and rays must be retained, but unless otherwise specified by scientific observers, all other skates and rays caught alive and with a high probability of survival should be released alive, by vessels, by cutting snoods, and when practical, removing the hooks, and the number should be recorded and reported to the Secretariat. (CCAMLR, 2006; CMS 2016: Memorandum of Understanding on the Conservation of Migratory Sharks (Sharks MOU). Review and gap analysis of shark and ray bycatch mitigation measures employed by fisheries management bodies (https://www.cms.int/sites/default/files/document/CMS_Sharks_CWG1_Doc_3_1.pdf)

The General Fisheries Council for the Mediterranean (GFCM)

The incidental capture of vulnerable species in fisheries (also known generically as bycatch) represents a key conservation issue in the Mediterranean for a number of taxonomic groups, namely sea turtles, marine mammals, seabirds, elasmobranchs and macrobenthic invertebrates. Necessary measures should be taken to minimize and mitigate negative anthropogenic impacts on marine biodiversity, especially in relation to these vulnerable species and to ecosystems. The adoption of such measures requires comprehensive knowledge of the extent of the problem.

Management measures

Resolution GFCM/43/2019/2 on enhancing the conservation of cetaceans in the GFCM area of application aiming to reduce the bycatch of cetaceans in the GFCM area of application, thus contributing to improve the conservation status of these animals, in line with an ecosystem approach to fisheries management; adopts the following resolution:1.Contracting parties and cooperating non-contracting parties (CPCs) should encourage further actions to improve the conservation status of cetacean species.2.CPCs should enhance data reporting information on incidental catch rates of cetaceans in line with the technical manual of the GFCM Data Collection Reference Framework (DCRF).3.CPCs are invited to take the necessary steps to implement existing legislation and mitigation measures to eliminate incidental catch of cetaceans during fishing operations.4.The SAC is requested to compile, assess and evaluate all available data, information and actions reported under Recommendation GFCM/36/2012/2,under the DCRF and any other source of additional information including scientific literature, surveys at sea, research projects etc.

Recommendation GFCM/42/2018/2 on fisheries management measures for the conservation of sharks and rays in the GFCM area of application, amending Recommendation GFCM/36/2012/3 Contracting parties and cooperating non-contracting parties (CPCs) shall ensure that sharks are kept on board, transshipped, landed and marketed at first sale in a way that species are recognizable and identifiable, and that the catch, incidental catch and, whenever appropriate, release of these species can be monitored and recorded. CPCs shall adopt fisheries management measures to ensure adequate conservation status of sharks. Elasmobranchs species under Annex II (list of endangered or threatened species) and Annex III (list of species whose exploitation is regulated) of the SPA/BD Protocol to the Barcelona Convention6.CPCs shall ensure a high protection from fishing activities for elasmobranch species listed in Annex II of the SPA/BD Protocol of the Barcelona Convention, which must be released unharmed and alive, to the extent possible. 7.Specimens of shark species listed in Annex II of the SPA/BD Protocol shall not be retained on board, transshipped, landed, transferred, stored, sold or displayed or offered for sale. 8.CPCs shall ensure that tope shark (*Galeorhinus galeus*) specimens caught with bottom-set gillnets, longlines and tuna traps be promptly released unharmed and alive, to the extent possible. Monitoring, data collection and research. CPCs shall ensure that: a)information on fishing activities, catch data, incidental catches, release and/or discarding of sharks species listed either in Annex II or Annex III of the SPA/BD Protocol, is recorded by the shipowner in the logbook or in an equivalent document, in line with the requirements of Recommendation GFCM/35/2011/1; b)such information is reported to the national authorities for notification to the GFCM Secretariat within their annual national reporting to the SAC and in accordance with the data reporting requirements of relevant GFCM recommendations, in line with the GFCM Data Collection Reference Framework (DCRF);

and c)any other additional measure is taken to improve data collection in view of the scientific monitoring of species.

In 2010 and 2011 the GFCM adopted ad-hoc measures to reduce the by-catch of pelagic sharks such as thresher sharks (according to ICCAT recommendations), mako and hammerhead sharks. In 2012, the GFCM banned finning practices in the Mediterranean and Black Sea and also prohibited the capture and sell of the sharks and rays species listed in Annex II of the SPA/BD Protocol of the Barcelona Convention. In 2010-2013 the GFCM carried out a three-year research programme to improve the knowledge and assess the status of elasmobranchs in the region, and it continues to work in close collaboration with the regional experts to contrast sharks and rays populations' decline.

In order to ensure the implementation of fisheries management measures that strong reduce the risk of incidental taking also of sea turtles, cetaceans and seabirds during fishing operations specific decisions dealing with the issue of by-catch and data collection were recently adopted by the GFCM.
GFCM decisions:

- Rec. GFCM/36/2012/2 (Cetaceans)
- Rec. GFCM/35/2011/3 (Seabirds)
- Rec. GFCM/35/2011/4 (Turtles)
- Rec. GFCM/37/2013/2

GFCM decision: Rec. GFCM/35/2011/5
The Mediterranean monk seal (*Monachus monachus*) is considered to be one of the most endangered mammal in the world with some 300–500 remaining individuals. Management measures to protect this critically endangered pinniped are therefore extremely urgent to avoid its extinction. The GFCM has contributed by issuing an ad-hoc decision to especially protect the monk seal from fisheries and it is currently working to produce the most updated maps indicating the actual occurrence of this species in the Mediterranean.

Medbycatch project

GFCM carried out the first phase of Medbycatch project (Understanding Mediterranean multitaxa bycatch of vulnerable species and testing mitigation – a collaborative approach: http://www.fao.org/documents/card/en/c/ca4949en/) between 2017 and 2020. This part of the project was focused in some areas of Morocco, Tunisia and Turkey, with the following objectives:

- Address knowledge gaps regarding the bycatch of vulnerable species occurring during fishing operations in the Mediterranean through a more systematic and standardized approach to data collection and capacity-building.
- Identify, and support the testing of, mitigation measures to reduce incidental catches and/or mortality of vulnerable species.
- Raise awareness on the issue of bycatch and provide bases for the formulation of national/regional strategies to reduce incidental catches, preserve vulnerable species and support the sustainability of fisheries.

The second phase of the Medbycatch project expanded the geographical scope of the project to include Croatia and Italy. France and Spain are included in policy and advocacy activities. In phase 2, the project is focused on:

- Conducting trials of technical solutions/mitigation measures that are effective in reducing the impact of bycatch on vulnerable species.
- Informing and supporting the development of policies related to the bycatch of vulnerable species at national and regional level (e.g. European and Mediterranean).
- Building capacities and supporting fishers to apply measures to tackler bycatch of vulnerable species.

So far, one of the outcomes of the project is the manual "Monitoring incidental catch of vulnerable species in the Mediterranean and the Black Sea: methodology for data collection" (FAO, 2019; http://www.fao.org/gfcm/publications/series/technical-paper/640/en/) in which the following methodologies for collecting fishery-dependent data were proposed: observer programs, interviews, self-sampling, stranding data and remote electronic monitoring .The document provides an analysis of these methods for obtaining bycatch data, considering their advantages and limitations. It also illustrates how can they be implemented in Mediterranean fisheries, by providing worked examples for two fleet segments: trawlers 12-24 m and small-scale fishing vessels 6-12 m. The use of fishery-independent data is also reviewed.

As the Medbycatch project is still ongoing, the final results are not available yet. The future publication of the Review on Incidental Catches of Vulnerable Species in the Mediterranean and the Black Sea will establish a baseline for bycatch in the region and will identify existing gaps. It will represent an important basis for informing and prioritizing future efforts on bycatch in the region.

The Northwest Atlantic Fisheries Organisation (NAFO)

The NAFO Conservation and Enforcement Measures - NCEM (NAFO, 2021), is revised each year at the NAFO Annual Meeting, and implemented a number of measures, for the vessels operating in the Regulatory Area, to prevent and manage the by-catch of species, such as:

Chapter I, **Article 6** deals with **measures to minimize bycatch of species from stocks** (in moratoria or not) that are regulated by NAFO, identified in Annex I.A of the NCEM (NAFO, 2021). Guidance to the calculation of the by-catch is also given. This article defines:

- Limits for Species Listed in Annex I.A Retained on Board as Bycatch

  These limits are related to each fishery, quota levels, and different species caught as bycatch.
- Exceeding Bycatch Limits in Any One Haul

  Measures to be taken when by-catches levels are overshoot, such as moving rules and trial sets.

Chapter I, **Article 12** deals with measures to **conservation and management of Sharks** (NAFO, 2021). This article defines:

- Duties of the Contracting Party

  Report all catches of sharks, prohibit the removal/retention/transshipment/landing of shark fins, prohibit directed fishery for Greenland shark (*Somniosus microcephalus*), minimize incidental catch and mortality of Greenland sharks.
- General Provisions

  Facilitate storage fins and carcass to on-board, encourage to release sharks alive, especially juveniles that are not intended for use as food or subsistence.
- Research

  Encourage Contracting Parties to undertake research to identify ways to make fishing gear more selective for the protection of sharks and conduct research on key biological and ecological parameters, life-history, behavioural traits and migration patterns, as well as on the identification of potential mapping, pupping and nursery grounds of key shark species.

In **NAFO** bycatch for skates is 2500 kg or 10%, whichever is the greater (listed in annex I.A of NAFO CEM). There is a **move-on rule** when the bycatch limits exceeds the greater of the limits specified above and the vessel shall: 1) immediately move a minimum of 10 nautical miles from any position of the previous tow/set throughout the subsequent tow/set; 2) leave the Division and not return for at least 60 hours if the bycatch limits are again exceeded following the first tow/set after moving; 3) undertake a trial tow for a maximum duration of 3 hours before starting a new fishery following an absence of at least 60 hours.

Chapter I, **Article 13** (and Annex III.A) deals with **gear requirements** (NAFO, 2021). This article defines:

- Mesh Sizes: Mesh size allowed for use in several target fisheries, storage of nets, and by catches permitted.
- Use of Attachments: Rules for use attachments to the net in order to not chance the net selectivity and avoid unavoidable by-catch and also protect juveniles.
- Lost or Abandoned Fishing Gears: Rules to prevent lost gear from continuing to fish.

Chapter I, **Article 14** (and Annex I.D) deals with **Minimum Fish Size Requirements** (NAFO, 2021). This article defines:

- Rules for dealing with live or processed minimum fish size specimens and moving rules when the number of undersized fish in a single haul exceeds 10% of the total number of fish in that haul.

Chapter II of the NAFO CEM (NAFO, 2021) is all dedicated of the **protection of the Vulnerable Marine Ecosystems (VMEs)** in the Regulatory Area from bottom fishing activities. This chapter has several articles that deal with:

- **Article 15** –Definitions

  Definition of the terms: "Encounter"; "Exploratory bottom fishing activities"; "Footprint"; "Significant adverse impacts"; "Vulnerable marine ecosystems (VMEs)"; "VME indicator element"; "VME indicator species".
- **Article 16** - Map of Footprint (Existing Bottom Fishing Areas)

  The map of existing bottom fishing areas in the NAFO Regulatory Area is delimited and illustrated.
- **Article 17** – Area Restrictions for Bottom Fishing Activities

  Definition and delimitation of close areas to bottom fishing activities: Seamounts Closures, Coral Area Closures and High Sponge and Coral Concentration Area Closures. Contracting Parties are also encouraged to the extent possible to record all coral and sponge catch in their annual government and/or industry research programs and to consider non-destructive means for the long-term monitoring of coral and sponge in the closed areas.
- **Article 18** – Exploratory Bottom Fishing Activities

  Rules for new exploratory bottom fishing activities.

- **Article 19** – Preliminary Assessment of Proposed Exploratory Bottom Fishing Activities; **Article 20** – Management of Exploratory Bottom Fishing and **Article 21** – Evaluation of Exploratory Bottom Fishing Activities: Related to article 18.
- **Article 22** – Provisions in Case of Encounter
Rules for deal with encounters of VMEs indicators species: Encounter Threshold; Duties of the Master such as reporting quantity, position, moving rule; Duties of the observer such as identification of the corals, sponges or other organisms to the lowest possible and delivers the results of such identification to the master of the vessel; Duties of the Contracting Party such as communication of encounter to all fishing vessels entitled to fly its flag; Duties of the Executive Secretary such as archiving of incident information reported by masters and reporting relevant information.
- **Article 23** – Reassessment of Bottom Fishing Activities
The Commission will request the Scientific Council regularly to assess bottom fishing activities and advice for necessary actions to protect VMEs, including potential adjustment of closed areas.
- **Article 24** – Review
The Commission will review regularly the provisions of this Chapter.

The NCEM presents the measures already approved. However, NAFO established the NAFO Commission Ad Hoc Working Group on Bycatches, Discards and Selectivity (WG-BDS) to handle with emerging cases, or unresolved cases of avoidable by-catch. This WG and NAFO Scientific Council has been addressing several requests, from NAFO COM, about how to mitigate catches of juveniles fishes, sharks, seabirds, turtles and marine mammals. Nevertheless, any recommendation from SC or WGBDS needs to be approved by NAFO COM to be mandatory.

NAFO COM also adopted in 2017 an Action Plan in the Management and Minimization of Bycatch and Discards (NAFO/COM, 2017) that will be in place at least up to September 2021.

The Northeast Atlantic Fisheries Commission (NEAFC)

NEAFC decides upon conservation and/or management measures for the regulatory area (see Article 5 of the NEAFC Convention). These 'measures' can cover different things, for example stocks or individual species and or a specific area or time period, depending on what policy makers want to achieve. Measures are decided by the Parties which make up the Commission on the basis of scientific advice from an independent scientific body The International Council for the Exploration of the Sea (ICES). The majority of these measures are decided at the Annual Meeting of the Commission held in November, but decisions can also be taken by postal vote throughout the year should the need arise. In order to operate within the regulations fishing vessels must abide by both the Current Management Measures and the NEAFC Scheme of Control and Enforcement. The NEAFC Scheme describes the procedures for Monitoring Control and Surveillance (MCS) of fishing activities within the NEAFC regulatory area. It the responsibility of the flag State which licenses the vessel to fish to ensure that it complies with all the regulations. https://www.neafc.org/managing_fisheries/measures

The NEAFC approach to conservation and management of deep-sea species and categorization of deep-sea species/stocks, adopted at the 35th Annual Meeting November 2016 (NEAFC, 2016), aims to place individual species/stocks into one of four categories requiring different character and level of NEAFC regulations. For example, all of the deep-sea sharks, rays and chimaeras that are subject to bycatch are classified in the second category, that refers to "Measures stipulating that directed fisheries are not authorized and that bycatches should be minimized. This should apply to stocks for which the ICES advice statement is "no directed fishery, minimize bycatch" or similar, but for which no specific catch limit is advised.

- They are no specific conservation and management measures to mitigate by-catch of **seabirds**. However, in the 39th Annual Meeting in 2020, NEAFC requested Scientific advice from ICES on this topic (non-recurring advice from ICES on bird bycatch as set out in document AM 2020-95 Rev1) (NEAFC, 2020g).
- For **sharks, rays and chimaeras** (NEAFC, 2020b; 2020c; 2020d; 2020e; 2020f; 2021a) Directed fishing for deep-sea sharks and rays is prohibited. Categorization of sharks, rays, and chimaeras on the NEAFC list of deep-sea species: 2 (directed fisheries are not authorized and bycatches should be minimized). Contracting Parties are encouraged to take conservation measures with equal effect within waters under their national jurisdiction. There are specific recommendations to mitigate bycatch for several species:

- Recommendation 07 2020 on Conservation and Management Measures for Porbeagle (*Lamna Nasus*) in the NEAFC Regulatory Area from 2020 to 2023.
- Recommendation 08 2020 on Conservation and Management Measures for Basking Shark (*Cetorhinus maximus*) in the NEAFC Regulatory Area from 2020 to 2023. Any incidental catches of this resource shall be promptly released unharmed, to the extent possible. Contracting Parties shall submit to ICES all available data on basking shark. This should include fisheries data, with incidental catches being recorded in numbers, and by size and weight (where possible).
- Recommendation 09 2020 on Conservation and Management Measures for Deep Sea Sharks in the NEAFC Regulatory Area from 2020 to 2023.
- Recommendation 10 2020 on Conservation and Management Measures for Deep Sea Rays (Rajiformes) in the NEAFC Regulatory Area from 2020 to 2023.
- Recommendation on Conservation and Management Measure for Deep Sea Chimaeras in the NEAFC Regulatory Area from 2020 to 2023.

- Recommendation 08 2021 on Conservation and Management Measures for Picked Dogfish /Spurdog (*Squalus acanthias*) in the NEAFC Regulatory Area for 2021 and 2022: Any incidental catches of this resource shall be promptly released unharmed, to the extent possible. Contracting Parties shall submit to ICES all available data on picked dogfish/spurdog, including data on discarding, for further evaluation of the state of the resource. For spurdog, ICES advice continued for no targeted fisheries in 2021 and 2022. It also noted that bycatch levels should not exceed 2468 tonnes. Spurdog would be benchmarked in 2021, with new advice in 2022.

- For **marine mammals**, NEAFC does not have any measures directly related to cetaceans, though they do have several measures that indirectly pertain to bycatch. For example, Recommendation 05 and 06 2021 on Grenadiers calls for reporting any bycatch to ICES. "Contracting Parties shall submit all data on the relevant fishery to ICES, including catches, bycatches, discards and activity information." Recommendation 03 2006 bans gillnets in waters over 200 m deep. Exploratory deep-sea fisheries require observers (Recommendation 19:2014), but otherwise NEAFC does not have a regional observer coverage requirement (Elliott, 2020).

- Recommendations related to **fish bycatch** (NEAFC, 2021b; 2021c):

  Recommendation 05 2021 on the Conservation and Management of Roundnose Grenadier (Coryphaenoides rupestris), Roughhead Grenadier (Macrourus berglax), and Roughsnout Grenadier (Trachyrinchus scabrus) and other Grenadiers (Macrouridae) in the NEAFC Regulatory Area (Divisions 10.b and 12.c, and Subdivisions 12.a.1 and 14.b.1) for 2021. A total allowable catch limitation of 574 tonnes of roundnose grenadier is established. 2. No direct fisheries for roughhead grenadier and roughsnout grenadier should be authorised, and bycatches of these grenadiers as well as other grenadiers (Macrouridae) should be counted against the total allowable catch of roundnose grenadier specified in Point 1. 3. Contracting Parties shall submit all data on the relevant fishery to ICES, including catches, bycatches, discards and activity information. Catches should be reported by species. Unidentified grenadiers should be recorded as Macrouridae.

Recommendation 06 2021 on the Conservation and Management of Roundnose Grenadier (Coryphaenoides rupestris), Roughhead Grenadier (Macrourus berglax), and Roughsnout Grenadier (Trachyrinchus scabrus) and other Grenadiers (Macrouridae) in the NEAFC Regulatory Area on Hatton Bank and Rockall (ICES Subdivisions 6.b.1 and 7.c.1 and 7.k.1, and Subdivisions 5.b.1.a and Division 12.b) for 2021. A total allowable catch limitation of 2 620 tonnes roundnose grenadier is established; No direct fisheries for roughhead grenadier and roughsnout grenadier should be authorised, and bycatches of these grenadiers as well as other grenadiers (Macrouridae) should be counted against the total allowable catch of roundnose grenadier as specified in Point 1 and Contracting Parties shall submit all data on the relevant fishery to ICES, including species-specific catches, bycatches, discards and activity information.

- **Benthic organisms related to VME**: Recommendation 10 2021 to amend Recommendation 19:2014 on the Protection of Vulnerable Marine Ecosystems in the NEAFC Regulatory Area, as amended (NEAFC, 2021d).
- Conservation and management measures (CMM) to prevent significant adverse impacts on VMEs are in place.
- There are **13 Area closures for the protection of VMEs** in the Regulatory Area.
- CMM adopted by NEAFC may include: (a) allowing, prohibiting or restricting bottom fishing activities; (b) requiring specific mitigation measures for bottom fishing activities and (c) allowing, prohibiting or restricting bottom fishing activities with certain gear types, or changes in gear design and/or deployment. Measures to undertake exploratory bottom fishing that includes a harvesting plan, mitigation plan to prevent SAI to VME, fine data collection systems, etc.
- **VME encounters**: if an encounter is discovered in connection with the hauling of a trawl gear, the fishing vessel shall cease fishing and move out of an area defined as a 2 nautical mile wide band (polygon) on both sides of the “track” of the trawl haul during which an encounter occurred. The “track” is defined as the line joining consecutive VMS positions, supplemented by more exact information, between the start

and the end of the tow, extended by 2 nautical miles at both ends. If an encounter is discovered in connection with other bottom fishing gears the fishing vessel shall cease fishing and move away at least 2 nautical miles from the position that the evidence suggests is closest to the exact encounter location. VME encounters shall be reported by the vessel to its flag state which shall forward the information to NEAFC Secretariat. A temporary closure in the identified areas is implemented until PECMAS has evaluated the evidence and determines if a VME is likely or exists.

- **VME thresholds**: For a trawl tow, and other fishing gear than longlines: the presence of more than 30 kg of live coral and/or 400 kg of live sponge of VME indicators. For a longline set: the presence of VME indicators on 10 hooks per caught per 1000 hook segment or per 1200 m section of long line, whichever is the shorter.
- **VME Data Collection Protocol**: Observers on fishing vessels in the Regulatory Area shall: (a) Monitor any set for evidence of presence of VMEs and identify coral, sponges and other organisms to the lowest level; (b) Record on data sheets the following information for identification of VMEs: vessel name, gear type, date, position (latitude/longitude), depth, species code, trip-number, set number, and name of the observer on data sheets, if possible; (c) Collect, if required, representative samples from the entire catch (biological samples shall be collected and frozen when requested by the scientific authority in a Contracting Party); and (d) Provide samples to the scientific authority of a Contracting Party at the end of the fishing trip.

The North Pacific Fisheries Commission (NPFC)

After discussions with the Science Manager of NPFC, the Commission have not fully addressed bycatch avoidance and management strategies, and protocols are currently under development (Alex Zavolokin, personal communication, May 2021). However, there are two conservation and management measures (CMMs) that detail some bycatch management protocols (detailed below).

CMM 2021-05 and CMM 2019-06 set out **conservation and management measures for bottom fisheries and protection of VMEs** in the northeastern and northwestern Pacific Ocean, respectively. NPFC apply catch and effort controls to deep-sea fisheries (including exploratory fisheries) via the implementation of a precautionary approach. This included precautionary effort limits for bycatch species, particularly where reliable assessments of exploration rates of such bycatch species are not available. The Scientific Committee (SC) is in charge of identifying and reviewing VMEs and assessments of significant adverse impacts (SAIs) on VMEs (including VME by-catch species), including proposed management measures intended to prevent such impacts by individual Members. Observers in the Annual Observer Programme collects catch data on target and by-catch species by area and season (and the percent observed out of the TAC) as well as representative length-frequency and biological data of the main by-catch species. These data form a component of annual National Reports submitted by members to the SC. In addition to the above CMMs, each NPFC member is required to collected information on all bycatch species.

CMM 2021-05

This measure is to be applied to all bottom fishing activities throughout the high seas areas of the **Northwestern Pacific Ocean** (here in after called "the western part of the Convention Area") including all such areas and marine species other than those species already covered by existing international fisheries management instruments, including bilateral agreements and Regional Fisheries Management Organizations or Arrangements. The objective of these Measures is to ensure the long-term conservation and sustainable use of the fisheries resources in the Convention Area while protecting the marine ecosystems of the North Pacific Ocean in which these resources occur. These measures shall set out to prevent significant adverse impacts on VMEs in the Convention Area of the North Pacific Ocean, acknowledging the complex dependency of fishing resources and species belonging to the same ecosystem within VMEs. The Commission shall re-evaluate, and as appropriate, revise, the definition based on further consideration of the work done through FAO and by NPFC.

CMM 2021 05 considers measures to protect VMEs, such as the following:

- **Limiting fishing effort** in bottom fisheries and not allowing bottom fisheries to expand into the western part of the Convention Area where no such fishing is currently occurring, except for exploratory fisheries with insignificant SAIs on VMEs (subjected to an exploratory fisheries protocol).
- **Prohibiting vessels from engaging in directed fishing** on the following taxa: Alcyonacea, Antipatharia, Gorgonacea, and Scleractinia as well as any other indicator species for VMEs as may be identified from time to time by the SC and approved by the Commission.
- Establishing a **move-on rule** for encounters with VME indicators: Considering accumulated information regarding fishing activities in the western part of the Convention Area, in areas where, in the course of fishing operations, cold water corals more than 50Kg are encountered in one gear retrieval, Members of the Commission shall require vessels flying their flag to cease bottom fishing activities in that location. In such cases, the vessel shall not resume fishing activities until it has relocated a sufficient distance, which shall be no less than 2 nautical miles, so that additional encounters with VMEs are unlikely. All such encounters, including the location, gear type, date, time and name and weight of the VME indicator species, shall be reported to the Secretariat, through the Member, within one business day, who shall immediately notify the other Members of the Commission so that appropriate measures can be adopted in respect of the relevant site. It is agreed that the cold-water corals include: Alcyonacea, Antipatharia, Gorgonacea, and Scleractinia.
- Establishing **closures**: C-H seamount and Southeastern part of Koko seamount, specifically for the latter seamount, the area South of 34 degrees 57 minutes North, East of the 400m isobaths, East of 171 degrees 54 minutes East, North of 34 degrees 50 minutes North, are closed precautionary for potential VME conservation. Fishing in these areas requires exploratory fishery protocol (Annex 1).

CMM 2019-06

This measure is to be applied to all bottom fishing activities throughout the high seas areas of the **Northeastern Pacific Ocean** (here in after called "the eastern part of the Convention Area") including all such areas and marine species other than those species already covered by existing international fisheries management instruments, including bilateral agreements and Regional Fisheries Management Organizations or Arrangements. Its objectives are very similar to those of CMM 2021-05, namely, to ensure the long-term conservation and sustainable use of the fishery resources of the Northeastern Pacific Ocean and, in so doing, protect the vulnerable marine ecosystems that occur there, in accordance with the Sustainable Fisheries Resolutions adopted by

UNGA. The implementation of these Measures shall: a) be based on the best scientific information available in accordance with existing international laws and agreements including UNCLOS and other relevant international instruments, b. establish appropriate and effective conservation and management measures, c. be in accordance with the precautionary approach, and d. incorporate an ecosystem approach to fisheries management. CMM 2019-06 considers similar measures to protect VMEs to the ones in CMM 2021-05 described above.

Both **CMM 2021-05** and **CMM 2019-06** include several annexes containing:

1. An exploratory fishery protocol in the North Pacific Ocean
2. Science-based standards and criteria for identification of VMEs and assessment of significant adverse impacts on VMEs and marine species
3. Scientific Committee assessment review procedures for bottom fishing activities
4. Format of national report sections on development and implementation of scientific observer programmes
5. NPFC bottom fisheries observer programme standards: scientific component type and format of scientific observer data to be collected

Both CMMs require that Flag members operating **observer programs** are to develop, in cooperation with the SC, lists and identification guides of protected species or species of concern (seabirds, marine mammals or marine reptiles) to be monitored by observers. The data to be collected on Incidental Captures of **Protected Species** (by scientific observers) as established in CMM 2021-05 and CMM 2019-06 includes:

(a) Species (identified as far as possible, or accompanied by photographs if identification is difficult).

(b) Count of the number caught per tow or set.

(c) Life status (vigorous, alive, lethargic, dead) upon release.

(d) Whole specimens (where possible) for onshore identification. Where this is not possible, observers may be required to collect sub-samples of identifying parts, as specified in biological sampling protocols.

Also, the SC is required to develop a guideline, species list and identification guide for **benthic species (e.g., sponges, sea fans, corals)** whose presence in a catch will indicate that fishing occurred in association with a **vulnerable marine ecosystem (VME)**. All observers on vessels shall be provided with copies of this guideline, species list and ID guide. At present, NPFC has produced a VME taxa identification guide for the Western North Pacific Ocean but there is no information whether this guide is being used by observers already (NPFC, 2020).

For each observed fishing operation, the following data are to be collected for all species caught, which appear on the list of vulnerable benthic species:

(a) Species (identified as far as possible or accompanied by a photograph where identification is difficult).

(b) An estimate of the quantity (weight (kg) or volume (m^3)) of each listed benthic species caught in the fishing operation.

(c) An overall estimate of the total quantity (weight (kg) or volume (m^3)) of all invertebrate benthic species caught in the fishing operation.

(d) Where possible, and particularly for new or scarce benthic species which do not appear in ID guides, whole samples should be collected and suitable preserved for identification on shore.

In addition, CMM 2021-05 includes a document describing the Implementation of the Adaptive Management for North Pacific armorhead (in 2021). Monitoring survey for the detection of strong recruitment of North Pacific armorhead and areas where bottom fishing with trawl gear is prohibited when high recruitment is detected

There are **no specific conservation and management measures to mitigate by-catch of seabirds, sharks and rays or marine mammals** in NPFC.

Research related to bycatch in NPFC

The NPFC Scientific Committee has created a five-year research plan for the period 2021-2025 (NPFC, 2021). With respect to ecosystem approach to fisheries management, this plan includes the following areas of work:

- Formulation of a work plan on how to implement the ecosystem approach to fisheries management in the Convention Area
- Vulnerable Marine Ecosystems
- Understand ecological interactions among species
- Ecosystem modelling
- Evaluate impacts of fishing on fisheries resources and their ecosystem components, **including bycatch species** and
- Other issues related to marine ecosystems including marine debris and pollution.

Regarding **VMEs**, the areas of work included in NPFC-SC's research plan are the following:

- Review existing NPFC standards on VME data collection, including guidelines set forth in the CMMs for bottom fisheries and protection of vulnerable marine ecosystems in the northwestern and northeastern Pacific Ocean (CMM 2019-05 and CMM 2019-06), and determine if any modifications to these standards are needed in the short-term and/or longer term

• Review of Encounter Protocol for bottom fisheries on Vulnerable Marine Ecosystems

• Determination of data requirements and identification of what data may be collected through commercial fishing operations

• Develop consensus on criteria used to identify VMEs and how this might be applied in the NPFC (note that guidelines from the FAO are already referenced in Annex 2 of the CMM 2019-05 and CMM 2019-06)

• Analysis of known or suspected VMEs in the Convention Area

• Visual surveys of VMEs for data collection

• Development of a framework to conduct assessments of Impacts of Bottom Fishing Activities on Vulnerable Marine Ecosystems

To date, Japan, Russia, Korea, the US and Canada have completed a report on identification of VMEs and an assessment of impacts caused by bottom fishing activities on VMEs and marine species. The Scientific Committee may build on these reports, which will be kept up to date by respective Parties (NPFC, 2021).

Also, a **joint PICES-NPFC Study Group for Scientific Cooperation in the North Pacific Ocean (PICES-NPFC** SG) was established in 2017 to determine if there were scientific areas of mutual interest on which both organizations can collaborate, and if so, to identify mechanisms to jointly implement activities that produce desired products and outcomes for each organization. North Pacific Marine Science Organization (PICES) are inter-governmental organizations with overlapping geographical areas and common scientific interests in the sub-Arctic regions of the North Pacific Ocean.

In response to these functions, the **NPFC developed a 2017-2021 Research Plan** which outlines priority research themes, including the rationale and more specific areas of work. These theme areas include (i) stock assessments for target fisheries and bycatch species, (ii) ecosystem approach to fisheries, (iii) **vulnerable marine ecosystems**, and (iv) data collection, management and security.

PICES and NPFC share a common objective of promoting marine research that helps ensure the long-term conservation and sustainable use of the fisheries resources while protecting the marine ecosystems in which these resources occur. There are several areas of possible collaboration between NPFC and PICES on VMEs. Focused research topics may include:

(1) Increasing scientific knowledge of biodiversity associated with known seamounts in the North Pacific, including identification of endemic species and distribution patterns of vulnerable taxa;

(2) Increasing scientific understanding of the functional relationships within the ecosystem, with a special focus on the complex dependency of fishing resources and benthic species within VMEs;

(3) Identification of suspected VMEs in the Convention Area through predictive modeling and empirical observations (visual survey tools, fishery-independent data, where possible, or landed bycatch).

These and other research projects on VMEs will (1) contribute towards PICES FUTURE goals to understand how marine ecosystems in the North Pacific respond to climate change and human activities, (2) support decision making regarding significant adverse impacts (SAIs) of bottom fisheries on VMEs, exploratory fisheries and encounter protocol, and (3) aid implementation of NPFC Conservation and Management Measures for bottom fisheries and protection of VMEs in the NW and NE Pacific Ocean.

Research regarding VMEs is a priority for the NPFC and PICES Study Group. FAO-NPFC VME workshop in March 2018, with invited expert support from PICES, identified several recommendations for further science activities to advance assessment and analysis of VMEs in the North Pacific; Sharing scientific results when they become available (NPFC, 2019).

The Southeast Atlantic Fisheries Organisation (SEAFO)

SEAFO has developed a comprehensive strategy to monitor, survey and control the fisheries. All vessels are required to:

- be formally authorised to fish;
- report catches on a 5-day interval;
- report VMS positions on a 2-hourly interval;
- have an independent scientific observer onboard (Section III of Interim Arrangements of the SEAFO Convention Text);
- comply with port inspection procedures; and
- not make transhipments in the SEAFO CA.

SEAFO (2006, 2009a, 2012) has implemented a number of Conservation Measures to prevent and manage the by-catch of species caught accidentally such as seabirds (CM 25/12 on "Reducing Incidental By-catch of Seabirds), turtles (CM 14/09: To Reduce Sea Turtle Mortality in SEAFO Fishing Operations") or sharks (CM 04/06 on "the Conservation of Sharks caught in association with fisheries managed by SEAFO").

There are also several recommendations (SEAFO, 2008, 2009b) aimed to limit the by-catch, namely Rec 1/2008 about "banning deep-water shark catches" that intends to ban deep-water shark directed fisheries in the SEAFO Convention Area until additional information becomes available to identify sustainable harvesting levels and Rec 2/2009 on "banning of gillnets".

According with the article 10 of the SEAFO (2019) System of Observation, Inspection, Compliance and Enforcement - Information on fishing activities, each contracting Party shall ensure that its vessels keep a bound fishing logbook that includes the proportion of the catch by live weight (Kg) retained on board, including retained by-catch species and discarded TAC species.

Then, in addition to the mandatory reporting of all by-catches, the only Conservation Measure that manage fish bycatch is the CM-TAC-01 (2020) "on Total Allowable Catches and related conditions for Patagonian Toothfish, Deep-Sea Red Crab, Alfonsino, Orange Roughy and Pelagic Armourhead for 2021 in the SEAFO Convention Area". According to this CM (SEAFO, 2020), fishing activities should be developed by first targeting one species (first target species). When the Secretariat determines that 95% of the TAC for one of that species is reached in a management area, the fleet should be instructed by the Secretariat to target the other species (second target species). A total by catch of 5% of the first target species TAC is allowed to be taken when targeting the second species in the same management area; and if 95% of the TAC for the second species is already reached by other vessels, the vessel can fish its second target species as long as the TAC is not exhausted.

Looking to VME protection, the Conservation Measure 30/15 on “Bottom Fishing Activities and Vulnerable Marine Ecosystems in the SEAFO Convention Area” established area closures for the protection of VMEs in article 5. Article 6, concerning Exploratory fisheries, requires a scientific observer to be carried on board and to collect data in accordance with a VME Data Collection Protocol and Article 8 stipulates the procedure to be followed when an encounter with potential VMEs occurs (SEAFO, 2015).

The SEAFO Commission agreed to include IUU vessels that are in the IUU lists of Northwest Atlantic Fisheries Organisation (NAFO), Northeast Atlantic Fisheries Commission (NEAFC,) The Commission for the Conservation of the Antarctic Living Marine Resources (CCAMLR) and the Southern Indian Ocean Fisheries Agreement (SIOFA) into the SEAFO IUU vessel list.

The article 14 of the System of Observation, Inspection, Compliance and Enforcement monitors the transhipments in ports and article 20 obliges countries to design a list of landing ports for all vessels that have been engaged in fishing or fishing related activities in the Convention Area (SEAFO, 2019).

The South Indian Ocean Fisheries Agreement (SIOFA)

SIOFA has implemented the following Conservation and Management Measures (CMM) to prevent and manage the by-catch of species caught accidentally (SIOFA,2019a,2019b,2020a):

- **Sharks**: CMM 2019/12: Conservation and Management Measure for Sharks (Sharks). The term "sharks" refers to Chondrichthyes for the purposes of this CMM.
- **Seabirds**: CMM 2019/13: Conservation and Management Measure on mitigation of seabirds bycatch in demersal longlines and other demersal fishing gears fisheries (Mitigation of Seabirds Bycatch)
- **Fish bycatch** and **bycatch in general**: CMM 2020/15 Conservation and Management Measure for the Management of Demersal Stocks in the Agreement Area (Management of Demersal Stocks)

Regarding marine mammals, there are no specific CMM but several CMMs indirectly refer to cetaceans (e.g., CMM 2019/02 and CMM 2020/15). For example, there are some measures to avoid interactions with cetaceans in Toothfish fisheries in the Del Cano Area, concerning specifically odontocete (toothed) whales.

CMM 2020/15 Conservation and Management Measure for the Management of Demersal Stocks in the Agreement Area (Management of Demersal Stocks). The objective of this CMM is to promote the sustainable management of deep-sea fisheries resources in the Agreement Area, including target fish stocks and non-target species.

Fishing with demersal longlines shall be prohibited in depths shallower than 500m. in order to protect benthic communities and juvenile *Dissostichus* spp.

Regarding toothfish fisheries, collaborative and complementary arrangements are in place for *D. eleginoides* between SIOFA and the Commission for the Conservation of the Antarctic Marine Living Resources (CCAMLR). By-catch limits regarding toothfish are set as follows:

- Toothfish caught by vessels not targeting *Dissostichus spp* may not exceed 0.5 t per season of *Dissostichus spp.*
- Should a vessel fishing for species other than *Dissostichus spp* reach the *Dissostichus spp* limit of 0.5 tonnes, the Del Cano area shall be closed for this vessel for that season.

CMM 2019/02, (Collection, Reporting, Verification and Exchange of Data relating to fishing activities in the Agreement Area) requires national scientific observer programs to collect data. These programs shall ensure that data on fishing activities, including for target, non-target and associated and dependent species such as marine mammals, marine reptiles, seabirds or 'other species of concern', are collected from vessels that are fishing in the Agreement Area. Thus, incidental bycatch of marine mammals, seabirds, reptiles and 'other species of concern' should be recorded. For each species caught the following information needs to be recorded: a) Species name, b) Number alive and c) Number dead or injured (SIOFA, 2019c).
Moreover, seabirds and marine mammals' interactions with the fisheries shall be recorded, which includes abundance of birds and mammal during the fishing operation (setting and hauling) and with observed interaction with the gears.
Vulnerable Marine Ecosystem interaction for each fishing operation, VME taxa observed and quantity, etc. shall be recorded as well (SIOFA, 2019d).

Encounters with VMEs. The threshold that triggers the encounter protocol for **longline gears** is the catch/recovery of 10 or more VME-indicator units of species in a single line segment. The threshold that triggers the encounter protocol for the **trawls** shall be more than 60 kg of live corals and/or 300 Kg of sponges in any tow. If VME encounter occurs, vessels should cease bottom fishing activities in the area and move away a certain distance. The distance depends on the type of gear being used (SIOFA, 2020b). Regarding benthic taxa by-catch, the Scientific Committee shall periodically review all benthic taxa bycatch data to inform its consideration of the location of potential VMEs and potential impacts thereon.

Other management measures. SIOFA's contracting parties and other participating entities are required to prepare bottom fishery impact assessments (BFIAS) for all proposed bottom fishing activities in the SIOFA Area, irrespective of the proposed scale, area or previous history of such fishing activities. This includes new fisheries. BFIAS shall take into account areas identified where VMEs are known or are likely to occur in the area to be fished. Thus, BFIAS require information on interactions with VME. (SIOFA, 2017).

The Southern Indian Ocean is also characterized by a management situation virtually unique in global fisheries, whereby an industry organization known as the **Southern Indian Ocean Deepsea Fishers Association (SIODFA)** has taken an active role in managing their members vessels and identifying sensitive areas that should be closed to demersal fishing by their members' vessels. Several states have incorporated these closed areas into their deep-sea management plans for their own flagged vessels, and in 2018 SIOFA adopted five of these for regional closures to bottom fishing. Moreover, SIODFA is carrying out research related to bycatch species, such as deep-water sharks. In 2022, a new project will use a combination of methods including (a) taxonomy and DNA barcoding (b), eDNA and (c) underwater cameras to rigorously document and catalogue the shark species of the Indian Ocean deep-sea. This data will then be used to build a database of life history, distribution, survivorship, and other biological information to assess the impact of fishing pressure on each species and to produce identification keys and observer training materials for ongoing monitoring.

Scientific observer coverage. Each CCP shall ensure that any vessel flying its flag and undertaking bottom fishing in the Agreement Area: a) using trawl gear has 100 percent scientific observer coverage for the duration of the trip; and b. subject to paragraph 46b, using any other bottom fishing gear type has 20 percent scientific observer coverage in any fishing year6.

The South Pacific Regional Fisheries Management Organisation (SPRFMO)

SPRFMO has implemented Conservation and Management Measures (CMM) to prevent and manage the by-catch of **seabirds**: CMM 09-2017 Conservation and Management Measure for minimizing bycatch of seabirds in the SPRFMO Convention Area (SPRFMO, 2017).

For **sharks and rays** (chondrichthyans), there are no specific CMM. Some management measures exist in the case of exploratory fisheries (e.g., CMM 14a 2019, CMM 14d-2020, CMM 14b 2021, CMM 14 e-2021).

For **marine mammals**, there are no specific CMM. Some management measures exist in the case of exploratory fisheries (e.g., CMM 14 e-2021).

There are general CMM for **Deepwater Species** (CMM 03-2021 Conservation and Management Measure for Deepwater Species in the SPRFMO Convention Area) (SPRFMO, 2021b).

According to **CMM 02-2021 (Conservation and Management Measure on Standards for the Collection, Reporting, Verification and Exchange of Data. Data on Fishing Activities and the Impacts of Fishing)** (SPRFMO, 2021a), Members and Cooperating non-Contracting Parties (Members and CNCPs) are to develop, implement and improve systems to ensure that data on fishing activities, including data to assess the impacts of fishing on non-target and associated or dependent species (including marine mammals, seabirds, reptiles or other species of concern), are collected from vessels according to the operational characteristics of each fishing method.
Thus, **incidental captures of species of concern (marine mammals, seabirds, reptiles or other species of concern) or benthic taxa shall be recorded**. The FAO species code and estimated amount of catch retained on board and discards has to be recorded for all species caught by the gear or fishing event (including bycatch and species of concern) catch and discards must be recorded in weight for fish and benthic material and numbers for marine mammals, seabirds, reptiles and other species of concern.

Members and CNCPs are to develop and implement observer programs consistent with **CMM 16-2021 (Observer Programme, SPRFMO 2021c)** to collect verified scientific data and additional information related to fishing activities in the Convention Area and its impacts on the ecosystem, and also to support the functions of the Commission and its subsidiary bodies, including the CTC.

Observers shall report the following information related to by-catch:

- Estimated catch of all species (FAO species code) retained and discarded, split by species, in live weight (to the nearest kg), including all benthic taxa;
- If any marine mammals, seabirds, reptiles or other species of concern were caught.
- If any benthic material, including VME Indicator Taxa, was caught.

Biological data should be collected for representative samples of the main target species and, time permitting, for **other main by-catch species** contributing to the catch.

- Record any **bycatch mitigation measures** employed (Tori lines, bird baffler(s), offal management, no discharge during shooting and hauling, only liquid discharge; waste batching ≥ 2 hours, night setting, line weighting, bait type, haul mitigation such as bird deterrent curtains).

According to **CMM 03-2021 (Bottom Fishing)** (SPRFMO, 2021b), Members and CNCPs shall require vessels flying their flag and undertaking bottom fishing to implement seabird mitigation measures in accordance with CMM 09-2017 (Seabirds), and shall report annually to the Commission on bycatch rates and total bycatch estimates in accordance with CMM 02-2021 (Data Standards) and the Guidelines for Annual National Reports to the SPRFMO Scientific Committee.

The Scientific Committee shall **provide advice biennially** to the Commission on:
a) direct and indirect interactions between bottom fishing and marine mammals, seabirds, reptiles and other species of concern;
b) any recommended spatial or temporal closures or spatially/temporally limited gear prohibitions for any identified hotspots of these species; and
c) any recommended bycatch limits and/or measures for an encounter protocol for any of these species.

Regarding **VME encounters**, CMM 03-2021 establishes that when VME indicator taxa are encountered in any one tow at or above the threshold limits in its Annex 6A, or three or more different VME indicator taxa at or above the weight limits in its Annex 6B, Members and CNCPs shall require any vessel flying their flag to: a) cease bottom fishing immediately within an encounter area of one (1) nautical mile either side of the trawl track extended by one (1) nautical mile at each end and b) report the encounter immediately to the Member or CNCP whose flag the vessel is flying and the Secretariat. The Scientific Committee, reviews at its annual meeting all encounters reported and provides advice on management actions proposed by the relevant Member or CNCP and any other management actions the Scientific Committee considers appropriate. Some of the aspects that SC considers in these reviews are VME indicator thresholds;

Management Areas; number of encounters; the relationship between benthic bycatch from fishing vessels (including encounter events) and the habitat suitability models; the relationship of benthic bycatch to estimates of abundance of VME taxa, the appropriateness of the management approach (e.g., scale), etc.

Regarding **observer coverage, a**ll Members and CNCPs participating in bottom fishing shall ensure scientific observer coverage of trips for vessels flying their flag consistent with the **minimum observer coverage levels set out in Annex 8** and shall ensure that such observers collect and report data as described in CMM 02-2021 (Data Standards). Annex 8 states that minimum observer coverage shall be:

a) For Vessels using bottom trawl and mid-water trawl gear: 100% observer coverage
b) For Bottom line gear: At least 10% observer coverage for the fishing year (Expressed as the percentage of the total number of observed hooks).

According to **CMM 08-2019 Conservation and Management Measure for Gillnets in the SPRFMO Convention Area** (SPRFMO, 2019a), large-scale pelagic driftnets and all deep-water gillnets are banned in the Convention Area

CMM have been established for **exploratory fisheries** in the SPRFMO Area. These CMM include measures to avoid by-catch of sharks, marine mammals, seabirds, turtles, and other species of concern

- **CMM 14a-2019 Conservation and Management Measure for Exploratory Fishing for Toothfish by New Zealand-Flagged Vessels in the SPRFMO Convention Area** (SPRFMO, 2019b)

  <u>Management measures (sharks).</u>

  If 250 kg or more of deep-water sharks (all species in class Chondrichthyes combined on a line) are caught, then no further lines will be set within 10 nautical miles of the location of that line until the information from that voyage has been reviewed by the Scientific Committee.

  <u>Marine Mammals, Seabirds, Turtles, and other Species of Concern</u>

  A vessel fishing pursuant to this measure shall use the following mitigation methods:

  a) the vessel shall use integrated weight line as described in the CCAMLR gear library with a weighting of 50 g of lead per meter of backbone line;

  b) there shall be no dumping of offal while lines are being set or while lines being hauled;

  c) any offal or discards shall be macerated by machine prior to discarding;

d) discarding shall take place only at the end of a haul or while steaming; and no biological material shall be discarded for at least 30 minutes before the start of any set or during any set;
e) discarding may only take place from the opposite side of the vessel from the hauling position;
f) a bird exclusion device (BED) shall be used to prevent birds entering the hauling area, to the extent allowed by prevailing weather;
g) other methods such as water spray, movement, et cetera, shall be used as appropriate to deter aggressive feeders from approaching the line.

The following information shall be collected for marine mammals, seabirds, turtles, and other species of concern:
a) At least one standardized seabird and marine mammal abundance count shall be made at the rear of the vessel during the setting of each line and again during the hauling of each line;
b) Other opportunistic observations, photography and identification of marine mammals shall be undertaken in collaboration with crew;
c) the observer shall have a target of observing 10% of hooks hauled for marine mammal, seabird and turtle captures, and for comparison with a sample of recorded video observations;
d) at least 50% of hooks hauled shall be viewed on recorded video after the voyage;
e) all marine mammals, seabirds, turtles, and other species of concern captured shall be identified, and photographs taken of all live birds released and any birds colliding with the ship that can be recovered;
f) all dead birds shall be retained for formal identification and necropsy.

- **CMM 14b-2021 Conservation and Management Measure for Exploratory Potting Fishery in the SPRFMO Convention Area** (SPRFMO, 2021d). Similar measures to mitigate bycatch as in **CMM 14a-2019.**

- **CMM 14d-2020 Conservation and Management Measure for Exploratory Fishing for Toothfish by Chilean-Flagged Vessels in the SPRFMO Convention Area** (SPRFMO, 2020b)
  <u>Marine Mammals, Seabirds, Turtles, and other Species of Concern</u>
  A vessel fishing pursuant to this measure shall use the following mitigation methods:
  a) the vessel shall use trotlines with “Cachalotera” with a maximum of 5,000 hooks per set;

b) there shall be no dumping of offal while lines are being set or while lines are being hauled;
c) discarding shall take place only at the end of a haul or while steaming; and no biological material shall be discarded for at least 30 minutes before the start of any set or during any set;
d) discarding may only take place from the opposite side of the vessel from the hauling position;
e) the Cachalotera system shall be used all the time to avoid incidental interactions with seabirds;
f) promptly release of sea turtles, in a manner that causes the least harm to the extent practicable;
g) at least one crew member will have training in techniques for handling and release of turtles to improve survival after release.

The following information shall be collected for marine mammals, seabirds, turtles, and other species of concern:
a) at least one standardized seabird and marine mammal abundance count shall be made at the rear of the vessel during the setting of each line and again during the hauling of each line;
b) other opportunistic observations, photography and identification of marine mammals shall be undertaken in collaboration with the crew;
c) the observer shall have a target of observing 25% of hooks hauled for marine mammal, seabird and turtle captures, and for comparison with a sample of recorded video observations;
d) at least 50% of hooks hauled shall be viewed on recorded video after the voyage;
e) all marine mammals, seabirds, turtles, and other species of concern captured shall be identified, and photographs taken of all live birds released and any birds colliding with the ship that can be recovered;
f) all dead birds shall be retained for formal identification and necropsy.
All information specified in CMM 03-2021 (Bottom Fishing) relating to bottom fisheries and all data necessary to assess encounters with VMEs shall be collected to enable assessment and monitoring of the distribution of marine ecosystem in the areas fished.

- **CMM 14e-2021 Conservation and Management Measure for Exploratory Fishing for Toothfish by the European Union in the SPRFMO Convention Area** (SPRFMO, 2021e)

  Marine mammals, seabirds, and other species of concern

All marine mammals, seabirds, sharks, and skates shall be released alive where possible. Information about birds colliding with the vessel will be recorded and all birds released alive where possible. Sharks and skates released alive shall not be counted as retained catch.

A vessel fishing pursuant to this measure shall use the following mitigation methods:

Seabird mitigation measures, in addition to those set out in CMM 09-2017 (Seabirds):

a) the vessel shall release weights before line tension occurs

b) there shall be no dumping of offal or discards whilst fishing lines are being set or hauled;

c) any offal or discards shall be macerated by machine prior to discarding;

d) discarding shall take place only after hauling has been completed and whilst steaming at a speed of at least 4 knots, and no biological material shall be discarded for at least 30 minutes before the start of any set or during any set;

e) discarding may only take place from the opposite side of the vessel from the hauling position;

f) two bird scaring devises (tori lines) shall be deployed when setting lines and at least one bird exclusion device (BED) shall be used to prevent birds entering the hauling area, to the extent allowed by prevailing weather;

g) in the instance of exceeding the trigger level of 0.01 birds/1000 hooks of CMM 09-2017 (Seabirds), an evaluation of mitigation measures will be made, including ensuring correct implementation of mitigation measures, and strengthening mitigation where possible (e.g., night-time setting).

<u>Seal and cetacean bycatch mitigation measures:</u>

h) any seal or cetacean bycatch will trigger a re-evaluation of fishing strategy. In the event of a cetacean entanglement and possible mortality as a result, prior to all subsequent lines being hauled a one-hour observation period will be conducted to ensure no whales are present.

<u>Shark, skate, and macrourid bycatch mitigation measures:</u>

i) If more than 4 individuals of any of the following families Somniosidae, Lamnidae, Cetorhinidae, Alopiidae are caught or if more than 2 individuals of any one of these families of sharks are caught in one haul or set, the vessel shall move on for the duration of the trip, and a next line shall not be set closer than 5 nm from the centre of the preceding line;

j) If the retained skate by-catch exceeds 5% of the toothfish catch or reaches a maximum of 100 kg in any one haul or set, the vessel will move-on to another location at least 5 nm distant;

k) Since *Macrourus* spp. can be a common by-catch species in other toothfish longline fisheries, as a precaution the vessel will move-on to another location at least 5 nm distant if the by-catch of *Macrourus* spp. reaches 150 kg and exceeds 16% of the catch of toothfish in any one haul or set.

Data collection for marine mammals, seabirds, and other species of concern

The following information shall be collected for encountered marine mammals, seabirds, and other species of concern:

a) At least one standardized seabird and marine mammal abundance count shall be made at the rear of the vessel during the setting of each line and again at the hauling of each line;

b) the observer shall have a target of observing 25% of hooks hauled for marine mammal and seabird interactions. Where observations take place, they will be recorded and stored for analyses and/or reference;

c) all marine mammals, seabirds, sharks, skates and other species of concern accidentally captured dead or moribund shall be identified, and photographs will be taken. Information about birds colliding with the vessel will be recorded and all birds released alive;

d) all dead birds will be retained for formal identification and necropsy;

e) opportunistic observations, photography and identification of marine mammals may be undertaken in collaboration with the crew.

VME

All information specified in CMM 03-2021 (Bottom Fishing) relating to bottom fisheries and all data necessary to assess encounters with VMEs shall be collected to enable assessment and monitoring of the distribution of marine ecosystem in the areas fished.

Environmental data collection

The vessel shall record additional environmental data including in situ imagery of seabed species and habitats, and CTD (conductivity, temperature, depth) sensors deployed on longlines.

FAO Area 41 (SW Atlantic)

There is no multilateral agreement concerning the high seas bottom fisheries of the southwest Atlantic with the competence to establish appropriate conservation and management measures. Vessels fishing in the high seas of the region are subject to regulation by their respective flag states, with the quantitatively important Spanish fleet also subject to European Union regulations.

In 2008 the European Commission presented the management measures and proposed a regulation for the areas of the high seas not covered by Regional Fisheries Management Organizations or Arrangement (RFMO/As).

The Council Regulation (EC) N° 734/2008 on the protection of vulnerable marine ecosystems in the high seas from the adverse impacts of bottom fishing gears was adopted by the Council of Ministers on 15 July 2008 and foresees a system of special fishing permits that shall be issued by the EC Member States if specific conditions for issuance, including the submission of a detailed fishing plan, have been met.

The competent authorities of the EC Member States shall issue a special fishing permit after having carried out an assessment on the potential impacts of the vessels intended fishing activities and concluded that such activities are not likely to have significant adverse impacts on Vulnerable Marine Ecosystems (VMEs). In areas where no proper scientific assessment has been carried out and made available, the use of bottom gears shall be prohibited. The Regulation also contains provisions on unforeseen encounters with VMEs, area closures and an observer scheme for vessels which have been issued a special fishing permit.

The observer program shall (Article 11 (EC) N°734/2008):

i) Record the catch information in the same format as that used in the vessel's logbook (Article 6 of Council Regulation (EEC) No 2847/93) establishing a control system applicable to the common fisheries policy.

ii) Record any instances of alteration of the fishing plan.

iii) Document any unforeseen encounters with vulnerable marine ecosystems referred to in Article 7, including the gathering of information that may be of use in relation to the protection of the site.

iv) Record depths at which gear is deployed.

v) Present a report to the competent authorities of the Member State concerned within 20 days following the termination of the observation period. A copy of this report shall be sent to the Commission, within 30 days following receipt of a written request.

According with the article 8 of the (EC) N°734/2008 on the basis of the best scientific information available of occurrence of vulnerable marine ecosystems in the region where their fishing vessels operate, Member States shall identify areas that shall be closed to fishing with bottom gears. Member States shall implement these closures without delay in respect of their vessels and immediately notify the Commission of the closure. The Commission shall circulate the notification to all Member States without delay.

Spain has mobilised financial, technical and human resources to improve marine environmental research in the high seas and to identify vulnerable ecosystems in FAO Area 41. Research the Southwest Atlantic was carried out under the Spanish ATLANTIS project in the period 2007–2010, by the Spanish Institute of Oceanography (IEO) and with cooperation from the Spanish General Secretariat for the Sea (Durán Muñoz et al., 2012, Portela et al., 2012, Río et al., 2015).

The Council Regulation (EC) Nº1035/2001 establishing a Catch Documentation Scheme for *Dissostichus* spp landed or transhipped by Community fishing vessels. Member States shall take all necessary measures to ensure that whenever Dissostichus spp. is landed or transhipped, their flag vessels authorised to engage in harvesting Dissostichus spp. have duly completed a catch document.

No information about regulations for other flagged vessels in the high seas of Southwest Atlantic was found for this review.

ANNEX II Specific information on by-catch mitigation for seabirds

Several RFMO have established a series of measures to mitigate seabird bycatch. In this section, the measures adopted by each RFMO are summarized.

CCAMLR has developed specific rules to reduce seabird by-catch in long-line fisheries and these are also outlined mainly in CM 25-02 (2018). Such limits include:

a) Setting long-lines at night time only when any vessels catch a certain number of seabirds (e.g., maximum of three seabirds in CM 41-03 (2020) and 41-05 (2020)).
b) Long-lines with weights and Time-Depth Recorders (TDRs).
c) Dumping of offal and discards is prohibited while long-lines are being set. Any discharge should take place on the opposite side of the vessel to where the long-lines are hauled.
d) Streamer lines to be deployed during long-line setting to deter birds from approaching the hook-line.

GFCM has a recommendation on reducing incidental bycatch of seabirds in fisheries in the GFCM Competence Area (GFCM/35/2011/3). Contracting Parties and Cooperating non-contracting Parties of GFCM (CPCs) should develop mechanisms to ensure that incidental taking of seabirds in fishing activities is monitored, recorded and kept to the lowest level as possible in particular for species under the Annex II of the SPA/BD protocol of the Barcelona Convention.

The GFCM Scientific Advisory Committee (SAC) and the GFCM Secretariat will assist in developing mechanisms to enable the CPCs to monitor and record data on seabirds and fishing interactions including regular reporting to the GFCM-Secretariat. Any event of incidental taking and release shall be recorded by the vessel owner/master in the logbook (or any equivalent document as developed by a Contracting Party to this specific end) and reported to national authorities for notification to GFCM Secretariat, the first time being no later than June 2013.

The SAC evaluates on the basis of available information, and in close cooperation with relevant international scientific committees, the risk of seabirds incidental taking and mortality in different types of Mediterranean fisheries, taking into account also areas and seasons, and compare the effects of bycatches among them. In addition, SAC is responsible for providing advice on the most adequate mitigation measures also in comparison to relative effect caused by anthropic disturbances due to other than fishing activity.

The SAC, in close cooperation with scientific committees of other international organizations, and in line also with the FAO International Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries (FAO-IPOA Seabirds), is requested to advice on the technical details, feasibility, likely effectiveness and side effects, in particular, of the following options for the mitigation of seabirds' bycatches in the Mediterranean fisheries:

a) Setting of demersal and/or pelagic longlines only at night (one hour after dusk and one hour before dawn);
b) Prohibition to set demersal and/or pelagic longlines one hour after dawn till noon;
c) Use of bird-scaring lines and wrap scares, in case of longlines setting during the day;
d) Setting of a minimum bait weight
e) Use of only thawed baits conditioning instead of frozen baits;
f) Discards and excess bait shall not be rejected at sea during setting or hauling operations;
g) Setting of a minimum distance to set bottom-set nets from sea-birds breeding areas.

The SAC is responsible to provide, also on the basis of the work done under the relevant international scientific committees, and in line with the FAO-IPOA Seabirds, a unified protocol for the collection of information on seabirds bycatches in fishing activities with high risk of interaction with seabirds in the Mediterranean. The GFCM shall, upon reception of SAC advice, consider adopting additional measures for the mitigation of incidental taking of seabirds whenever is considered endangering the survival of seabirds populations while taking into account the socio-economic impact to fisheries. (GFCM, 2011. 'Recommendation on reducing incidental bycatch of seabirds in fisheries in the GFCM Competence Area (GFCM/35/2011/3)'. Available at: http://www.fao.org/gfcm/decisions/en/).

NAFO has not yet implemented specific measures for mitigation of seabirds bycatch, but it is working towards it. The Action Plan in the Management and Minimization of Bycatch and Discards that was adopted in 2017, for example, aims at identifying best practices and possible mitigation measures to avoid by-catch per time, area, depth, fleet and fishery. Moreover, the NAFO Scientific Council has been addressing several requests from NAFO Commission regarding bycatch mitigation of juvenile fish, sharks, seabirds, turtles and marine mammals. In this regard, research is being carried out in order to provide information to the Commission on the species that are present in NAFO Regulatory Area. Such research is improving the knowledge of interactions of cetaceans, seabirds and turtles with fisheries.

In **NEAFC**, there are no specific conservation and management measures to mitigate by-catch of seabirds. However, in the 39th Annual Meeting in 2020, NEAFC requested Scientific advice from ICES on this topic (Non-recurring advice from ICES on bird bycatch as set out in document AM 2020-95 Rev1) (NEAFC, 2020g).

SPRFMO has a series of mitigation measures for seabirds bycatch in place methods for exploratory fisheries (e.g. in CMM 14a-2019, CMM 14d-2020 and CMM 14e-2021 for toothfish fisheries in the SPRFMO Convention Area). For these fisheries, the following measures are implemented:

a) the vessel shall use integrated weight line as described in the CCAMLR gear library with a weighting of 50 g of lead per meter of backbone line;
b) there shall be no dumping of offal while lines are being set or while lines being hauled;
c) any offal or discards shall be macerated by machine prior to discarding;
d) discarding shall take place only at the end of a haul or while steaming; and no biological material shall be discarded for at least 30 minutes before the start of any set or during any set;
e) discarding may only take place from the opposite side of the vessel from the hauling position;
f) a bird exclusion device (BED) shall be used to prevent birds entering the hauling area, to the extent allowed by prevailing weather;
g) other methods such as water spray, movement, et cetera, shall be used as appropriate to deter aggressive feeders from approaching the line.

Moreover, the following information shall be collected for seabirds:

a) At least one standardized seabird abundance count shall be made at the rear of the vessel during the setting of each line and again during the hauling of each line;
b) the observer shall have a target of observing 10% of hooks hauled for seabird captures, and for comparison with a sample of recorded video observations;
c) at least 50% of hooks hauled shall be viewed on recorded video after the voyage;
d) all seabirds captured shall be identified, and photographs taken of all live birds released and any birds colliding with the ship that can be recovered;
e) all dead birds shall be retained for formal identification and necropsy.

SEAFO has established measures for **longliners** fishing south of the parallel of latitude 30 degrees South and for trawl gears (Conservation Measure 25/12; SEAFO, 2012). For longliners, the following measures apply:

a) vessels shall carry and use bird-scaring lines (procedures are detailed),
b) night setting using the minimum ship's lights necessary for safety,
c) the dumping of offal is prohibited while gear is being shot or set while at hauling shall be avoided and
d) additional measures are recommended such as all birds captured alive during fishing operations shall be released alive and whenever possible hooks should be removed without jeopardizing the life of the bird concerned and others.

Concerning **trawl gears** the following measures are in place**:**

a) A streamer (or tori) line shall be deployed outside of both warp cables, the tori lines shall be attached to the stern at the maximum practical height above water line. Back-up tori lines shall be carried by all vessels and be ready for immediate use. Technical specifications for tori lines are given in Appendix B.
b) The dumping of offal is prohibited while gear is being shot or set. The dumping of offal during the hauling of gear shall be avoided.
c) Nets shall be cleaned prior to shooting to remove items that might attract seabirds.
d) Vessels shall adopt shooting and hauling procedures that minimize the time that the net is lying on the surface with the meshes slack. Net maintenance shall, to the extent possible, not be carried out with the net in the water.
e) Each Contracting Party shall encourage their vessels to develop gear configurations that will minimize the chance of birds encountering the part of the net to which they are most vulnerable. This could include increasing the weighting or decreasing the buoyancy of the net so that it sinks faster, or placing colored streamer or other devices over particular areas of the net where the mesh sizes create a particular danger to birds.

In Appendix A of the same CM, there are guidelines for design and deployment of longline Tori lines is described as well as for the line weighting. In Appendix B, there is similar information for trawlers. In Appendix C there is a protocol for vessels monitoring longline sink rate (three different methods according with the vessel preferences).

SIOFA

According to CMM 2019/13 Conservation and Management Measure on mitigation of seabirds bycatch in demersal longlines and other demersal fishing gears fisheries (Mitigation of Seabirds Bycatch):

CCPs shall require any **demersal longliners** flying their flag and operating in this area to apply the following mitigation measures:

a) any vessel catching a total of three (3) seabirds in a single season shall immediately change to night setting only (i.e., setting only during the hours of darkness between the times of nautical twilight);
b) vessels are encouraged to use white color lines, to increase visibility which decreases the bycatches of birds;
c) at least one bird scaring line (in accordance with Annex 1) shall be deployed when setting longlines and at least one bird exclusion device (BED, in accordance with Annex 2) shall be used to prevent birds entering the hauling area, to the extent allowed by prevailing weather;
d) there shall be no discharging of offal or discards immediately prior to and during the deployment or retrieval of fishing gear;
e) fishing vessels using autoline systems shall add weights to the hookline or use integrated weight (IW) hooklines while deploying longlines. IW longlines of a minimum of 50 g/m or attachment to non-IW longlines of 5 kg weights at 50 to 60 m intervals are recommended;
f) fishing vessels using the Spanish method of longline fishing shall release weights before line tension occurs; traditional weights (made of rocks or concrete) of at least 8.5 kg mass shall be used, spaced at intervals of no more than 40 m, or traditional weights of at least 6 kg mass shall be used, spaced at intervals of no more than 20 m, or solid steel weights of at least 5 kg mass shall be used, spaced at intervals of no more than 40 m;
g) fishing vessels using the trotline system exclusively (not a mix of trotlines and the Spanish system within the same longline) shall deploy weights only at the distal end of the droppers in the trotline. Weights shall be traditional weights of at least 6 kg or solid steel weights of at least 5 kg; and
h) fishing vessels alternating between the use of the Spanish system and trotline method shall use: (i) for the Spanish system: line weighting shall conform to the provisions in paragraph 3 f; (ii) for the trotline method: line weighting shall be either 8.5 kg traditional weights or 5 kg steel weights attached on the hook-end of all droppers in the trotline at no more than 80 m intervals.

For **demersal longliners of less than 25 m**, at least one of the following measures shall apply:

a) at least one bird scaring line (in accordance with Annex 1) shall be deployed when setting lines, and at least one bird exclusion device (BED, see specifications in Annex 2), shall be used to prevent birds entering the hauling area, to the extent allowed by prevailing weather;
b) fishing vessels using autoline systems shall add weights to the hookline or use integrated weight (IW) hooklines while deploying longlines. IW longlines shall have a minimum of 50 g/m or a weight of a minimum of 5 kg attached to non-IW longlines at 50 to 60 m intervals; and
c) lines shall be set only at night (i.e. during the hours of darkness between the times of nautical twilight). The exact times of nautical twilight are set forth in the Nautical almanac tables for the relevant latitude, local time and date.

Other demersal fishing gears

CCPs shall require any fishing vessel flying their flag and operating in the Agreement Area using demersal pots or traps to ensure the cleanliness of the traps and pots not to attract birds, and ensure that buoy lines shall not be left floating at the surface.

ANNEX 5

Deliverable 3:

Review of existing and recommended criteria and methodologies for the establishment of historical and cumulative fishing footprints (Task 4 – Sub-task 4.1

CONTENTS

DELIVERABLE 3

TITLE

Deliverable 3 – *"Review of existing and recommended criteria and methodologies for the establishment of historical and cumulative fishing footprints".*

RELATED TASK

Task 4 – *"Criteria for establishment of footprints and historical fishing; and the development of a framework for exploratory fisheries and scientific surveys"*

This task was focused on the review of the existing criteria/methods for characterisation of fishing footprint in Deep-Sea Fishing (DSF) in relevant RFMOs, as well as in FAO Area 41. Furthermore, a framework for exploratory fisheries and scientific surveys will be developed.

RELATED SUB-TASK

Sub-task 4.1 – *"Criteria and methodologies for fishing footprints"*

This Sub-task was focused on the review of existing and recommend criteria and methodologies for the establishment of historical and cumulative fishing footprints based on literature review and methodologies/approaches developed in relevant fora, such as NEREIDA programme reports, published RFMO working group meeting reports, FAO workshop reports, published material and data on RFMO websites and personal contact with selected RFMO secretariat staff to obtain less 'visible' data and information sources relevant to this study. Moreover, preliminary documents or work done by EU scientists in the framework of RFMOs, were considered relevant to perform this review.

OBJECTIVE AND STRUCTURE OF THE DELIVERABLE 3

The aim of Deliverable 3 is to carry out a review of information related to fishing footprint from relevant RFMOs (NAFO, NEAFC, SEAFO, GFCM, NPFC, SPRFMO, SIOFA and CCAMLR) as well as FAO Area 41 (Southwest Atlantic Ocean). The draft presented in Month 3 was the basis for the present report.

Additionally, a section on general considerations and recommendations applicable to the different RFMOs and FAO Area 41 is included in this report.

The review takes into account the difficulties and limitations to define fishing footprints in DSF, addressing the following issues:

a. Diversity of fishing fleets, their practices and strategies.
b. Operative/technical characteristics of the fishing gear.
c. Definition of spatial footprint for a typical fishing gear deployment event.
d. Time frame used for each RFMO/FAO Area 41 to calculate the fishing footprint.
e. Spatial resolution of the data used to calculate the footprint.
f. Availability of data and coverage.
g. Quality of data.
h. Effort units that are being used.
i. Identify the link between the fishing techniques/gears and the specific challenges/issues related to the definition of the fishing footprint.
j. Identify strengths and weaknesses of the methodologies used for establishment of historical and cumulative fishing footprint.
k. Suggest/propose recommendations that could be considered as guidelines for future EU proposals regarding the definition of footprint.

- Other issues to consider.
- References.

INSTITUTES AND RESEARCHERS INVOLVED

- Task Leader: **IEO** (Pablo Durán Muñoz and Mar Sacau)

- Participating Institutes/Researchers: **IEO** (Pablo Durán Muñoz; Mar Sacau; Beatriz Guijarro; Francesc Ordinas; Roberto Sarralde; José Luis del Río and Leticia Vidal-Liñán), **IPMA**[1] (Ricardo Alpoim and Hugo Mendes) and **MRAG EU** (James Moir Clark; Laurence Kell; Georgina Hunt and Stephen Mangi).

The list of Partners involved on Deliverable 3 (by alphabetic order) and the main role played by each Partner is in Table 1.

[1] NEAFC review was re-allocated from IPMA to MRAG-EU, due to IPMA work overload (see details in *First Progress Meeting Minutes*).

Table 1. List of Partners involved in the Deliverable 3 (by alphabetic order) and main role played.

Partner no.	Role	Consortium Partner name	Partner acronym / short name	Country
3	Task Leader; Templates preparation for data collection to be used by partners; Send periodic reminders prior to the deadline to ensure Partners contribution; Review, collect and summarize the information on: **NAFO, SEAFO, GFCM, FAO Area 41, SPRFMO and SIOFA**; Integration of the information provided by partners; Prepare and review the Deliverable.	Instituto Español de Oceanografía	IEO	Spain
4	Review, collect and summarize the draft information on: **NEAFC**[2]; Prepare and review the Draft Deliverable.	Instituto Português do Mar e da Atmosfera	IPMA	Portugal
5	Review, collect and summarize the information on: **NEAFC**[2], **NPFC and CCAMLR**; Prepare and review the Deliverable.	MRAG Europe Ltd.	MRAG EU	Ireland

THE CONCEPT OF "FISHING FOOTPRINT" IN THE RFMOs

RFMOs have delineated the "existing bottom fishing areas" in response to the United Nations General Assembly (UNGA) request to regulate bottom fisheries that cause a significant adverse impact on vulnerable marine ecosystems (UNGA Res. 61/105, paragraph 83).

According to the UNGA mandate, the International Guidelines for the Management of Deep-sea Fisheries in the High Seas[3] call for the mapping of "existing bottom fisheries[4]" (paragraph 64[5]). Consequently, RFMOs members have been required to identify their existing bottom fishing footprints, and comprehensive maps of the spatial extent of bottom fisheries have been compiled by the RFMOs. Moreover, some flag states have mapped their bottom fisheries in areas not covered by RFMOs (e.g. Spain in FAO Area 41).

Despite the relevance of the concept "fishing footprint" in the context of deep-sea fisheries management, it is not specifically defined in the FAO Guidelines as a "key concept". Nevertheless, in line with paragraph 64 of the Guidelines, in most of the RFMOs the portion of the RFMO area (Convention or Regulatory Area) where bottom fishing occurred in a certain reference historical period is referred as "footprint", "fishing footprint", "bottom fishing footprint", "existing bottom fishing areas" or "existing deep-sea bottom fishing areas" (see Table 2). So, these terms seem to be equivalent and they refer to the same concept (i.e. those locations in which some level of bottom fishing activity has previously been conducted in a reference period).

[2] NEAFC review was re-allocated from IPMA to MRAG-EU, due to IPMA work overload (see details in *First Progress Meeting Minutes*).
[3] FAO (2009) International Guidelines for the Management of Deep-sea Fisheries in the High Seas.
[4] The Guidelines has been developed for fisheries that occur in areas beyond national jurisdiction, in which the total catch includes species that can only sustain low exploitation rates, and the fishing gear is likely to contact with the seafloor.
[5] *"Paragraph 64. Comprehensive maps showing the spatial extent of existing fisheries should be compiled by RFMO/As. For areas not covered by RFMO/As, each flag State should develop such maps and cooperate with other States concerned and FAO in developing joint maps for relevant areas".*

Table 2. Overview of the concept "fishing footprint/existing bottom fishing areas" in the RFMOs.

Atlantic Ocean and adjacent waters	NAFO[6]	"*Footprint*", otherwise known as "*Existing bottom fishing areas*", means that portion of the Regulatory Area where bottom fishing has historically occurred (based on information concerning the period 1987-2007)[7], and is defined by the coordinates shown in Table 4 and illustrated in Figure 2 of NAFO CEM.
	NEAFC[8]	"*Existing bottom fishing areas*" means the portion of the Regulatory Area where bottom fishing has historically occurred, based on information concerning the period 1987-2007 (Article 4). Areas where the NEAFC Commission decides to authorise new bottom fishing based upon the exploratory fisheries conducted in the previous two years are also defined as "existing bottom fishing areas".
	SEAFO[9]	"*Existing bottom fishing areas*" means the portion of the Convention Area where bottom fishing occurred in the period 1987-July 2011. Areas where new bottom fishing activities are authorised shall be defined as "existing bottom fishing areas" pursuant to Article 4.
	GFCM[10]	"*Existing deep-sea bottom fishing areas*", means that portion of the GFCM area of application where deep-sea bottom fishing has occurred up to and including 2019.
Pacific Ocean	NPFC[11]	Under CMM 2021-05 and CMM 2019-06, members are required to submit to the Scientific Committee (SC) an estimate of their impacts on VMEs and the footprint is assessed according to the standards laid out in the Annex 2 '*Science-based Standards and Criteria for Identification of VMEs and Assessment of Significant Adverse Impacts on VMEs and Marine Species'*. Member states submit the required data the on an annual basis which are reviewed by the Scientific Committee.
	SPRFMO[12]	Area of the sea floor potentially contacted by bottom fishing gear. It was constructed from reported demersal and midwater trawling, and bottom longlining fishing effort records from 1989 to 2019[13].
Indian Ocean	SIOFA[14]	"*SIOFA bottom fishing footprint*" means a map of the spatial extent of historical bottom fishing in the Agreement Area, for all vessels flagged to all Contracting Parties, Cooperating Non-contracting Party (CNCPs) and Participating fishing entities (PFEs) over a period to be defined by the Meeting of the Parties. The SC agreed that the maps will include all grid squares in which fishing effort has been recorded between 2000 and 2015[15].
Southern Ocean	CCAMLR[16]	"*Fishing footprint*" is the area of the seafloor within which fishing gear interacts with benthic organisms. Fishing footprint may be expressed per unit of fishing effort for a particular gear configuration (e.g. for longlines, km^2 seabed contacted per km of longline deployed), or as a cumulative footprint when calculated and summed for all fishing gear deployments in a defined period and area. This areal measure does not incorporate the level of impact within the footprint. This defines both the fishing footprint from an individual fishing event and the cumulative footprint.

[6] NAFO Conservation and Enforcement Measures (CEM) 2021.
[7] NAFO Secretariat (2009) https://www.nafo.int/Portals/0/PDFs/fc/2009/fcdoc09-20.pdf
[8] NEAFC Recommendation 10:2021. Recommendation to amend Recommendation 19:2014 on the Protection of Vulnerable Marine Ecosystems in the NEAFC Regulatory Area, as amended.
[9] SEAFO Conservation Measure 30/15 on Bottom Fishing Activities and Vulnerable Marine Ecosystems in the SEAFO Convention Area (Adopted 03/12/2015).
[10] GFCM-WGVME (2017) Scientific Advisory Committee on Fisheries (SAC). Report of the first meeting of the Working Group on Vulnerable Marine Ecosystems. Malaga, Spain, 3-5 April 2017.
[11] NPFC (2021) Sustainable use and conservation handbook.
[12] SPRFMO CMM 2.03. (2014) Conservation and Management Measure for the Management of Bottom Fishing in the SPRFMO Convention Area. Paragraphs 6 & 8(d). For the purpose of this measure, the term '*bottom fishing footprint'* means a map of the spatial extent and distribution of historical bottom fishing in the Convention Area of all vessels flagged to a particular Member or CNCP over the period 1 January 2002 to 31 December 2006. CMM 2.03 is superseded/expired and since 2019, the definition of '*bottom fishing footprint'* is missing in the SPRFMO CMMs for the Management of Bottom Fishing (CMM 03-2019, CMM 03-2020, CMM 03-2021).
[13] SC8-DW07 rev 1 Cumulative Bottom Fishery Impact Assessment for Australian and New Zealand bottom fisheries in the SPRFMO Convention Area, 2020.
[14] SIOFA Conservation and Management Measure for the interim management of bottom fishing in the Agreement Area (interim management of bottom fishing) CMM 2020-01.
[15] SIOFA (2019) Report of the Fourth Meeting of the Scientific Committee of the Southern Indian Ocean Fisheries Agreement (SIOFA) Yokohama, Japan 25 – 29 March 2019.
[16] Sharp and Parker (2010) An updated glossary of terms relevant to the management of Vulnerable Marine Ecosystems (VMEs) in the CCAMLR Area (WG-FSA-10/28) https://www.ccamlr.org/en/wg-fsa-10/28.

ATLANTIC OCEAN AND ADJACENT WATERS

1. NORTHWEST ATLANTIC FISHERIES ORGANISATION (NAFO)

1.a. Diversity of fishing fleets, their practices and strategies

Currently NAFO has 13 Contracting Parties: Canada; Cuba; Denmark (in respect of Faroe Islands and Greenland); European Union (EU); France (in respect of St. Pierre et Miquelon); Iceland; Japan; Norway; Republic of Korea; Russian Federation; Ukraine; United Kingdom and United States of America.

The NAFO regulated fishery takes place in the NAFO Regulatory Area (NRA), which is defined in the NAFO Convention as that part of the Convention Area which lies beyond the areas in which Costal States exercise fisheries jurisdiction (outside of the Exclusive Economic Zones). The NAFO Convention Area includes the entire northwest Atlantic extending to the coastlines of the North American continent and Greenland. A distinct NRA is recognized, comprising the high seas portion of the Convention Area. This has been divided into subareas, divisions and sometimes subdivisions (FAO, 2020) (see Figure 1).

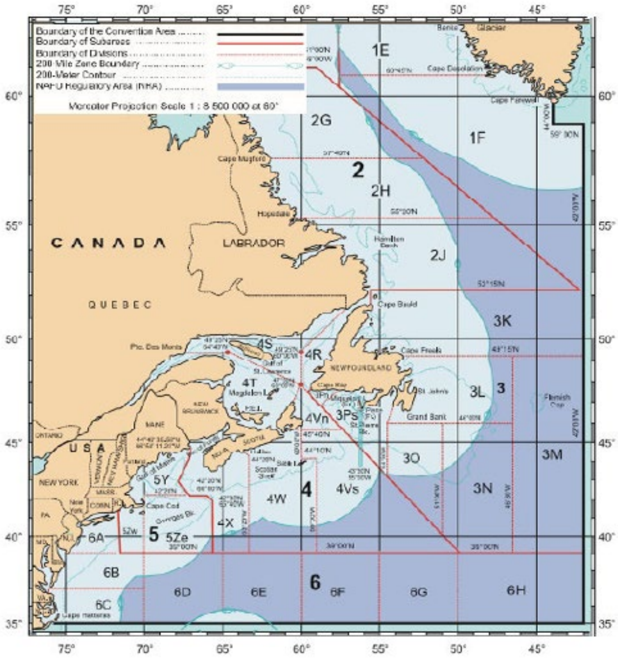

Figure 1. The northwest Atlantic showing the NAFO Regulatory Area, part of the Convention Area, and the statistical divisions. Source: Cropped from NAFO (2018).

The management of NAFO fisheries is controlled through the NAFO Conservation and Enforcement Measures (CEMs)[17]. These include measures that manage the fisheries directly (e.g. catch quotas) and the procedures needed to implement such limits, in addition to conservation objectives, rebuilding strategies, harvest control rules and other restrictions on the organization’s own future decision-making. The CEMs

[17] https://www.nafo.int/Fisheries/Conservation

(NAFO, 2021a) are provided for the management[18] of 20 discrete stocks of 12 species (see Figure 2) or species groups (including the alfonsino seamount fishery), although some of them are currently closed to directed fishing[19] (see Table 1). CEMs also restrict bottom fishing and provide for protection of VME, primarily through spatial measures but in combination with an assessment, an exploratory fishery protocol and an encounter protocol (Campbell, 2016). The spatial measures include a bottom fishery "footprint" covering the area where bottom fishing is currently permitted, an area outside of this where there is currently no bottom fishing, and 14 closed areas to protect VMEs[20]. Proposed new bottom fishing activity outside the "footprint" – or inside it if there is a significant change to the conduct or in the technology – is subject to the exploratory fisheries protocol.

Table 1. Summary of stocks that have been subject to TAC=0/No directed fishing/Ban on fishing in force. This table is updated up to 2021. Source: NAFO Conservation and Enforcement Measures 1992–2021, from NAFO website.

Species	Stock	Years where TAC=0/No directed fishing/Ban on fishing in force
Cod	COD 3M	1999-2009
	COD 3L	2004-2021
	COD 3NO	1995-2021
American plaice	PLA 3LNO	1995-2021
	PLA 3M	1995-2021
Witch flounder	WIT 3L	2004-2021
	WIT 3NO	1995-2014
Yellowtail flounder	YEL 3LNO	1995-1997
Capelin	CAP 3LNO	1993-2021
Shrimp	PRA 3M	2011-2019
	PRA 3L	2015-2021
	PRA 3NO	2004-2021
Redfish	RED 3LN	1998-2009
Alfonsinos	ALF 6 (Sub-area 6)	2020-2021
Beaked redfish (pelagic)	REB 1F_2_3K (Sub-area 2 and Div. 1F + 3K)	2012-2021

The Grand Bank (Divs. 3LNO) and Georges Bank (Div. 5Ze) in the northwest Atlantic Ocean have been favored fishing grounds for approximately 500 years. NAFO holds catch statistics dating back to 1804 (NAFO, 2015; Reilly, 2014). The fisheries of Grand Bank and Flemish Cap (Div. 3M) started with longlines and later included trap nets. Trawling became widespread in the 1920s and 1930s and has continued to the present day.

According to 2020 Annual Compliance Review (NAFO, 2020a), NAFO traditionally identifies three main fisheries in its Regulatory Area: the groundfish (GRO - primarily in Div. 3LMNO), shrimp (PRA - primarily in Div. 3L and Div. M) and pelagic redfish fisheries (REB - primarily in Div. 1F and Div. 2J). A summary of the stocks that have

[18] NAFO does not manage sedentary species (e.g. shellfish) and species managed by other fishery bodies, i.e. salmon (NASCO), tunas/marlins (ICCAT), and whales (NAMMCO).

[19] Closures to directed fishing respond to the Objectives and General Principles laid down in the Convention on Cooperation in the Northwest Atlantic Fisheries (NAFO Convention, available at: https://www.nafo.int/Portals/0/PDFs/key-publications/NAFOConvention.pdf). They will help to: (i) stock rebuilding; (ii) restore to or maintain the stock at B_{msy}; (iii) eliminate overfishing; (iv) apply Precautionary Approach and (v) minimise harmful impacts on living marine resources and ecosystems.

[20] Apart from the closures within the footprint, there are 6 Seamount closures in the NRA (NAFO, 2021a)

been subject to TAC=0/No directed fishing/Ban on fishing in force is presented in Table 1.

In 2019, fisheries in the NRA comprised demersal fisheries and the pelagic fisheries on alfonsinos and redfish. There were 131 trips by 47 fishing vessels spending a total of 4674 days in the NRA. One vessel (class size 5) spent 10 fishing days, as part of its fishing trip, in Division 6G catching alfonsinos. Another four vessels spent 46 fishing days in Div. 1F targeting pelagic redfish (REB) under the unilateral quota established by the Russian Federation (NAFO, 2020a). Smaller vessels (<500 MT) tend to use longlines to fish for cod in Div. 3M and Atlantic halibut. The vast majority of the effort comes from larger vessels (> 500 MT) which account for 93% of fishing effort in terms of fishing days. The larger vessels use bottom trawl and fish in Divisions 3LMNO. The major species caught by the bottom trawlers are cod, Greenland halibut, yellowtail flounder, redfish, and thorny skate (NAFO, 2020a).

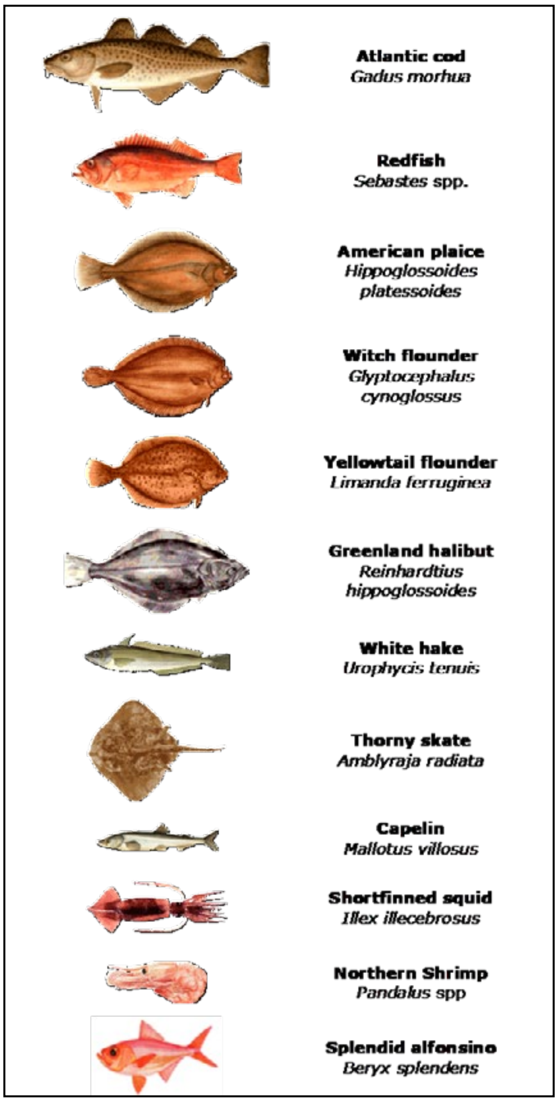

Figure 2. NAFO managed species. Source: www.nafo.int.

1.b. Operative/technical characteristics of the fishing gear

Today, bottom fishing in the northwest Atlantic is almost exclusively with bottom trawls and varying codend mesh sizes depending upon the target species: prawns and shrimp (minimum mesh size 40 mm), shortfin squid (60 mm), other groundfish (130 mm) and skate (280 mm in the codend and 220 mm in all other parts of the trawl) (NAFO 2021a, Article 13).

In 2021, an updated description of demersal fisheries in the NRA, based on the logbook and VMS data for the period 2016-2019 was conducted under the EU NEREIDA programme (NEREIDA, 2021). This description included gear characteristics and mesh size for all the operational fisheries identified in the NRA (Table 2).

Table 2. Operational fisheries (with their characteristics) identified in the NRA. The fisheries for consideration in the process of developing the Reassessment of Bottom Fishing Activities based on the 2016-2019 data are highlighted in grey. Source: NEREIDA (2021).

Fishery	Target Species	Main Area of Operation	Gear and mesh size	Mean length of the vessels
Greenland halibut fishery	*Reinhardtius hippoglossoides*	Divs 3LMNO	Bottom otter trawl (130 mm)	67 m
Northern shortfin squid fishery	*Illex illecebrosus*	NAFO SA 2+3	Bottom otter trawl (60 mm)	63 m
Redfish fisheries	*Sebastes spp.*	Div. 3M	Bottom otter trawl (130 mm)	68 m
	Sebastes spp.	Divs 3LNO	Bottom otter trawl (130 mm)	65 m
	Sebastes spp.	Divs 3O	Bottom otter trawl (130 mm)	66 m
	Sebastes spp.	Divs. 1F2G (moratorium 2016-2019)	Pelagic trawl	
Cod fisheries	*Gadus morhua*	Div. 3M	Bottom otter trawl (130 mm)	64 m
	Gadus morhua	Div. 3M	Longline	42 m
	Gadus morhua	Div. 3NO (moratorium 2016-2019)	Bottom otter trawl	
	Gadus morhua	Div. 3L (moratorium 2016-2019)	Bottom otter trawl	
Skate fishery	*Amblyraja radiata*	Divs. 3LNO	Bottom otter trawl (280 mm)	66 m

Fishery	Target Species	Main Area of Operation	Gear and mesh size	Mean length of the vessels
Yellowtail flounder fishery	*Pleuronectes ferruginea*	Div. 3LNO	Bottom otter trawl (130 mm)	62 m
Witch flounder fisheries	*Glyptocephalus cynoglossus*	NAFO Divs. 3NO	Bottom otter trawl (130 mm)	71 m
	Glyptocephalus cynoglossus	Div. 3L (moratorium 2016-2019)	Bottom otter trawl	
American plaice fisheries	*Hippoglossoides platessoides*	Divs. 3LNO (moratorium 2016-2019)	Bottom otter trawl	
	Hippoglossoides platessoides	Div. 3M (moratorium 2016-2019)	Bottom otter trawl	
Shrimp fisheries	*Pandalus spp.*	Div. 3M (moratorium 2016-2019)	Bottom otter trawl	
	Pandalus spp.	Div. 3L (moratorium 2016-2019)	Bottom otter trawl	
White hake fisheries	*Urophycis tenuis*	Divs. 3NO	Bottom otter trawl (130 mm)	64 m
	Urophycis tenuis	Divs. 3NO	Longline	38 m
Atlantic halibut fisheries (not managed by NAFO)	*Hippoglossus hippoglossus*	Divs. 3NO	Bottom otter trawl (130mm)	67 m
	Hippoglossus hippoglossus	Divs. 3NO	Longline	30 m
Silver hake fishery (not managed by NAFO)	*Merluccius bilinearis*	Divs. 3NO	Bottom otter trawl (130 mm)	65 m
Splendid alfonsino fishery	*Beryx splendens*	Div. 6G	Pelagic trawl	

1.c. Definition of spatial footprint for a typical fishing gear deployment event

The distribution of fishing effort is focused on the upper slopes around the edges of the Grand Bank and Flemish Cap, and within this there is a clear concentration of effort corresponding to the major bottom fishing grounds for groundfish, redfish and shrimp (Campanis, 2007; Campanis *et al*., 2008).

The total area subjected to bottom fishing by all gears combined from 1987–2007 were plotted from data submitted by Contracting Parties (these data did not distinguish between mobile and static fishing gears) and used to delineate a perimeter around the existing fishing areas by fishery. This was determined from an analysis of logbook and VMS data for bottom trawling and the process took over two years (Campanis, 2007; Campanis *et al*., 2008). The information was provided for all gears combined in various formats, some easier to map than others. Additionally, information on effort was included only in some submissions, and the VMS data used to support the submissions had only been collected since 2003. In the final analysis made by the Secretariat, it was generally possible to filter the supplied information to "areas that had been fished twice" but the spatial resolution to do this was somewhat arbitrarily selected, and this affected the extent of the delineated areas (NAFO Secretariat, 2009). The final composite map, for all gears combined, was adopted in 2010 and has not been revised to date (NAFO, 2021a) (Figure 3).

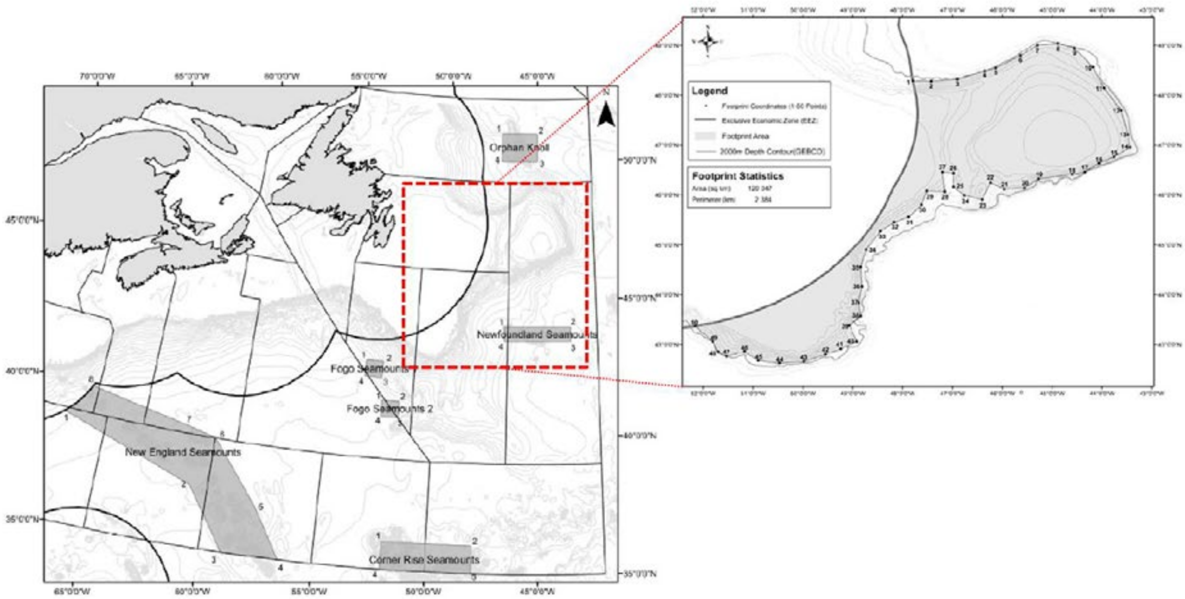

Figure 3. Seamount closures (left) and NAFO Regulatory Area footprint map (right). Source: NAFO (2021a)

The map of existing bottom fishing areas in the NAFO Regulatory Area illustrated in Figure 3 is delimited on the western side by the Canadian EEZ boundary and the eastern side by a set of coordinates (NAFO, 2021a). The map shall be revised regularly to incorporate any new relevant information (NAFO, 2021a, Article 16). Contracting Parties may propose revising the map on the basis of any information available, in particular on the haul by haul catch data.

The NAFO fishing footprint adopted in 2010 is located over the Grand Banks, Flemish Pass and Flemish Cap. Regarding seamount (Smt.) fishing areas, NAFO (NAFO Secretariat, 2009) indicates that only one of the Corner Rise Smt. would have had enough fishing activity to qualify as an existing fishing area, with fishing activity in the Newfoundland and New England Smt. likely falling below the threshold level for inclusion. However, these seamounts are now closed to all bottom fishing activities (see Figure 3).

Work developed by the Working Group on Ecosystem Science and Assessment (WGESA) regarding the classification of fisheries and distribution of effort in the NRA

In 2014, WGESA (NAFO, 2014) used the Daily Catch Records (DCR) and Vessel Monitoring System (VMS) as the data sources and used the adopted NAFO CEMs definition of a directed fishery (NAFO CEMs Art. 5.2[21]) to provide a basis to classify various fisheries. In many cases, one-to-one matching of the data sources is not possible because DCR are reported per day and VMS per hour. The difficulty is that several hauls can be conducted in one day that could span different directed fisheries. Therefore, it was decided to classify the fishing activities into groups of directed fisheries that are conducted in a similar spatial areas and depth zones. The use of the VMS data required some assumptions to be made for determining a 'trawling' event from all other possibilities that could exist when the VMS data is transmitted (e.g., vessel was steaming, weather bound). In this regard, the data were aggregated by a grid bounded by 0.05 degree of latitude and 0.05 degree of longitude where the reported speed was between 0.5 knots to 5.0 knots.

The groundfish fisheries were separated into different components depending on the target species, area, depth and gear (mesh size). Based on these aspects, and assuming Spanish observer data from 2005-2011 and preliminary 2015 logbook data are representative of most fleets' general activity, the demersal fisheries in the NRA were initially classified and plotted in several maps (NAFO, 2014).

Work developed under NEREIDA EU Programme (Research in support of the re-assessment of NAFO bottom fisheries in 2021)

In 2021, an update of the classification of fisheries and distribution effort was conducted under the EU NEREIDA Programme (NEREIDA, 2021) to understand the extent of fishing activities within the NRA and their footprint for a four-year period (2016 to 2019). This characterization was done on the basis of two data sources: Haul by haul logbook information and Vessel Monitoring System (VMS) data. The method developed for this study has been described by Sacau *et al*., (2020). The method uses the logbook haul-by-haul information to assign the VMS pings as "fishing" or "non-fishing" based on whether or not they fall within fishing time intervals reported in the haul-by-haul logbook information. This method also allows the different pings to be assigned to the different fisheries based on the catches collected in the logbooks. The results indicated that logbook data and VMS are complementary and the coupling of both datasets is a powerful methodology for describing the spatial distribution of fishing activity.

Figure 4 shows an example of the updated maps obtained using the "coupling VMS with logbook" methodology (NEREIDA, 2021 and Sacau *et al*., 2020), in this case for one of the main demersal fisheries currently conducted in the NRA (Greenland halibut Divs. 3LMNO).

[21] Article 5.2. For any one haul, the species which comprises the largest percentage, by weight, of the total catch in the haul shall be considered as being taken in a directed fishery for the stock concerned.

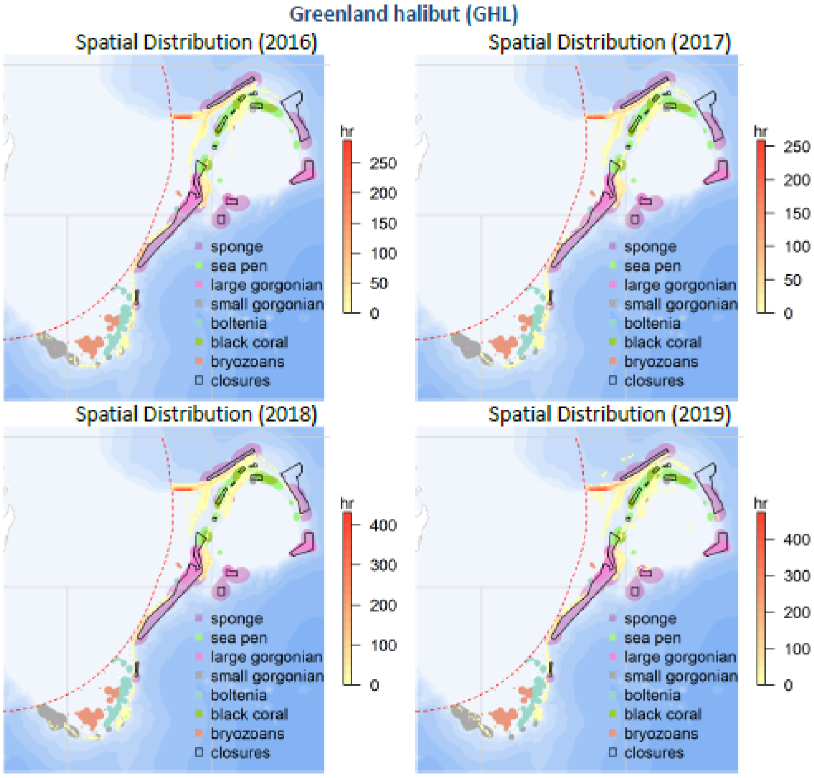

Figure 4. Greenland halibut Divs. 3LMNO fishery footprint together with the location of the VME polygons in the NRA, colour coded by taxon. Closed areas are indicated in black outline. Fishing activity (from yellow to red) is expressed in hours fished in each cell. Source: NEREIDA (2021).

The resulting yearly mapping of the cumulative and fisheries-specific fishing footprint and effort distribution was useful to analyze how fishing effort was changing over years and to estimate the area of VME polygons that is overlapped. These maps were also considered to be an improvement over past effort maps derived from a 1-5 nm per hour speed filter because it reduced spurious points.

Despite the problems with the data and the fact that the information available in the logbooks is not the most adequate to describe the effort of longliners, WGESA considered that the merging VMS with logbook method can describe reasonably well the footprint of the longliners fisheries carried out in NAFO. However, WGESA maintains the recommendation to collect and compile additional information[22] in the logbooks to better describe and represent a more precise fishing bottom longline footprint.

Considering their target species/stocks identified in the NCEM Annex I.A or I.B, main area of operation and gear, a total of 21 fisheries have been initially identified. Twelve of the 21 fisheries have been operational in the period studied (2016-2019) and were taken into account for the Reassessment of Bottom Fishing Activities regarding to the Significant Adverse Impact Assessment (SAI). The analyses also included small-scale

[22] Currently, in the logbook only information on the start and end of the haul is recorded, being not possible to know the exact location where the longline was deployed over the seabed. In NAFO (2020b), Table 1.3 illustrates the additional information that WGESA recommended to collect: Start/End Line set (Date, Time, Lat, Lon, Depth); Start/End Line haul (Date, Time, Lat, Lon, Depth); Line set number; Type of bottom longline used: automatic/manual; Main Line length; Line material; Line diameter; Number of hooks set; Number of hooks lost; Hook type; Hook size; Type of baits used.

fisheries not managed by NAFO targeting Atlantic halibut and Silver hake in the NRA for which NAFO does not set a TAC.

Consideration of NEREIDA EU Programme in the definition of spatial footprint in the NAFO Regulatory Area

NEREIDA EU Programme was crucial to conduct an update on the classification of fisheries distribution effort, particularly the description of demersal fisheries (footprint, fleet characteristics, etc.), based on the logbook and VMS data for the period 2016-2019. Distribution and intensity of fisheries-specific and cumulative fishing effort, together with the location of the VME polygons in the NRA, closed areas and fishing activity, expressed in hours fished in each cell, were yearly mapped (NAFO, 2021b; NEREIDA, 2021). Moreover, a simple overlay analysis to estimate the area of VME polygons that was overlapped by the 2016 to 2019 cumulative fishing effort and fisheries-specific effort layers was conducted. All this work was considered by NAFO as a fundamental element for the reassessment of NAFO bottom fisheries in 2021, the discussion on VME fishery closures and to the assessment of Significant Adverse Impacts (SAI) on VME in the NAFO Regulatory Area. Fulfilling the reassessment of bottom fisheries, is a requirement set out in Chapter 2 (Article 23) of the NAFO Conservation and Enforcement Measures (NAFO, 2021a).

The results (e.g. NAFO, 2021b; NEREIDA, 2020, 2021) were presented and discussed during various NAFO meetings (e.g. WGESA, SC meeting, Annual meeting, etc.). Additionally, NEREIDA research activities have significant implications in the improvement of description of the spatial distribution of the fishing activity (see details in "section 1.g").

Other important specific objectives, indirectly related with the definition of the spatial footprint, and addressed by NEREIDA EU Programme were: i) Study of the sea pen resilience, model validation sensitivity analysis; ii) Determination and mapping essential fish habitat in relation to VME; iii) Fishery specific VME risk and impact assessment; iv) Empirical determination of sea-bed impact and validation of sea pen assemblage resilience model in the NAFO fishing footprint; v) Assessment of the overlap of NAFO fisheries with VME to evaluate fishery specific impacts and implementation of modelling techniques for sea pen specific data; vi) Update the empirical determination of VME cumulative biomass response curves (as an indicator of VME sensitivity/resilience) using the newly defined VME and functional polygons; vii) Complete the analysis of potential functional links between VME and commercial fish species through spatially stratified multivariate statistical analysis of survey trawl data; viii) Conduct a review of bottom fishery habitat impact risk assessment methods being applied or developed by other similar fishery management organisations (e.g. RFMOs, RFBs, EU-CFP etc).

1.d. Time frame used to calculate the fishing footprint

The delineated fishing footprint in Figure 3 is based on the submitted bottom fishing activity by Flag states over a 20 year period (1987–2007) and satisfying the criteria of mobile and static fishing gears (the submitted data did not distinguish between them) within a 5nm×5nm square and does not closely follow a particular depth contour (NAFO Secretariat 2009).

The demersal fisheries in the NRA were classified in 2016 (NAFO, 2016) by assuming Spanish observer data from 2005-2011 and preliminary 2015 logbooks data as representative of most fleets general activity.

Moreover, the time frame used to map the distribution and intensity of fishing effort in the NAFO Regulatory Area, under the EU NEREIDA Programme, was from 2016-2019. A new logbook data format was implemented as an improvement in 2016, when the data were recorded by haul only for the top three species caught by weight. The improvement consisted of including fishing timestamps, geographic coordinates for gear deployment and retrieval, as well as the catch and discard weight for each species caught. It is for the above reason that the timeframe conducted under the EU NEREIDA Programme was put in place since 2016, to make a characterization of distribution and intensity of fishing effort by using the "coupling VMS with logbook" methodology.

1.e. Spatial resolution of the data used to calculate the footprint (NAFO Secretariat, 2009)

The data received by the Secretariat from Flag states (e.g. both point and haul data from varying sources, i.e. VMS, logbook, and observers, from 1987–2007 period) were combined based on year and filtered to include only coordinates that appeared in at least two different years[23]. Data received from flag States with speed included (Japan, Norway and Portugal) were filtered by criteria of occurrence (at least in least two different years) and speed (1.0-4.0 knots) to include actual fishing activity. Conversely, coordinates with associated speeds outside of this 1.0-4.0 knots range were excluded from the footprint map as they were deemed to be from vessels dodging bad weather or steaming (NAFO Secretariat, 2009)

A coordinate with a corresponding speed of between 1.0 and 4.0 knots was deemed to be fishing. Conversely, coordinates with associated speeds outside of this 1.0-4.0 knots range were excluded from the footprint map as they were deemed to be from vessels dodging bad weather or steaming (ICES, 2008).

In order to standardize the information and create a composite map, all haul-by-haul data start and end coordinates were combined and plotted as distinct points. Latitude and longitude coordinates were plotted based on the WGS 84 datum[24]. Contours were derived from an interpolation (kriging) of GEBCO (1x1 minute) bathymetric data, and correspond closely to those on the Gulf of Maine Canadian Hydrographic Service chart No. 4001.

For the purpose of plotting, a grid is defined as the unit for a "fishing spot". Plots of various grid sizes were prepared (e.g. 2nm × 2nm, 5nm × 5nm, 10nm x 10nm). Finally, a 5nm × 5nm square was chosen as the basis for delineating the footprint because this is the largest grid size that would not double count 2-hourly reported VMS data (noting that a trawler would travel 6-7nm during a 2 hour tow). The delineation of the footprint boundary was achieved by simply drawing a boundary around the observed fishing activity, based on a 5nm × 5nm grid as is shown in Figure 5.

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[23] See NAFO Secretariat (2009): According to NAFO CEM 2009, chapter 1bis, paragraph 3, the term "existing bottom fishing areas" initially means areas where VMS data and/or other available geo-reference data indicating bottom fishing activities have been conducted at least in two years within a reference period of 1987 to 2007. This shall be revised regularly in accordance with Article 2bis.4.

[24] WGS84 is an Earth-centered, Earth-fixed terrestrial reference system and geodetic datum. WGS84 is based on a consistent set of constants and model parameters that describe the Earth's size, shape, and gravity and geomagnetic fields. WGS84 is the standard U.S. Department of Defense definition of a global reference system for geospatial information and is the reference system for the Global Positioning System (GPS). https://confluence.qps.nl/qinsy/latest/en/world-geodetic-system-1984-wgs84-182618391.html

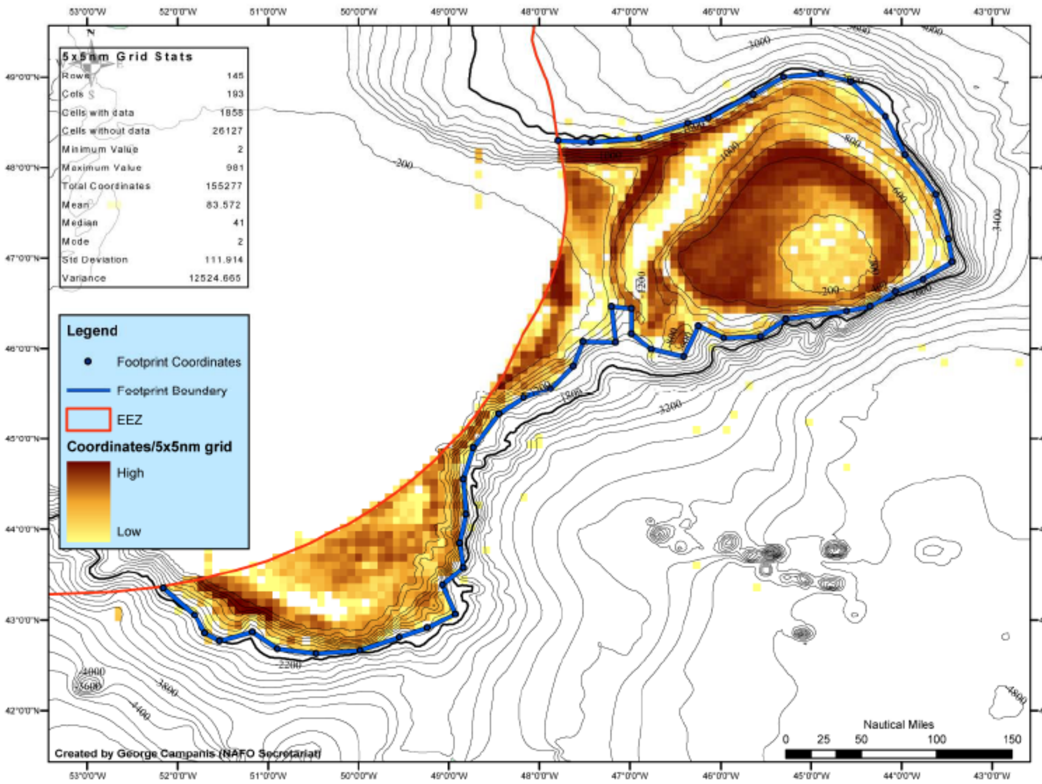

Figure 5. Footprint map based on 5 x 5 nm grid, showing relative intensity of bottom fishing activities. Source: NAFO Secretariat (2009).

Work developed by the Working Group on Ecosystem Science and Assessment (WGESA) regarding the classification of fisheries and distribution of effort in the NRA.

Data were aggregated by a grid bounded by 0.05 degree of latitude and 0.05 degree of longitude

Work developed under NEREIDA EU Programme (Research in support of the re-assessment of NAFO bottom fisheries in 2021)

Data were aggregated by a grid bounded by 0.05 degree of latitude and 0.05 degree of longitude

1.f. Availability of data and coverage (NAFO Secretariat, 2009)

The Fisheries Commission (FC) drafted a new chapter for the NAFO Conservation and Enforcement Measures (NCEM) in 2008 that calls for the submission of maps identifying bottom fishing areas in the NRA for 1987-2007, with trawl activity being given priority (NAFO, 2009). The Secretariat received the relevant information from flag States and presented the compiled maps to the FC and Scientific Council (SC) during the September 2008 Annual Meeting in Vigo, Spain. Owing to the presence of anomalous fishing positions, FC requested flag States to "submit or re-submit their respective footprint data".

The Working Group of Fishery Managers and Scientists (FCWG FMS), during its meeting held in Vigo, Spain, during March 2009, reviewed a draft presentation by the NAFO Secretariat on data submitted by flag States for the delineation of the existing fishing footprint. It was decided that the Secretariat would proceed with preparing a draft footprint map that includes boundary coordinates for review by SC in June 2009 and then FC in September 2009. Russia and Spain submitted their point data, respectively, during and soon after the FCWG FMS March 2009 meeting.

The data from flag States includes both point and haul data from varying sources (i.e. VMS, logbook, and observers). Ten flag States provided bottom fishing activity coordinates, three of which (Portugal, Japan, and Norway) further provided speed information. Germany's submitted an image of their fishing activity that did not contain bottom fishing in the NRA during the 1987 – 2007 period, and was thus omitted in the analysis. The VMS dataset covering years 2003-2007, held by the NAFO Secretariat, was not used in the delineation of the footprint since this information had already been included in the flag State submissions. A visual examination of area of fishing activity derived from the Secretariat's VMS data showed that this was well within the footprint defined by the flag State submissions. A summary of flag State submissions is given in Table 3.

Table 3. Summary of flag State submissions on bottom fishing activities in the NRA for the period 1987-2007. Source: NAFO Secretariat (2009).

	Submission Information		Data Supplied				Filter
Flag State	Date	Data format	Years	Lat/Lon[1]	Date/time	Speed (knots)	Speed (knots)
Canada	18-Sep-08	point data	1987-2007	dec	year	-	-
Estonia	12-Sep-08	haul data	1996-2007	dec	year	-	-
Faroe Is.	16-Sep-08	haul data	2003-2007	dec	year	-	-
Germany	03-Mar-09	-	2001-2007	-	-	-	-
Greenland	10-Sep-08	haul data	1993-2008	deg	year	-	-
Iceland[2]	19 (23) Sep 08	point data	1993-2006	dec	-	-	-
Japan	24-Nov-08	point data	2001-2007	dec	date/time	0-6.9	1.0-4.0
Norway	30-Dec-08	point data	2000-2007	dec	year/month	1.0-5.0	1.0-4.0
Portugal	12-Sep-08	point data	1997-2007	deg	date/time	0-14.0[4]	1.0-4.0
Russia[3]	16-Apr-09	point data	1987-2007	dec	year/month/day	-	-
Spain[3]	24-Apr-09	point data	1987-2007	dec	year	-	-

[1] dec: decimal degrees as DD.dddd; deg: DDMMdd
[2] Iceland re-submitted their information after the September 2008 Annual meeting.
[3] Russia and Spain submitted their point data, respectively, during and soon after the FCWGFMS March 2009 meeting.
[4] Submission indicated maximum speed of 28.0 knots which is assumed to be an outlier.
- not submitted or no information.

An analysis of the Secretariat's VMS data (2003-2007) for fishing vessels travelling at 2.0-4.0 knots, that were assumed to be actively trawling at these speeds, showed a bimodal peak with very little evidence of fishing beyond 1600m. The shallow water component (0-700m) represents a variety of groundfish and shrimp, whereas the deepwater component of this fishery is mainly Greenland halibut (Figure 6).

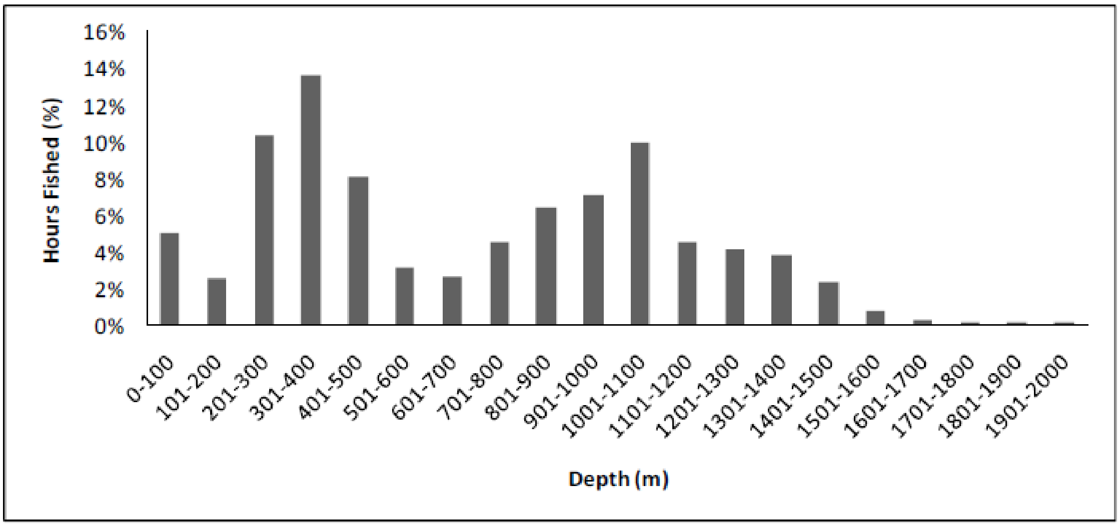

Figure 6. Percentage of fishing activity, assumed to be trawling, by depth within the NRA. The source data was the Secretariat's VMS data for 2003-2007. Source: NAFO Secretariat (2009).

1.g. Quality of data

The data received by the Secretariat from flag States (1987–2007 period) did not distinguish between mobile and static fishing gears (e.g. trawls, longlines, etc.) and therefore only a generalized fishing footprint (Figure 3 and 5) can be given (NAFO Secretariat, 2009).

Problems detected in the NAFO VMS and logbook databases

Two recent analyses (Garrido *et al*., 2020 and Sacau *et al*., 2020) have focused on the quality and coverage of VMS and logbooks data. According to Garrido *et al*. (2020) there are a few problems, both in terms of quality and coverage of these data. The source of these problems is varied and is more related to submission problems and human errors in logbooks while in VMS they are usually to the result of technical problems. The problems with the submission of logbooks seem to have been declining gradually since 2016 and the present submission rates of fishing trips information is near to 100%. These errors may have an impact on the subsequent analyses carried out with the VMS, the logbooks or the merged VMS logbooks data. The effects of the misreporting are enhanced when both data sets are merged using the "coupling VMS with logbook" methodology in order to describe the NAFO bottom fisheries footprint. VMS data problems (over- and under- transmission) may have an effect in the VMS speed filter and in the merging (VMS and logbook) methods, as the missing pings are lost in both treatments.

NEREIDA EU Programme: implications in the improvement of description of the spatial distribution of the fishing activity

The quality of the information, both in the VMS system and in the logbooks, is now a concern to NAFO WGESA (NEREIDA, 2021; NAFO, 2021b). The improvement of the quality of these data is crucial for better studying the effort distribution and the tasks related to this effort (SAI, fisheries footprint, fishing overlap with VME, assessments, etc). These errors are not unusual and so, Sacau *et al.* (2020) proposed a new improved "coupling VMS with logbook" methodology that takes into account those missing VMS pings considering all "fishing pings" comprised between start and end of the haul, including when the dates for the same haul and vessel are not the same day. Solving this issue is really important as all subsequent analyses depend on the success of the linking with the selection of all the "fishing pings" (detailed information can be found in NEREIDA, 2021).

The new improved methodology (Sacau *et al.,* 2020) was presented and discussed during the 13th meeting of the NAFO WGESA in 2020 (see "section 1.c" for more details on NEREIDA implications on NAFO advice). The working group concluded that such new methodology demonstrated to improve the identification of "fishing VMS pings" (NAFO, 2021b). This new methodology also considered the fact that the parameters needed to describe the footprints and associated impacts of trawlers and longliners are different and therefore, their corresponding "fishing VMS pings" must be considered separately when calculating the cumulative fishing effort. Even though the new methodology has been found to be an improvement over the original application, thereby refining the spatial distribution of bottom fishing activity, many issues were raised in terms of quality of data. Therefore, misreporting and errors found in VMS and logbook data should be further analysed (e.g. to be implemented by NAFO Secretariat through an improvement in the quality control check process).

1.h. Effort units that are being used

The map of the NAFO bottom fishing footprint adopted in 2010 (Figure 5), shows the relative intensity of bottom fishing activities based on 5 x 5 nm grid (NAFO Secretariat, 2009). The legend in this map does not indicate any information regarding the specific effort units (only low – high). According to NAFO Secretariat (Federizon, 2021 *personal communication*), the unit used in such is the number of points (coordinates from VMS) occurring in a 5 x 5 nm grid. Information on the size of the class interval and lower/upper limits of the intervals of the frequency distribution, which determine to the colour of the grid, was not available.

Work developed by the Working Group on Ecosystem Science and Assessment (WGESA) regarding the classification of fisheries and distribution of effort in the NRA

Effort units adopted by this WG for the description of demersal fishing effort per fishery were hours fished per grid cell (size of the cell: 0.05 degree of latitude x 0.05 degree of longitude). Hours fished were calculated using VMS pings falling within each grid cell where the reported speed was between 0.5 kts to 5 kts.

Work developed under NEREIDA EU Programme (Research in support of the reassessment of NAFO bottom fisheries in 2021)

Effort units adopted under the EU NEREIDA research was hours fished per grid cell (size of the cell: 0.05 degree of latitude x 0.05 degree of longitude). Hours fished were calculated using VMS "fishing pings" falling within each grid cell, calculated used the "coupling VMS with logbook" methodology.

1.i. Identify the link between the fishing techniques/gears and the specific challenges/issues related to the definition of the fishing footprint

Bottom trawl gear characteristics

Available information on characteristics of the bottom trawl gears currently used by the different fleets fishing in the NAFO Regulatory Area (NRA) is scarce. This information (e.g. gear type and typical dimensions) is necessary to calculate swept area when studying the overlapping between trawl fishing footprint and VMEs in the context of the SAI assessment. In 2020, NAFO Scientific Council (SC) recommended (NAFO, 2020b) that NAFO Secretariat compiles basic information related to each directed fishery defined by stock and gear type (e.g. types of fishing conducted, range of vessel powers, range of vessel lengths, depth range of fishing, gear type including typical dimensions, target and bycatch species, and the spatial distribution of fishing effort).

Bottom longline footprint

Bottom trawl and bottom longline fishing gears can produce negative impacts on VMEs, but technical and operative characteristics of both gears are very different. Consequently, the parameters needed to describe their footprints and associated impacts are very different too. For this reason, trawl and longline cumulative fishing effort in the NRA need to be calculated separately (NAFO, 2021b).

The original NAFO "coupling VMS with logbook" methodology (NAFO, 2017) calculates the "cumulative fishing effort" taking into account available data from bottom trawlers and bottom longliners. It also calculates the "longline specific fisheries footprint" (e.g. Atlantic halibut and cod) taking into account available data from bottom longliners only. But, it is recognized that information from longline activity currently available from the NAFO logbooks is insufficient to describe appropriately the longline footprint[25] and the associated impacts. This issue was discussed during the SC 2020 Annual Meeting (NAFO, 2020b). The SC noted that "*... in the case of longline fisheries, collection and compilation of additional information would be crucial to start the process of defining a more precise fishing bottom longline footprint since with the information that is currently available, it is not possible to obtain the* real footprint for this fishery".

Despite this issue, WGESA (NAFO, 2021b) considers that the merging VMS with logbook method can describe reasonably well the footprint of the longliners fisheries carried out in NAFO. However, WGESA maintains the recommendation to collect and compile additional information in the logbooks to better describe and represent a more precise fishing bottom longline footprint.

Improving the quality control process for VMS/logbook data

VMS/logbook data for footprint related studies are provided by the NAFO Secretariat. The quality of the information, both in the VMS system and in the logbooks, is a current concern to NAFO (2021b). The improvement of the quality of these data is crucial for better studying the effort distribution and the tasks related to this effort. For more details see "section 1.g".

WGESA (NAFO, 2021b) recommended that the NAFO Secretariat carry out a study on the problems detected (Garrido *et al*., 2020; Sacau *et al*., 2020) and propose measures to solve them. Therefore, misreporting and errors found in VMS and logbook data should be further analysed (e.g., to be implemented by NAFO Secretariat through a previous quality control check process).

[25] While in trawl fisheries is enough to know the start and the end of the haul, in longline fisheries is necessary to know the start and end of the line set as well as the start and end of the line haul. Currently, in the logbook only information on the start and end of the haul is recorded, being not possible to know the exact location where the longline was deployed over the seabed.

1.j. Identify strengths and weaknesses of the methodologies used for establishment of historical and cumulative fishing footprint

Strengths

- Data Availability: NAFO Secretariat makes VMS and logbook data available for scientific purposes, such as NAFO's SAIs on VMEs, fish stock assessment and reassessment of bottom fisheries.

- Amount of data: The amount of data available each year is substantial, e.g. for the period comprised between 2016-1019 there were more than 171 000 VMS pings and more than 131 000 logbook records from 21 fisheries (12 operational for the period 2016-2019) corresponding to different gears (mainly bottom trawl and longline).

- Logbook data collection form: The new NAFO logbook data format (implemented in 2016) included records for fishing timestamps, geographic coordinates for gear deployment and retrieval, as well as the catch and discard weight for each species caught. This information is an important improvement for as it allows a finer spatial resolution of the fisheries-specific footprint, tending to have fewer spurious points outside of the main footprint area.

- Discrimination between "fishing" and "non-fishing" VMS pings: NEREIDA methodology permits VMS pings to be assigned as "fishing" or "non-fishing" (e.g. steaming) based on whether or not they fall within fishing time intervals reported in the haul-by-haul data. Additionally, VMS points were assigned to a fishery based on the species with the highest retained catch weight in the logbook during the corresponding logbook fishing time interval.

Weaknesses

- Erroneous entries: In many instances, both data sources (i.e. VMS and logbook) contain erroneous entries, namely: points with incomplete timestamps; wrong vessel positions; duplicated records; headings outside compass range, etc. These errors can be due to several factors:

    - *Human factor affecting logbook data quality:* In the case of logbook data, errors could be caused by typing when entering data. In this regard it can be reasonably assumed that errors will be more frequent in the logbooks than in the VMS since they depend to a greater extent on the human factor. Another problem regarding the typing mistakes in the information of the logbooks is that the haul time does not represent the real fishing activity (e.g. very long hauls). These errors may have an impact on the subsequent analyses that are carried out with the VMS, the logbooks or the merged VMS logbooks data. These failures imply that the selected pings of these hauls in the merging (VMS and logbook) database are incorrectly selected, including pings that correspond to time where the vessels are not fishing. The number of pings assigned erroneously will depend on the error in the duration of the haul typed in the logbook (Garrido *et al*., 2020).

    - *Technical factors affecting the VMS transmission:* Although VMS pings are supposed to be sent automatically by the vessel at a frequency of around an hour, it is not always the case. This may be due to some technical error in the transmission systems. VMS data problems (over and under transmission) may have an effect in the VMS speed filter and in the merging (VMS and logbook) methods, as the missing pings are lost in both methodologies.

The issues mentioned above, could imply a wide range of impacts on the subsequent analyses that will be conducted using these data (see “section 1.g” for more details).

- Lack of use/consideration of complementary and alternative supporting information: Automatic Identification System (AIS) data is not currently taken into consideration as a support for the analysis of the NAFO fisheries footprint. It is worthy to note that this information has been widely used to monitor fishing activity in real time especially in remote areas and the High Seas (de Souza *et al*., 2016), although these data have some limitations and challenges (Taconet *et al*., 2019).

- Lack of information regarding fishing gear characteristics: Current available information on fishing gear characteristics is incomplete (see “section 1.i”) and should be improved by including gear dimensions, as it was recommended by NAFO SC (NAFO, 2020b).

- Data frame used under the NEREIDA EU Programme: The analysis of the distribution and intensity of fishing effort in the NAFO Regulatory Area using the “coupling VMS with logbook” methodology, conducted under the EU NEREIDA Programme, can only be implemented from 2015 onwards. This is due to an improvement done within the logbook data (see “section 1.d” for more details).

1.k. Suggest/propose recommendations that could be considered as guidelines for future EU proposals regarding the definition of footprint

Lessons learned from NAFO experience could be useful as guidelines to study the fishing footprint in other RFMOs:

Data needs

The following information is considered essential to define appropriately the bottom fishing footprint in the NRA:

1. Vessels fishing in the NRA are required to have onboard functional VMS as an integral part of NAFO’s Monitoring, Control and Surveillance scheme. VMS uses the Global Positioning System to display the accurate geographic position of the vessel. VMS data collected by NAFO secretariat includes (i) NAFO Vessel Identification, (ii) Flag State, (iii) Radio (vessel call sign), UTC date and time of the vessel position, vessel position by latitude and longitude, speed[26] and heading. Some of this information is considered confidential (e.g. Radio vessel call sign) and not strictly necessary for the definition of a general fishing footprint.

2. Haul-by-haul catch data is logbook data collected during fishing vessel activities. Specifically, details for each vessel on (i) date, (ii) type of gear used, (iii) timestamps and geographic coordinates for gear deployment and retrieval are recorded, as well as the (iv) catch and (v) discard weight for each species caught. The new NAFO logbook data format, implemented in 2016,

[26] According to NAFO Secretariat (Federizon, 2021 *personal communication*) the vessel speed indicated in the VMS record is the speed at the instant the data are recorded with positional information.

includes this kind of information allowing a finer spatial resolution of the cumulative and fisheries-specific footprint.

3. Information on technical and operative characteristics (e.g. gear type and typical dimensions, mode of operation, etc.) of the bottom fishing gears used by the different fleets is necessary to (i) calculate swept area when studying the overlapping between trawl fishing footprint and VMEs in the context of the SAI assessment and to know (ii) the location where the longlines were deployed over the seabed in order to better describe and represent a more precise fishing bottom longline footprint. As was noted in "section 1.i", current available information on fishing gear characteristics is incomplete and should be improved (NAFO, 2020b).

4. Although NAFO RFMO does not have experience with AIS, this data source could be used as supporting information for the spatial analysis of fisheries as a complementary source (e.g. https://globalfishingwatch.org/ and www.fao.org/3/ca7012en/ca7012en.pdf). Exploration of the utility of AIS data is recommended as potential data source.

Data compilation and availability

The VMS device transmits the information from the vessel to the Fisheries Monitoring Centres (FMCs) of each Contracting Party. FMCs are the land-based national centres to which registered fishing vessels connect via satellites. The information received by the FMC is then forwarded to NAFO's Headquarters (https://www.nafo.int/Fisheries/ReportingRequirements/VMS):

- Vessels report every hour their geographic position, speed, course, etc.
- Vessels transmit daily catch information directly to their FMCs.
- NAFO Contracting Parties have the responsibility to ensure that the information is transmitted to the Secretariat.

NAFO Secretariat compiles and maintains VMS and logbook data, having the duty to make available such data to the NAFO SC (NAFO 2021b, Article 28-9f and Article 29-10d), without the vessel's/flag State identification, to be used for scientific purposes (e.g. assessment of SAIs on VMEs, fish stock assessment, and reassessment of bottom fisheries). This allows SC to have available an essential amount of information.

As VMS and logbook data are complementary, an adequate collection and compilation of data on VMS, logbook and gear characteristics is crucial to allow the use of "coupling VMS with logbook" methodology (NEREIDA, 2021) and other analysis (see "sections 1.c and 1.g" for more details).

Data quality: VMS and logbooks

The accuracy of fishing effort estimation is primarily linked to the quality of the input data and by the cumulative effect of linking different datasets with difference level of accuracy together. Some quality issues were identified in the NAFO VMS and logbook data, related with human and technical errors (Garrido *et al*., 2020; Sacau *et al*., 2020). These errors may have an impact on the subsequent footprint related analysis.

Therefore, it is recommendable to develop further studies on the problems detected, (including an implementation of an improved quality control check process) with the aim to propose measures to solve the detected problems (NAFO, 2021b).

Methodology: Simple speed filter vs Coupling VMS and logbook data

While applying a "simple speed filter" is a very common method for extracting VMS points associated with fishing, there will inevitably be some points that are misclassified at a rate that is difficult to quantify (Sacau *et al*., 2020). In previous years (NAFO, 2015), a simple speed filter of 1 – 5 knots was used to filter VMS points and assign them as fishing activities, but this presented challenges in terms of threshold speeds across entire fleets.

The improved "coupling VMS with logbook" methodology used by NAFO (NEREIDA, 2021) is a powerful tool. In comparison with a "simple speed filter" methodology, this method allows describing and mapping the spatial distribution of fishing activity at a much finer resolution, thanks to the discrimination between "fishing" and "non-fishing" VMS pings (e.g. "steaming" pings). Moreover, different pings can be assigned to the different fisheries based on the catches collected in the logbooks, allowing creating fishery-specific effort maps to better describing directed fisheries.

Other issues to consider

Identification of needs (Potential funding for NEREIDA 2021-2022 EU Programme)

Even though the actual methodology has been found to improve the original, refining the spatial distribution of bottom fishing activity in relation to the simple speed filter method, NEREIDA analysis showed the existence of many issues in terms of quality of data, compromising a better quality of the results. Misreporting and errors found in VMS and logbook data should be further analysed (e.g. through a previous quality control check process). All these improvements will help to increase the quality of data (VMS and logbook) that is being used, among other analysis, to better understand if and how fishing effort is changing over the years in the NAFO Regulatory Area.

This is a crucial need as it may have a beneficial impact on the subsequent analyses that will be conducted using these data (SAI, fisheries footprint, fishing overlap with VMEs, assessments, etc).

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2. NORTHEAST ATLANTIC FISHERIES COMMISSION (NEAFC)

2.a. Diversity of fishing fleets, their practices and strategies

NEAFC is made up of eight contracting parties (CPs) namely: Denmark (in respect of the Faroe Islands & Greenland), the European Union, Iceland, Norway, the Russian Federation and the United Kingdom. NEAFC adopts management measures and allocations for the whole distribution area of the stock for including the Regulatory Area and also areas inside and beyond the jurisdiction of CPs. The main stocks are, redfish (Oceanic *Sebastes Mentella* and Pelagic Deep-Sea *Sebastes Mentella*), mackerel, haddock, herring (Norwegian Spring-Spawning Atlanto-Scandian), blue whiting, and deep-sea species.

For demersal species there are Fisheries Management Units (FMUs) for the demersal trawl fisheries for North East Atlantic haddock at Rockall and demersal fisheries for North East Atlantic deep-sea species. In recent years over 80% of landings of Rockall haddock (had.27.6b, the waters bounded by a line beginning at a point at 60°00' north latitude, 12°00' west longitude; thence due west to 18°00' west longitude; thence due south to 54°30' north latitude; thence due east to 12°00' west longitude; thence due north to the point of beginning. 6b.1 is shown, while 6b.2 is inside territorial waters) are taken by the UK (Scotland), with smaller proportions taken by Ireland, the Russian Federation and Norway (Table 1). The main gears are bottom otter trawl directed at demersal fish with a mesh size of 100-119 mm and mesh size greater than 120 mm directed at all species without selectivity devices. The demersal fishery for haddock at Rockall, only accounts for a small proportion of total haddock catches in the North East Atlantic ecoregion (Figure 1, right). The haddock box is closed to protect juvenile haddock, and the control of fishing mortality is via annual TACs.

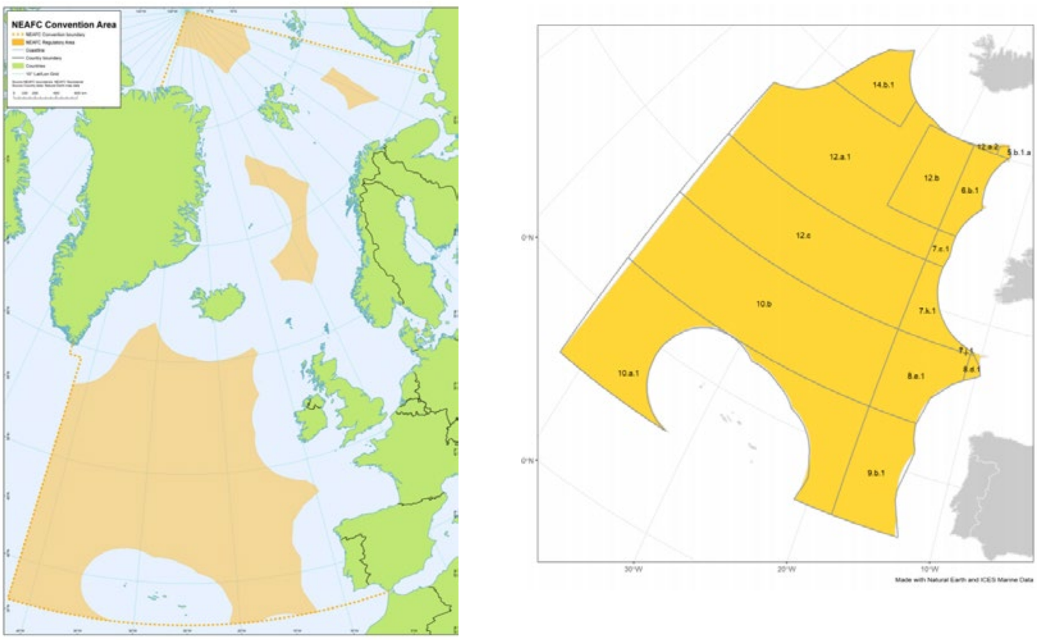

Figure 1. NEAFC Convention and Regulatory Areas (left) (Source: NEAFC website www.neafc.org); Northeast Atlantic ecoregion showing ICES statistical areas (right).

Table 1. Haddock catches (tonnes) taken in the NEAFC Regulatory Area in 2019 (the last available year) by CP, note catches not reported separately for UK.

Aggregated Catch Statistics of Haddock for 2019			
CPs	**European Union**	**NEAFC RA**	**CPs Total**
European Union	6,812	552	7,364
DFG Faroes			0
DFG Greenland			0
Iceland			0
Norway	6	7	13
Russian Fed.		245	245
Zone Total	6,818	804	7,622

The main deepwater demersal resource species of the northeast Atlantic Ocean are illustrated in Figure 2. Fisheries for a number of deep-sea species are also conducted in the NEAFC Regulatory Area (Table 2), and 53 species are formally classified in the NEAFC Scheme of Control and Enforcement as "Regulated Resources", and subject to legally binding conservation and management measures[27].

Table 2. Aggregated Catch Statistics (tonnes) of deep-sea species by CP for 2019

European Union	DFG Faroes	DFG Greenland	Iceland	Norway	Russian Fed.	Total
46,006	21,925	2,978	25,501	68,947	12,939	178,296

By-catch of non-target species and of species of non-commercial interest also occur. Fishing gear used in the deep-sea fisheries include bottom trawl, longline and gillnet which all have bottom contact. In 2016 NEAFC agreed on an approach to conservation and management of deep-sea species and categorization of deep-sea species/stocks. This includes measures for specific stocks stipulating that directed fisheries are not authorised and that by-catches should be minimised. Other measures are directed at potentially developing fisheries targeting previously unexploited or lightly exploited deep-sea species/stocks. These prevent unregulated expansion of new deep-water fisheries in the Regulatory Area before sufficient information has been gathered to facilitate ICES assessment and advice. In addition to these general measures, specific TACs exist for grenadiers, while certain gears are banned (e.g. gill nets in depths greater than 200m) and actions against ghost fishing by lost gear are in place. Areas are also closed to fisheries to protect vulnerable marine ecosystems. Authorisation to start bottom fishing in new areas outside the existing deep-sea foot print follows a strict exploratory fishing protocol.

[27] http://www.neafc.org/scheme/Annex1/b

Pelagic Fisheries also occur for smaller pelagic species, i.e. North East Atlantic Blue whiting, North East Atlantic Norwegian spring spawning herring and North East Atlantic mackerel and deep-sea redfish, i.e. North East Atlantic Pelagic redfish in the Irminger Sea and adjacent waters, and North East Atlantic Pelagic redfish fisheries in the Norwegian sea.

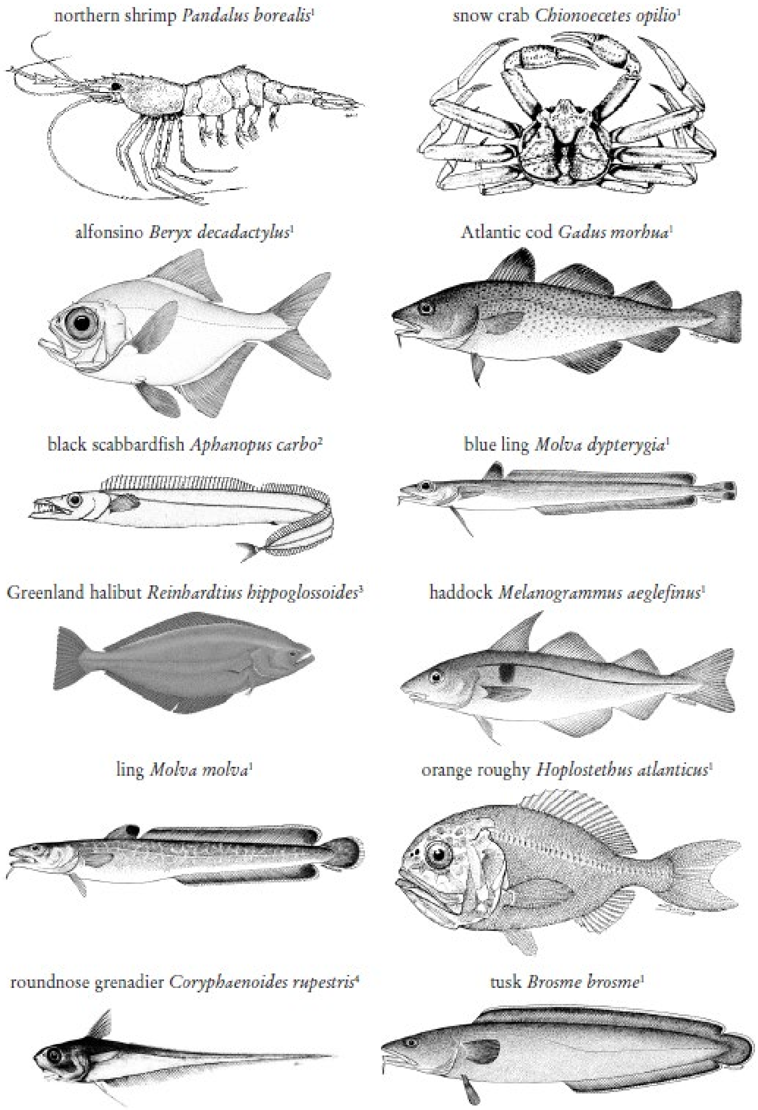

Figure 2. Principal demersal resource species of the high seas of the northeast Atlantic Ocean (FAO, 2020). [Sources of pictures: [1] Food and Agriculture Organization of the United Nations, Original Scientific Illustrations Archive. [2]www.fao.org/fishery/species/2469/en. [3] www.fao.org/fishery/species/2544/en [4] www.fao.org/fishery/species/3035/en].

2.b. Operative/technical characteristics of the fishing gear

Pelagic trawlers account for the majority of the fishing effort in the region, mainly in the northeastern (blue whiting) and northwestern (two pelagic beaked redfish stocks) parts of the North East Atlantic ecoregion. The main demersal otter trawl fisheries in the area take place on the western part of the Rockall Bank, targeting haddock, saithe, anglerfish (anf.27.3a46), and megrim (lez.27.6b). Some longline fisheries target ling, blue ling, greater forkbeard (gfb.27.nea), and tusk at Rockall and around the Hatton Bank. Furthermore, some pelagic longline and hook and line fisheries, mainly in the southern part of the ecoregion, target large pelagic fish, such as tuna, swordfish, and pelagic sharks.

Bottom fisheries in the NEAFC Regulatory Area (i.e. the high seas of the North East Atlantic) are limited by the legally binding measures for the protection of vulnerable marine ecosystems (VMEs). These measures[28] limit bottom fishing to areas where bottom fisheries took place in a specific reference period, and which have not been closed due to VMEs occurring or being likely to occur. This limits the areas where bottom fishing is authorised to a small proportion of the NEAFC Regulatory Area. Areas where VMEs occur or are likely to occur are closed to bottom fishing, but as a precautionary measure, encounters with VME indicator species above a specific threshold result in a temporary bottom fishing closure for all vessels. Outside the areas where bottom fisheries took place in a specific reference period, only strictly regulated exploratory bottom fishing can be authorised. These need to undergo an environmental impact assessment and be explicitly agreed to by NEAFC before being authorised, and in practice no such exploratory bottom fishing has taken place.

2.c. Definition of spatial footprint for a typical fishing gear deployment event

NEAFC has limited the fishing footprint by designating existing fishing areas within which bottom fishing is permitted. Outside these areas bottom fishing is prohibited, and any new fishery wanting to be developed must do so under an exploratory fishing protocol. In addition, extensive areas within the fishing areas have been closed to protect vulnerable marine ecosystems (VMEs). NEAFC has banned targeted fisheries on deep-sea elasmobranchs. Individual parties to NEAFC have implemented additional measures for their own fleets fishing in international waters, e.g. the recent changes in EU fishing opportunities for deep-sea species. NEAFC measures are legally binding, and activity by contracting parties or third parties not complying with the measures is regarded as illegal and may lead to sanctions, such as the blacklisting of vessels. All fishing vessels in the NEAFC area are monitored by electronic vessel monitoring systems (VMS). NEAFC receives scientific advice on stocks and ecosystem components from ICES. The Long Distance Fleet Advisory Council (LDAC) also provides advice via the European Commission.

NEAFC has now adopted FLUX[29]. The FLUX system allows detailed information to be collected on fishing trips and activity within a trip, including haul-by-haul information, catches and discards, and transhipments. This includes the location where the majority of the catch was taken, duration in minutes of deployment, fishing gear type, any fishing problems encountered, and whether fishing occurred with related vessels. Detailed data on hauls can also be recorded, such as when the gear was shot and retrieved, location and gear characteristics. Additional, information on catches such as stock, FAO species code, live weight (kg) of the reported catch, size distribution of the catch, can also be recorded.

The NEAFC regulations specify what information must be collected[30], and hence the data contained in the FLUX system, namely:

1. Each Contracting Party shall ensure that all fishing vessels flying its flag and conducting fishing activities keep either a bound fishing logbook with numbered

[28]http://www.neafc.org/system/files/Rec_19-2014_as_amended_by_09_2015_fulltext_0.pdf
[29]https://www.neafc.org/system/files/Recommendation-16-to-adopt-NEAFC-FLUX-FA-ERS-Implementation-v2.pdf
[30]https://www.neafc.org/scheme/Chapter3/article9

pages or an electronic logbook and, where appropriate, a production logbook and stowage plan.

2. Fishing logbooks shall contain the following recordings in accordance with the specifications set out in Annex IV:

a. each entry into and exit from the Regulatory Area and the cumulative catches retained on board;

b. on a daily basis and/or for each haul, by species in live weight kilograms:

- catches retained on board;
- the estimated cumulative catch since the entry into the Regulatory Area;
- the type of gear (number of hooks, length of gill nets, etc);
- the number of fishing operations per day (where appropriate);
- the small statistical rectangle or fishing location (longitude and latitude);
- the amount of fish discarded.
- the fishing depth (where appropriate)

c. on each occasion when fish is transhipped, where appropriate, the quantities by species on-loaded and off-loaded.

d. on each occasion a vessel engaged in a joint fishing operation shall record:

i. where the catch is taken on board:

- the date and time (UTC);
- the location (longitude/latitude);
- catches taken on board and any catch discard from the vessel;
- the name and international radio call sign of the fishing vessel from whose gear the catch has been taken.

ii. where the catch is not taken on board:

- the date and time (UTC);
- the location (longitude/latitude);
- that no catch has been taken on board;
- the name and international radio call sign of the fishing vessel which has taken the catch

3. After each communication of a report pursuant to Articles 11(4), 12 and 13, the following details are to be immediately entered in the logbook:

- date and time (UTC) of transmission of a report;
- in case of radio transmission, name of radio station through which the report is transmitted.

4. Fishing vessels engaged in fishing activities conducted on fisheries resources which process and/or freeze their catch shall, in accordance with specifications in Annex IV:

- record their cumulative production by species and product form in a production logbook; and

- stow in the hold all processed catch in such a way that the location of each species can be identified from a stowage plan maintained by the master of the fishing vessel;

5. Fishing vessels, with frozen catch on board of fisheries resources caught in the Convention Area by more than one fishing vessel, may stow the fish from each of these vessels in more than one part of the hold but shall keep it clearly separate (for example by plastic, plywood, netting etc) from fish caught by other vessels. Similarly, all catches taken inside the NEAFC Convention Area shall be stowed separately from all catches taken outside the area.

6. Vessels exempt from keeping a fishing logbook pursuant to paragraph 1 shall record in a production logbook and stowage plan:

- the information under paragraph 3 a) and b);
- the date and time (UTC) of the transhipment operation;
- the location (longitude/latitude) of the transhipment operation;
- the quantities of species on-loaded;
- the location in the hold of frozen fish referred to under paragraph 5;
- the name and international radio call sign of the fishing vessel from which the catch has been off-loaded.

7. The quantities recorded in accordance with this Article shall correspond accurately to the quantities kept on board. The original recordings contained in the logbook shall be kept on board the fishing vessel for period of at least 12 months.

2.d. Time frame used to calculate the fishing footprint

To the nearest minute when reporting haul-by-haul fishing activities. The footprint was defined in 2014 based on information concerning bottom fishing activities in the period 1987-2007 (Recommendation 19 2014: Protection of VMEs in NEAFC Regulatory Areas as Amended by Recommendation 09:2015).

2.e. Spatial resolution of the data used to calculate the footprint

Latitude and longitude coordinates are expressed in WGS84, decimal degree notation, using a precision of at least 3 decimal positions.

In order to better provide NEAFC with information on fishing activities in or near vulnerable habitats and closed areas, it is necessary to use the vessel monitoring system (VMS) with linked catch and gear data. ICES has identified problems with the data provided by NEAFC[31].

The first issue concerns a lack of confidence in the NEAFC data, as it is uncertain whether data provided to NEAFC by the relevant authorities includes information from all vessels using the NEAFC Regulatory Area. ICES has seen automatic identification system (AIS) data (that may not be comprehensive) and has noted fishing vessel activity that does not appear in the VMS data provided to ICES. ICES advice relies on comprehensive data, and without it, there has to be a degree of uncertainty in its advice.

The second issue is that it is not possible to accurately relate the vessel activity to the catch and gear data (because of the mis-match in temporal resolution between

[31] https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2017/2017/vme.neafc.pdf

these two pieces of information). There is therefore less confidence in the real vessel activity becoming clear from the current data.

That this problem has been identified, and that NEAFC will move to the UN/CEFACT FLUX standard for sustainable fisheries management, this has been implemented by some Contracting Parties in 2020, it will be fully implemented following a transition period of 2 years. This will mean that there will be an improvement in the future

2.f. Availability of data and coverage

The NEAFC VMS data associated with the logbooks, is held by NEAFC, and is not publicly available. NEAFC does not have a scientific committee and scientific advice is conducted mainly by ICES who have signed a Memorandum of Understanding (MoU) with NEAFC[32,33]. VMS data are provided under a specific data provision agreement within the overall context of the MoU between NEAFC and ICES.

Vessel monitoring system (VMS) data and regular catch report data is provided to ICES for scientific purposes. While these data are primarily collected for monitoring control and surveillance purposes, they are also a vital source of information for scientific purposes. The data held by ICES are not considered as publicly accessible (under the general ICES Data Policy), as they contain detailed vessel movements and commercial information about catches. In order to maintain industry confidentiality, no information is provided which can identify vessels and flag State. The standard provision of advice by ICES to NEAFC not only focuses on the main commercial stocks, but also can include further advice on specific stocks or categories of stocks (e.g. deep-sea species or sharks and rays). Advice on Vulnerable Marine Ecosystems is also given. More recently ICES has been developing more generally (i.e. not under the NEAFC MoU) comprehensive advice in terms of (sub-regional) fisheries overviews as well as (sub-regional) ecosystem overviews which take in broader ocean science[34].

Since 2000 NEAFC has used a standardised format namely: The North Atlantic Format (NAF) for communication between fishing vessels, Flag State Fisheries Monitoring Centres and the NEAFC Secretariat. In 2016 NEAFC began to explore the feasibility to use the UN/CEFACT P1000 Fisheries Language for Universal Exchange (FLUX) standard for exchange of fishing activity. FLUX provides a harmonized message standard that allows RFMO´s to automatically access the electronic data (generated from the ELogbooks) from fishing vessels. The FLUX system will allow fishing activity information recorded and transmitted by the master of a vessel and trip identification Fishing operations (daily catch or haul-by-haul) Fishing data (catch area, species and quantity, date and time, and gear used).

European Union (EU) Member States have implemented the VMS FLUX and are now reporting position reports to the NEAFC FLUX node.

VMS and catch data for scientific analysis are provided to ICES under a separate NEAFC–ICES arrangement[35]. These data include the vessel's profile and randomly generated id number, and all VMS positions received from vessels, including where available speed and heading. The vessel profile includes length, engine power, vessel type, gear type and authorised species. In addition, catch reported are available.

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[32]http://prep.ices.dk/about-ICES/Documents/Cooperation%20agreements/NEAFC/20191113_MoU_ICES_NEAFC_signed.pdf

[33]https://www.ices.dk/sites/pub/Publication%20Reports/Data%20Visualization/ICES%20Data%20Flow%20Schematics_No.1-VMS-NEAFC.pdf

[34]https://www.un.org/depts/los/consultative_process/contributions_20cp/NEAFC.pdf

[35]https://www.ices.dk/about-ICES/Documents/Cooperation%20agreements/NEAFC/20190201-NEAFC-ICES-agreement-VMS-Logbook_2019.pdf

2.g. Quality of data

The quality of the VMS data, provided by NEAFC to ICES, significantly improved in 2020 compared to previous years. However, despite improvements by NEAFC through the inclusion of data that allow catches to be linked to vessels, ICES still noted several systematic errors in the quality of VMS data supplied by NEAFC. VMS data supplied by NEAFC to ICES contained errors in reported vessel speeds; these data are used by ICES to determine if a vessel is fishing or not. There are also errors in decimal places, but not in a consistent manner across the dataset[36]. A large proportion of vessels were found to have no gear specified and the number of gear types reported was low compared to previous years. The systemic issues with the gear coding of vessels trawling for redfish in midwater over the Reykjanes Ridge also continue within the NEAFC VMS data.

2.h. Effort units that are being used

The type of gear (number of hooks, length of gill nets, etc), and the number of fishing operations per day. This allows quantities such as fishing hours for bottom-contacting trawl gear and total length for static gears to be derived.

2.i. Identify the link between the fishing techniques/gears and the specific challenges/issues related to the definition of the fishing footprint.

The FLUX system will allow many derived measures, such as fishing hours for bottom-contacting trawl gear, static gears and tow tracks (i.e. swept area) for bottom-contacting otter-trawl, to be calculated as required.

2.j. Identify strengths and weaknesses of the methodologies used for establishment of historical and cumulative fishing footprint.

The inclusion of VME indicators is the basis for the detection and representation of VME habitats. ICES uses VME indicators to calculate a vulnerability index for the VME habitats. Three vulnerability classes are presently in the classification (low, medium, and high). More refinement and testing of the method is required before the VME vulnerability index classes can be finalized for use in assessing the likelihood of VME occurrence.

ICES plotted VMS pings, based on VMS data received in and near the Rockall Bank and Hatton Bank closures. There were no records of such fishing near other closures. There were minor infringements into the Hatton Bank and Rockall Bank closures. Some trawling still occurs in the north western part of the Haddock Box and outside the fishing areas southwest of Rockall.

2.k. Suggest/propose recommendations that could be considered as guidelines for future EU proposals regarding the definition of footprint

NEAFC regulates a large area, but only a small fraction of that is an existing fishing area with a subsequent fishing footprint. No fishing is allowed outside the existing footprint except as an exploratory fishery, which requires an impact assessment. Drawing from this, a footprint should be determined by the existing fishing area and any expansion to this should be classed as exploratory fishing with the requirement to undertake an impact assessment including the calculation of a fishing footprint.

[36] ICES Special Request Advice Published 24 September 2019 vme.neafc ICES Advice 2019.

ICES recommends that NEAFC implement a QC (quality control) procedure similar to the one used by ICES when receiving VMS and logbook submissions. This would ensure feedback to those submitting data and them to correct any errors and re-submit if necessary. ICES also recommends that the gear coding of the VMS data be improved by including the gear type (e.g. bottom trawl, setnet, mid-water trawl) so as to provide the link between VMS and gear type data. This would improve the quality of data and its subsequent availability to ICES for the provision of advice.

Other issues to consider

The FLUX system and the reporting requirements present a state-of-the-art system. The MoU with ICES provides a flexible and high-quality peer reviewed method to evaluate fishing footprint.

References

FAO (2020) *Worldwide review of bottom fisheries in the high seas in 2016. FAO Fisheries and Aquaculture Technical Paper No. 657*. Rome: Food and Agriculture Organization of the United Nations (FAO). Available at: https://doi.org/10.4060/ca7692en.

3. SOUTH EAST ATLANTIC FISHERIES ORGANISATION (SEAFO)

3.a. Diversity of fishing fleets, their practices and strategies

There are currently 6 contracting parties (CPs) in SEAFO, namely Angola; European Union; Japan; Rep. of Korea; Namibia and South Africa (Norway officially left SEAFO on the 28 October 2021).

The SEAFO Convention Area (CA) is a large area with several seamount chains, isolated seamounts, guyots and banks. It covers all waters beyond areas of national jurisdiction in the region (Figure 1). The SEAFO CA is not rich in fisheries resources with about 2-3 % of the whole area being shallower than 2000m of depth. The fishing pressure in the SEAFO CA is considered as very low. Due to the low level of exploitation, SEAFO finds itself in a data poor situation when it comes to stock assessment and ecosystem management.

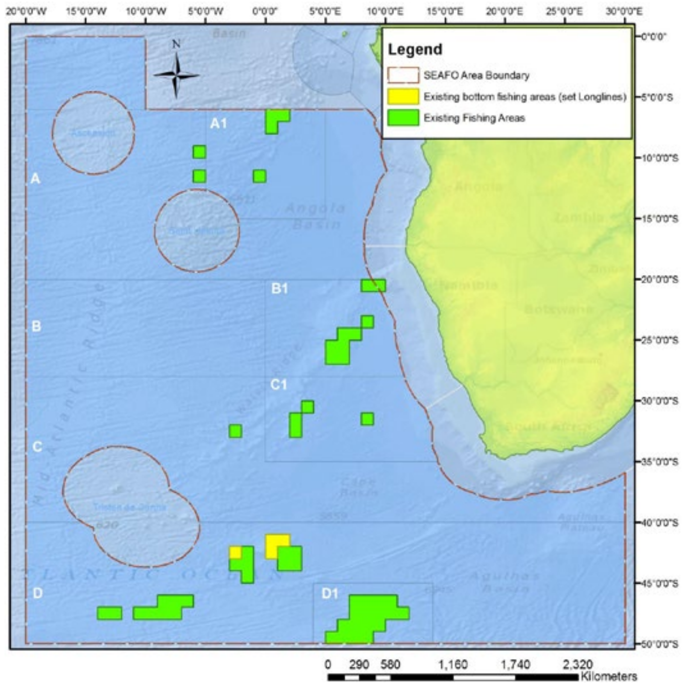

Figure 1. Composite map of existing bottom fishing areas in the SEAFO Convention Area (Source: CM 30-15).

All fishing in SEAFO occurs on or around seamounts. The main commercial target species (see Figure 2) caught in recent years are the deep-sea red crab (mainly *Chaceon erytheiae*); alfonsino (*Beryx splendens*); patagonian toothfish (*Dissostichus eleginoides*) and pelagic armourhead/southern boarfish (*Pseudopentaceros richardsoni*).

Fish by-catch is dominated by the blackbelly rosefish (*Helicolenus mouchezi*) in the Valdivia Bank trawl fishery; and macrourid species (*Macrourus sp.*) in the Patagonian toothfish fishery.

<u>*Patagonian toothfish longline fishery*</u>

Fishing for Patagonian toothfish in the SEAFO CA started around 2002. All fishing has occurred in SEAFO Sub-Area D, in two distinct regions: Discovery Seamount (East and West areas) and Meteor Seamount (Figure 1). Historically, the main fishing countries include vessels from Japan, the Republic of Korea, Spain and South Africa. The Trotline and Spanish set longline systems are used by vessels to fish for Patagonian toothfish. In 2019 and 2020 the only vessel fishing in the SEAFO CA has been a bottom longliner (Figure 3).

Deep-sea red crab pot fishery

Since 2005, Japan, Republic of Korea and Namibia have fished for deep-sea red crab. All fishing has occurred on the Valdivia Bank in SEAFO Division B1. Japan ceased fishing for deep-sea red crab in 2010, and Namibia did not fish in 2015. However, the Republic of Korea deployed a vessel in 2015 to fish for crab in the SEAFO CA. Japan and Namibia both used Japanese beehive pots.

Pelagic armourhead and alfonsino trawl fisheries

Since 2010, only the Republic of Korea has fished using trawl gear in the SEAFO CA. All fishing, since 2010, has occurred in SEAFO Division B1; predominantly occurring on Valdivia Bank, and to a lesser extent on a fishing area in the northeastern corner of the Walvis Ridge. Beginning in 2010, two Korean trawlers fished for alfonsino and pelagic armourhead. One vessel used a custom manufactured bottom trawl (HAMPIDJAN NET), and the other a stern trawler with both mid-water (KITE) and bottom (PE NET) trawl gear onboard.

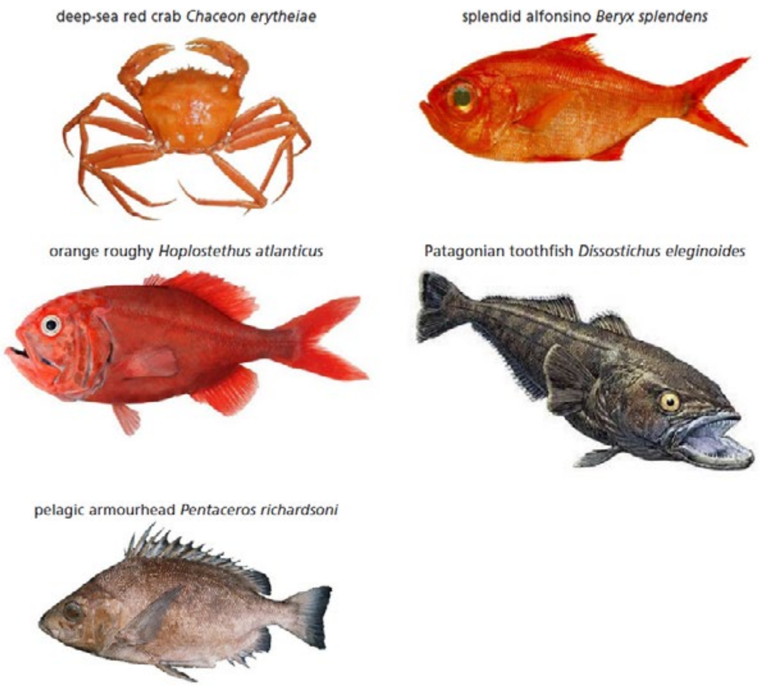

Figure 2. Principal demersal resource species of the high seas of the southeast Atlantic. (FAO, 2020). [Sources of pictures: Stock Status Reports (http://www.seafo.org/Documents)].

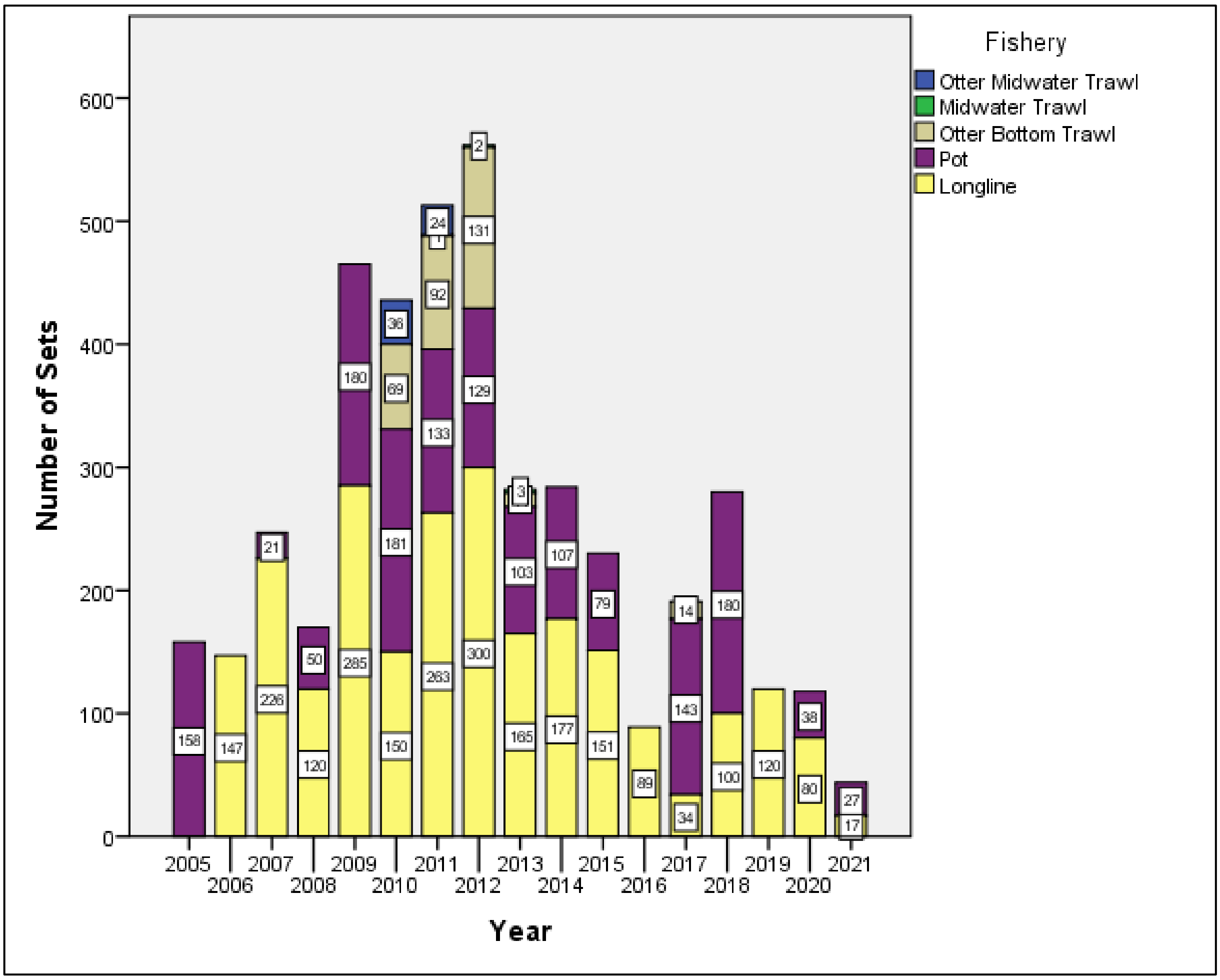

Figure 3. Temporal distribution of fishing activities by fishery. Source: DOC_SC_05_2021.

3.b. Operative/technical characteristics of the fishing gear

The fishing gear types below are those used by fisheries conducted in this area:

Mobile gears: Pelagic Armourhead and Alfonsino Trawl Fisheries.

- *TRAWL FISHERIES (DEMERSAL AND MID-WATER). See Annex 1, Paragraph 5*

Static gears: Deep-sea Red Crab Pot Fishery and Patagonian toothfish Longline Fishery (Trotline and Spanish set longline)

Demersal longlining is a passive fishing technique making use of baited hooks to attract and catch fish. The demersal longlines is weighted and set onto or close to the seabed and anchored at each end. The lengths of demersal longlines can vary greatly with larger commercial longliners setting lines over 30 km long with more than 30 000 hooks in depths over 2000m. A number of variations exist in demersal longline design, and these include: (i) Auto or Single lines, (ii) Double lines (Spanish longline system), and (iii) Trot lines.

All longlines are anchored by various means to the seabed with an anchor line leading to the surface buoys for recovery. The surface buoys are usually large plastic (A5) floats with a radio buoy attached to assist in location the buoys.

- *DOUBLE (SPANISH) LINE SYSTEMS. See Annex 1, Paragraph 1*
- *TROT LINE SYSTEM. See Annex 1, Paragraph 2*

The trot line has an advantage in that it allows for the addition of cetacean mitigation device (CED) to prevent marine mammal predation

- *CRAB POT LINES. See Annex 1, Paragraph 4*

3.c. Definition of spatial footprint for a typical fishing gear deployment event

In 2009 the Commission agreed to develop a fishing footprint in compliance with *Conservation Measure 17/09*. The Commission agreed the format that Contracting Parties (CPs) and Fishing Parties (FPs) should report to the Secretariat on the basis of digital catch position data (hauling position in decimal latitude/longitude to the nearest minute) for individual hauls/sets for the period 1987-2007.

Each haul/set record should also include gear type (bottom longline, bottom trawl, traps etc.) and date. The criteria for the establishment of the footprint will be if an area that has been fished in two consecutive years during the period 1987-2007. Such information should be provided by the CPs and fishing nations by 1 March 2010.

3.d. Time frame used to calculate the fishing footprint

As an interim measure, the SC Subcommittee (SSC) in 2010 explored two footprints based on the simple spatial distribution of catch haul position data for the following fleets:

- Spanish bottom fishing (Source: Observer catch logsheets – 1996 onwards).
- Japanese bottom fishing (Source: Observer catch logsheets – 2005 onwards).
- Korean bottom fishing (Source: Observer catch logsheets – 2008 onwards).
- Namibian bottom fishing (Source: Skipper Logsheets – 1999-2004).

Based on these data the following footprints were developed.

- Footprint 1: All available data up to 2007.
- Footprint 2: All available data up to 2010.

Historical fishing from 1996-2010, expressed as the presence and absence of fishing activity, as indicated from logbook data submitted by all CPs, in 10' x 10' cells, was used as an indicator of the level of fishing in identified seamount areas. Data for mid-water trawlers were excluded.

Because the SC in 2010 could not agree on a protocol to qualitatively distinguish between no fishing, lightly fished, moderately fished and heavily fished areas, the protocol used by SC when Regulation 06/06 was developed in 2006 was applied so that three categories were defined: (i) "considered to be unexploited", (ii) "already slightly exploited", and (iii) "already exploited".

3.e. Spatial resolution of the data used to calculate the footprint

The SC has investigated the use of two cell sizes: 10' x 10' (10 x 10 nm) and 1° x 1° (60 x 60 nm). In 2011, SEAFO 1°x1° based footprint areas were established using the information from 1987-July, 2011.

According to the CM30-15-3, all 1ºx1º areas within the exploratory area that contain a VME encounter should be excluded from the proposed new fishing area.

3.f. Availability of data and coverage

The 2010 Commission Report recognizes that, given that some of the data on the fishing footprint provided to the Secretariat was not in the format requested by the Commission (catch position data in terms of latitude and longitude to the nearest minute) and that some Contracting Parties and Non Contracting Parties did not make any data available, the Scientific Committee proceeded to develop a fishing footprint using exclusively data supplied in the adequate format, namely those for EU and Namibia. The Scientific Committee emphasises that these data do not constitute all the data needed to develop an accurate and final footprint.

UK's National Oceanographic Centre (NOC) at the request of SEAFO noted that data on South East Atlantic seamounts, especially in terms of biologically-significant data is at best described as very patchy and of variable quality.

3.g. Quality of data

In the Article 13 Vessel Monitoring System (VMS) extracted from "the system of observation, inspection, compliance and enforcement, 2019" says that in the event of a technical failure or non-operation of the Vessel Locating Device (VLD) fitted on board a vessel, the device shall be repaired or replaced within a month. After this period, the vessel is not authorised to begin a new trip with a defective VLD. If the trip is lasting more than one month, the repair or the replacement has to take place as soon as the vessel enters a port; the vessel shall not be authorised to begin a new trip without a VLD having been repaired or replaced; and that a vessel with a defective VLD shall manually communicate to the flag State FMC, at least daily, reports containing the information (Article 13, sub-paragraph b) by other means of communication (email, radio, fax, etc.).

Only data where the catch is reported by set and location were used for the footprint definition. The Scientific Committee in 2010 emphasised that these data do not constitute all the data needed to develop an accurate and final footprint.

3.h. Effort units that are being used

The effort units that are being used in the SEAFO context, are as follows:

- Crab pot lines: Catch/number of pots
- Trawl gears: kg/trawl hour
- Bottom longlines: kg/1000 hooks

3.i. Identify the link between the fishing techniques/gears and the specific challenges/issues related to the definition of the fishing footprint

In 2010 the data supplied in the requested format (digital catch position data (hauling position in decimal latitude/longitude to the nearest minute) for individual hauls/sets for the period 1987-2007, gear type and date, were initially used for the definition of the fishing bottom footprint. Only those for EU (Spain) and Namibia met the requirements.

Subsequently some of the data used to establish a bottom fishing footprint came from VMS data. Protocols had to be implemented to discern the different events happening in vessels. In this way, following guidelines taken by other RFMOs such as

NAFO and NEAFC, it was considered that for fixed bottom fishing gears when vessel speed was zero knots and the depth was <1000m (data supplied by EU (Portugal) during the period 1987-2007) it was assumed that vessels were carrying out fishing activity and therefore suitable for inclusion in updating the SEAFO bottom fishing footprint in 2011.

For other gears such as Japanese trotline it was decided to exclude VMS records where vessels speed was >4.9 knots.

The SC in 2010 didn't include the estimated footprints of midwater trawls targeting benthopelagic species. Probably the reason for the exclusion of this gear has been that the potential impact on the seafloor has been considered to be very low.

3.j. Identify strengths and weaknesses of the methodologies used for establishment of historical and cumulative fishing footprint

Different grid cells were analyzed by the experts and the progress made in this area in other RFMOs was considered. However, the quality and quantity of data from the fishing activities used for the establishment of historical and cumulative fishing footprint were very different depending on the CP.

Historical catch data for Norway were only reported for FAO area 47 (SE Atlantic) and therefore cannot be used in the footprint calculations.
Apart from Norway, the only outstanding information likely to impact the fishing footprint is the historical information for ex-Soviet Union countries. Preliminary information from the FAO suggests that these historical data are not available at the required level of spatial precision to be plotted in a grid cell, so cannot be used to define the footprint.

As the footprint is based on data (1987-2007) which also includes VMS, reported shooting and hauling positions may only be represented by a single coordinate (SC-2011) The fishing location estimated from the VMS may not fully reflect the actual area fished, because of the difficulties in discerning whether the vessel is in a fishing situation or steaming given that vessel speed is not always included in VMS data reported.

3.k. Suggest/propose recommendations that could be considered as guidelines for future EU proposals regarding the definition of footprint

Fishing activities in the SEAFO CA are very limited.

The closure of 11 areas to all fishing and a new area on the Valdivia to gears other than pots and longlines were problematic because some of these closures had previously been fished. These closures were based both on the likely occurrence of VME taxa and the intensity of the fishing in order to protect such ecosystems from significant adverse impacts within the convention area. Further information from scientific investigations at sea has been recognized. In the cases, as in SEAFO, where scientific evidence from observations of VME distributions at relevant spatial scales was largely lacking, the closing of specific areas was based on likelihood assessments rather than evidence of presence of VMEs in the areas closed. While it is assumed that correct decisions were made based on best available knowledge, the lack of direct mapping data also created the uncertainty that some areas may have been closed that do not contain VMEs, and other areas that do contain VMEs were left open to fishing.

Despite that some scientific research efforts were conducted in selected subareas of the SEAFO Convention Area in recent years, the scarcity of scientific information recognized by the SC when the closures were introduced largely persists. This situation continues to prevent the SC from making full and satisfactory assessments of the appropriateness of currently adopted fishing closures. While it is likely that most seamounts have VME indicator presence and many contain VMEs, it should also be recognized that seamounts are diverse features and that it cannot be universally assumed as a fact that all seamounts have VMEs and therefore require protection against bottom-touching fishing gears.

Scientific survey proposals must be implemented by CPs or other interesting parties. Considering that research surveys are expensive and not always available, in order to get information about the presence/absence of VMEs in these closed areas and the established closures be reviewed there could be recommended the possibility of opening these areas to commercial vessels presenting a research proposal designed to collect data on both commercial/bycatch species and VMEs, similar to that adopted in CCAMLR for data-poor areas.

Other issues to consider

Exploratory fishery proposals based in the Exploratory fishing protocol, might expand the fishing footprint. The only CP that has put forward such exploratory proposals in recent years has been Japan. This fishing is targeting Patagonian toothfish.

Rules and procedures for opening new fishing areas after exploratory fishing

1. It is required to have exploratory fishing data within a specified area without reaching the VME threshold to open that area for fishing: (i) two years of data within 5 year period for an area (<2000m) adjacent to an existing fishing area, (ii) and three-years of data within 5 years for areas (<2000m) not adjacent to an existing fishing area,(ii) Existing fishing records/data that contain VME data may be counted as a first year data set.

2. All 1x1° areas within the exploratory area that contain a VME encounter should be excluded from the proposed new fishing area.

3. Exploratory data stations should be set in such a way that it covers the exploratory area representatively above the 2000m depth isobath.

4. In case VME encounters are reported to the Executive Secretary after opening an area, the SC should re-evaluate the status of the newly opened fishing area.

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Figure 1 and 3:

DOC_SC_05_2021 - Spatial and temporal distribution of fishing activities and biological data collected. SEAFO.

Section 3.a:

http://www.seafo.org/Documents/Scientific-Committee

Section 3.b:

SEAFO_Online_Observer_Manual_Sep2019-1. http://www.seafo.org/Documents/

Section 3.g:

SYSTEM OF OBSERVATION, INSPECTION, COMPLIANCE AND ENFORCEMENT (2019). http://www.seafo.org/Documents/SEAFO-System

Section 3.i:

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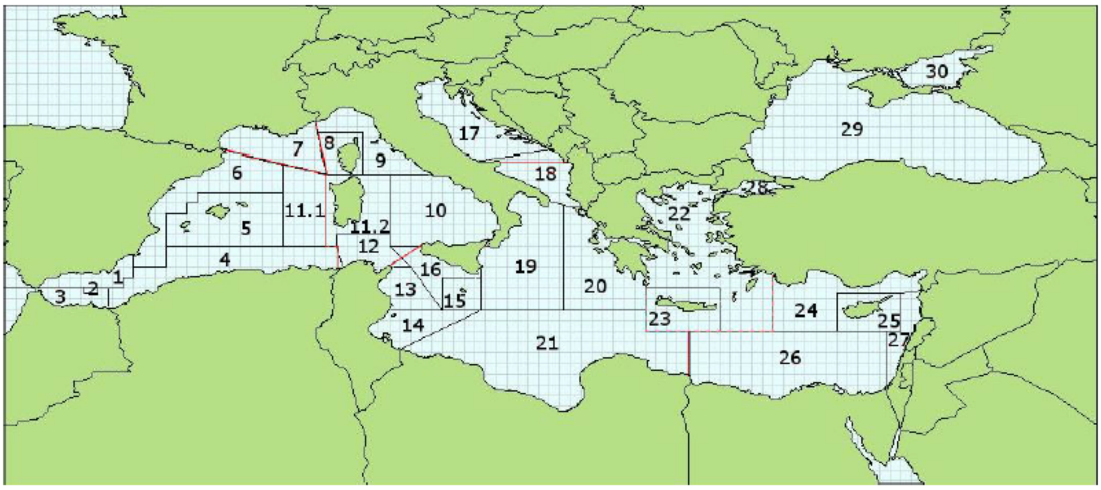
4. GENERAL FISHERIES COMMISSION FOR THE MEDITERRANEAN (GFCM)

4.a. Diversity of fishing fleets, their practices and strategies

The General Fisheries Commission for the Mediterranean is composed of 23 contracting parties: 19 Mediterranean states (Albania; Algeria; Croatia; Cyprus; Egypt; France; Greece; Israel; Italy; Lebanon; Libya; Malta; Monaco; Montenegro; Morocco; Slovenia; Spain; Syria; Tunisia); 3 Black Sea states (Turkey; Bulgaria and Romania) and European Union. It also counts 5 cooperating non-contracting parties: Bosnia and Herzegovina (2016); Georgia (2015); Jordan (2018); Republic of Moldova (2017) and Ukraine (2015).

The fishing fleets in operation in the Mediterranean (Geographical Sub-Areas, GSAs, 1 to 27), Marmara Sea and the Black Sea (GSAs 28 and 29) consist of around 87 600 vessels, with a gross tonnage (GT) of around 903 000 tonnes and total engine power of 5 745 000 kW. Around 60 percent of the total reported number is represented by just four countries: Turkey (17.5 percent), Tunisia (15.2 percent), Greece (14.6 percent) and Italy (12.4 percent). Around 83% of the total fishing vessels operating in the GFCM area of application (Mediterranean and Black Sea) belong to the group "Small-scale vessels", after which follow "Trawlers and beam trawlers" (7.8 percent), "Purse seiners and pelagic trawlers" (5.1 percent) and finally "Other fleet segments" (4.2 percent).



---- FAO Statistical Divisions (red) *---- GFCM Geographical Subareas (black)*

01 – Northern Alboran Sea	07 – Gulf of Lion	13 – Gulf of Hammamet	19 – Western Ionian Sea	25 – Cyprus
02 – Alboran island	08 – Corsica	14 – Gulf of Gabès	20 – Eastern Ionian Sea	26 – Southern Levant Sea
03 – Southern Alboran Sea	09 – Ligurian Sea and northern Tyrrhenian Sea	15 – Malta	21 – Southern Ionian Sea	27 – Eastern Levant Sea
04 – Algeria	10 – Southern and central Tyrrhenian Sea	16 – Southern Sicily	22 – Aegean Sea	28 – Marmara Sea
05 – Balearic Islands	11.1 – Western Sardinia 11.2 – Eastern Sardinia	17 – Northern Adriatic Sea	23 – Crete	29 – Black Sea
06 – Northern Spain	12 – Northern Tunisia	18 – Southern Adriatic Sea	24 – Northern Levant Sea	30 – Azov Sea

Figure 1. Map of the GFCM Geographical Sub-Areas (GSAs) established in the resolution GFCM/33/2009/2 (GFCM, 2009). Source: http://www.fao.org/gfcm/data/maps/gsas

The main deepwater demersal resource species of the Mediterranean are illustrated in Figure 2.

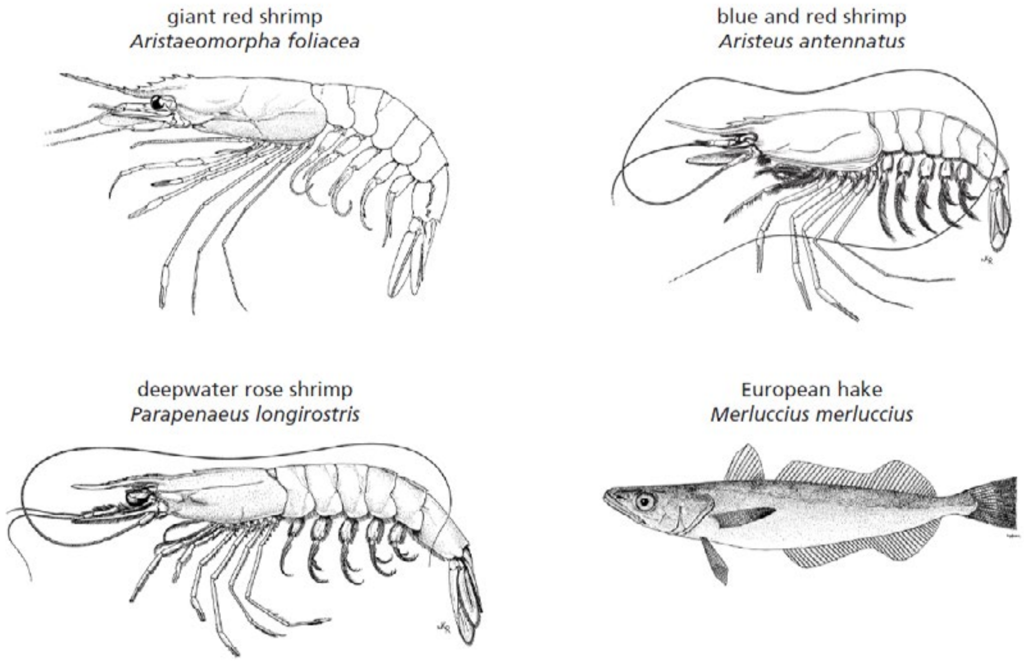


Figure 2. Principal deepwater demersal resource species of the Mediterranean (FAO, 2020a). [Sources of pictures: Food and Agriculture Organization of the United Nations, Original Scientific Illustrations Archive].

4.b. Operative/technical characteristics of the fishing gear

According to the most up-to-date information reported to the GFCM (FAO, 2020b), the capacity of operating fishing vessels in the Mediterranean and the Black Sea reaches about 903 000 GT and 5 745 000 kW. It is important to underline that five countries alone account for around 63 percent of the total fishing capacity (in GT) in the GFCM area of application: Turkey (19 percent), Italy (14.7 percent), Tunisia (11.8 percent), Egypt (9.9 percent) and Algeria (8.3 percent). Although Japan is also relevant in terms of capacity (around 77 000 GT), its fishing fleet is not currently operating in the area and therefore not considered in the analysis. Indeed, although 191 of its vessels are authorized to carry out fishing operations in the Mediterranean Sea, they are not fishing in this area. Other national fleets of substantial capacity (more than 49 000 GT) are from Greece, Libya and Spain. In the Mediterranean Sea, five GSAs alone account for around 52 percent of all the operating fishing vessels: GSA 22 (Aegean Sea, 18.2 percent), GSA 17 (northern Adriatic Sea, 12 percent), GSA 14 (Gulf of Gabès, 8.4 percent), GSA 4 (Algeria, 7.6 percent) and GSA 21 (southern Ionian Sea, 6.3 percent).

The Mediterranean Sea fleet is characterized by fishing vessels with an average age of 30 years old, with data coverage reaching about 76 percent, whereas the Black Sea has a younger fleet (24 years on average), with very low data coverage (only 26 percent). However, the average construction year of the fishing vessels varies among each state or relevant non-state actor. Romania has the youngest fleet, with an average age of 13 years old, followed by Morocco (14 years old), Egypt (15 years old) and Algeria (20 years old). By contrast, the oldest fishing vessels are from Israel (46 years old), Slovenia (41 years old), Croatia (39 years old) and Albania (38 years old). While the ageing of the fleet in these latter countries may be a matter of concern for safety, the replacement of ageing vessels can present its own drawback. Potential increases in fishing capacity could ensue if no rules are in place to regulate the entry of new vessels into the fishery.

4.c. Definition of spatial footprint for a typical fishing gear deployment event

The work carried out at the GFCM in relation to spatial footprint is mainly focused in deep-sea fisheries (DSF). The WGMPA (2019) considered fundamental for the GFCM to start mapping the fishing footprint of DSF in its area of application in order to assess where the fishing grounds overlap with sensitive benthic ecosystems. The SAC (2019) recommended to adopt a binding decision on mapping the fishing footprint of DSF according to existing agreed protocols, highlighting the need for a clear roadmap and timetable for action. The GFCM has recently launched a process similar to those carried out in other regional fisheries management organizations with the competence over deep-sea fisheries to formulate rules guiding deep-sea fisheries and mapping their deep-sea fishing footprint (FAO, 2020). According to endorsed protocols, contracting parties and cooperating non-contracting parties (CPCs) with vessels involved in deep-sea bottom fisheries are required to submit comprehensive maps of existing deep-sea bottom fishing areas (exploited at least within a five-year period prior to present) to the GFCM Secretariat, who will, in turn, produce composite maps, preferably by gear type, of the existing deep-sea bottom fishing areas within the GFCM area of application. Priority is given to bottom trawl fisheries at depths below 300 m. There is not any specific definition of spatial footprint.

4.d. Time frame used to calculate the fishing footprint

The GFCM WGVME 2018 recommended the bottom fishing footprint be determined using VMS data from the recent past (five years was suggested) and be revised regularly (every five years was suggested).

4.e. Spatial resolution of the data used to calculate the footprint

At this point, there is no information on the resolution. The requests to the GFCM members was to submit comprehensive maps of existing deep-sea bottom fishing areas to the GFCM Secretariat, who will, in turn, produce composite maps.

4.f. Availability of data and coverage

NA

4.g. Quality of data

NA

4.h. Effort units that are being used

NA

4.i. Identify the link between the fishing techniques/gears and the specific challenges/issues related to the definition of the fishing footprint

No fishing footprint has been defined for any fishing technique/gears in the GFCM. FAO (2020) refers to fishing footprint as the spatial extent of bottom fishing activities. It is mapped based on the area of seabed fished by bottom contact gear at least once over a specified time period (Amoroso *et al.*, 2018). The final objective of this mapping exercise is to identify the location and intensity of current – and, if data are available, historical – bottom fishing activities with different types of gear. The identification of such fishing grounds is instrumental in assessing fishing effort in space, as well as the pressure exerted by bottom contact fisheries on benthic ecosystems. It also provides information useful for evaluating the effects on marine protected areas and fisheries restricted areas

4.j. Identify strengths and weaknesses of the methodologies used for establishment of historical and cumulative fishing footprint

There are not agreed methodologies for the establishment of fishing footprint at GFCM level.

4.k. Suggest/propose recommendations that could be considered as guidelines for future EU proposals regarding the definition of footprint

The methodologies may differ depending on the data available for each fishing techniques/gears and countries and their way of operating: small-scale fisheries (the most abundant fleet in the GFCM in terms of number of boats) do not usually carry specific systems (such as vessel monitoring systems) which may allow the determination of fishing footprint. At GFCM level, the first efforts tend to focus on fleets operating at the deep-sea, owing to the acknowledged high vulnerability of deep-sea species and habitats to disturbances. The definition of footprint and the tasks of mapping it should be based on already formulated rules on other regional fisheries management organizations, as summarised by Bell *et al.* (2019).

Other issues to consider

The last meeting of the WGVME (2018) agreed that the determination of the historical bottom fishing footprint is crucial for the adequate management of deep-sea fisheries, and in particular to produce adequate management measures for the protection of VMEs, including through the adoption of encounter and/or exploratory fishing protocols. The determination of the fishing footprint will, thus, comprise a necessary first phase of work upon which more consolidated measures could be based.
In particular, it considered that this footprint should be dynamic and according to gear type. The working group recommended that the statistical methodologies used to determine the footprint be investigated in the intersession between the different working groups focused on this work, also based on the experience matured by other RFMOs.
According to Recommendation GFCM/33/2009/7 concerning minimum standards for the establishment of a Vessel Monitoring System (VMS) in the GFCM area, trawlers over 15 meters length, as well as all fishing vessels of the same size, are to be equipped with VMS in accordance with the GFCM recommendation on VMS.

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5. FAO AREA 41: SOUTH WEST ATLANTIC OCEAN

5.a. Diversity of fishing fleets, their practices and strategies

Geographic description of the region

The South West Atlantic (FAO Area 41), covers a total surface of 17.65 million km^2 off the east coast of South America (Vasconcellos and Csirke, 2016), from northern Brazil to southern Argentina (See Figure 1), including a shelf area of 1.96 million km^2. In addition to the above mentioned countries, the Falkland Islands (Malvinas) also border FAO Area 41. Just one third of the area's waters are under national jurisdiction, leaving over two thirds in the high seas. The fraction of ocean in the high seas is slightly higher than all the FAO areas' average (about 54 %). In the northern area (along Brazil) the continental shelf is rather narrow, rocky and coralline and mostly unsuitable for trawling. Closer to the southern extent of Area 41, it widens and becomes more suitable for trawling. The best and largest trawling areas are found in the River Plate area and over the Patagonian shelf and the Falkland/Malvinas area, where the shelf extends well beyond the 200-nm limit (more than 370 km) off the continental coastline, turning this into the largest shelf area in the southern hemisphere (FarFish, 2017). The high seas fishing mainly takes place on a shallow bank (<300m) beyond the EEZ of Argentina and outside the Falkland/Malvinas conservation Zones (FICZ and FOCZ). The fleet operating in the SW Atlantic mainly works in FAO sub-areas 3.1 and 3.2 (see Figure 1).

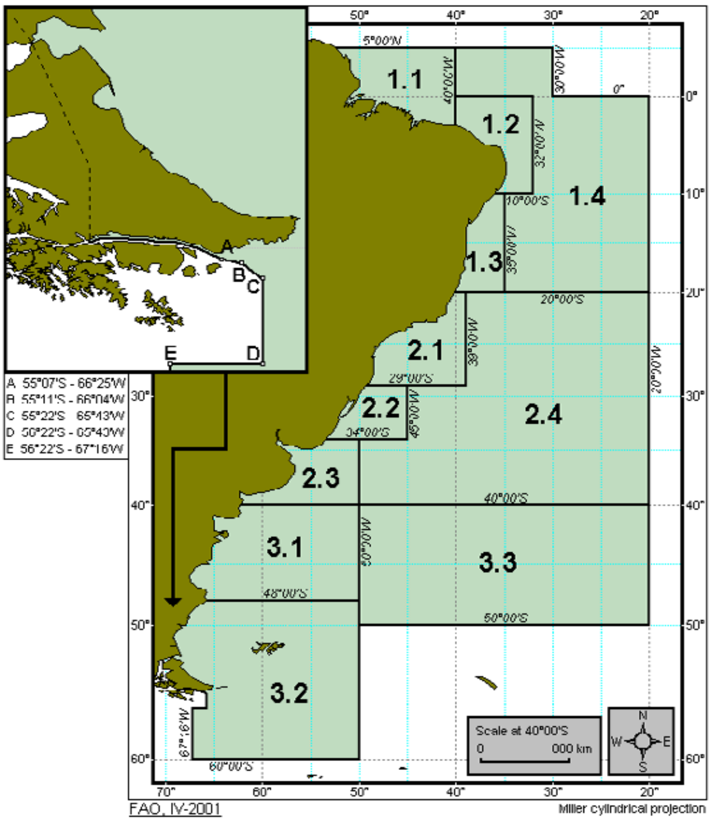

Figure 1. FAO major fishing area 41 and subareas.
Source : http://www.fao.org/fishery/area/Area41/en

History of fisheries in the high seas of Southwest Atlantic region

The area of the high seas at fishable depths (up to 2000 m) in the Southwest Atlantic is relatively small (FAO, 2020) (see Table 1)

Table 1. Area statistics for the Southwest Atlantic Ocean

Geographical area	Surface area (km^2)
Total sea area	13 929 0000
Area of high seas[1]	10 315 000
Area of high seas shallower than 200 m	9 000
Area of high seas shallower than 400 m	15 000
Area of high seas shallower than 1000 m	53 000
Area of high seas shallower than 2000 m	188 000

[1] Taken as the 200 nautical mile limit.

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

A fishery also took place on the Rio-Grande Rise area seamounts in the 1980s, targeting mainly alfonsino (*Beryx* spp.). This fishery, undertaken by the former USSR, was resumed in 2000 when a new seamount in the area was discovered, but no data are available on the catch. Other fisheries are reported to have taken place on individual seamounts in the area. (Clark *et al*., 2007) Spain and Japan and, to a lesser extent, Poland, Portugal and the Russian Federation report substantial fisheries for Argentine hake between the mid-1980s and the early 1990s, with only Spain continuing to report significant catches since the mid-1990s (between 15 000 and 27 000 tonnes per year from 1996 to 2001). The Argentine fishery for Argentine hake extends as far back as the 1950s with reported catches in the period 1977–2005 ranging between 250 000 and 600 000 tonnes per year. Unfortunately, it is not possible to determine from the available data the extent to which the catch of Argentine hake, Argentine short-fin squid or other species caught by distant water fleets reporting catches in the region has been taken on the high seas (or within national jurisdiction) (FAO, 2008).

Regional Fisheries Management Organization/Arrangement

The high-seas fisheries in this area is a mixed fishing region, being the only worldwide significant area for high seas fisheries not subject to any international agreements and not covered by any Regional Fisheries Management Organisation (RFMO) competent to manage bottom fisheries (Portela *et al*., 2010).

In line with the provisions of the UNCLOS, it is the responsibility of States to cooperate in the management of high seas fisheries, including to "*enter into negotiations with a view to taking the measures necessary for the conservation of the living resources concerned*" States shall also cooperate to establish subregional or regional fisheries organizations to this end (LOS Convention, Article 118). Under international law, Vessels fishing in the high seas of the region are subject to regulation by their respective flag states, with the quantitatively important Spanish fleet also subject to European Union regulations.

In July 2008, Council Regulation EC 734/2008 for the protection of VMEs in the high seas from adverse impacts of bottom fishing gears was adopted. This applies to areas where such bottom fishing is not regulated by a Regional Fisheries Management Organization. In line with the provisions of UNGA Resolution 61/105 of 2006, in particular its paragraph 86, this regulation requires Member States to identify and close areas, where vulnerable marine ecosystems occur or are likely to occur, to bottom fishing.

The Instituto Español de Oceanografía (IEO), under the ATLANTIS project, conducted a series of research surveys between 2007 and 2010 to identify VMEs on the high seas of the Southwest Atlantic in the area where Spanish vessels had historically operated, and prepared a comprehensive assessment regarding the potential impact of Spain's bottom trawl fisheries in the region (IEO, 2011). Based on this assessment, most of the seabed below 300-400 meters depth is now closed to bottom fishing by Spanish vessels (9 closures amounting to approximately 41 300 km^2) because of the likely presence of VMEs (Durán Muñoz *et al*., 2012, Portela *et al*., 2010, 2015; Del Río *et al*., 2012).

The closure proposal was made public in April 2011, in Madrid (Spain), at an international meeting organised by the Secretaría General del Mar with collaboration from the IEO, and where representatives from the EC, the FAO, the NGOs, the fishing industry, etc. were also present.

While the European industry operating in the area accepted these conditions, other fishing fleets of other nationalities, mainly Asian countries (China, Taiwan and South Korea) have not adopted any equivalent conservation measures, implementing the provisions from UNGA Resolution 61/105 of 2006 for the area. This means that fishing in the international waters of the Southwest Atlantic is no longer a level playing field, and importantly the main objectives of these area closures to prevent significant adverse impacts on VMEs, as required in the UNGA Resolution, will not be achieved.

Regulation (EU) 2017/2403 of the European Parliament and of the Council on the sustainable management of external fishing fleets, established the conditions for fishing authorisations by Union fishing vessels on the high seas. The flag Member State may issue a fishing authorisation for fishing operations on the high seas only if the planned fishing operations are in accordance with a scientific evaluation, demonstrating the sustainability of the planned fishing operations, provided or validated by a scientific institute in the flag Member State, or part of a research programme, including a scheme for data collection, organised by a scientific body.

Only the EU and Spain, as the flag State, have adopted regulations, conducted an impact assessment, identified VMEs, or established measures to protect them in order to implement the UNGA Resolutions (DSCC, 2020). No other regulations and measures were identified for other flagged vessels undertaking fishing in the high seas of Southwest Atlantic region (Tingley *et al*., 2016).

Current fisheries

There are a wide range of species caught with gears that fish on or close to the sea floor (see Figure 2).

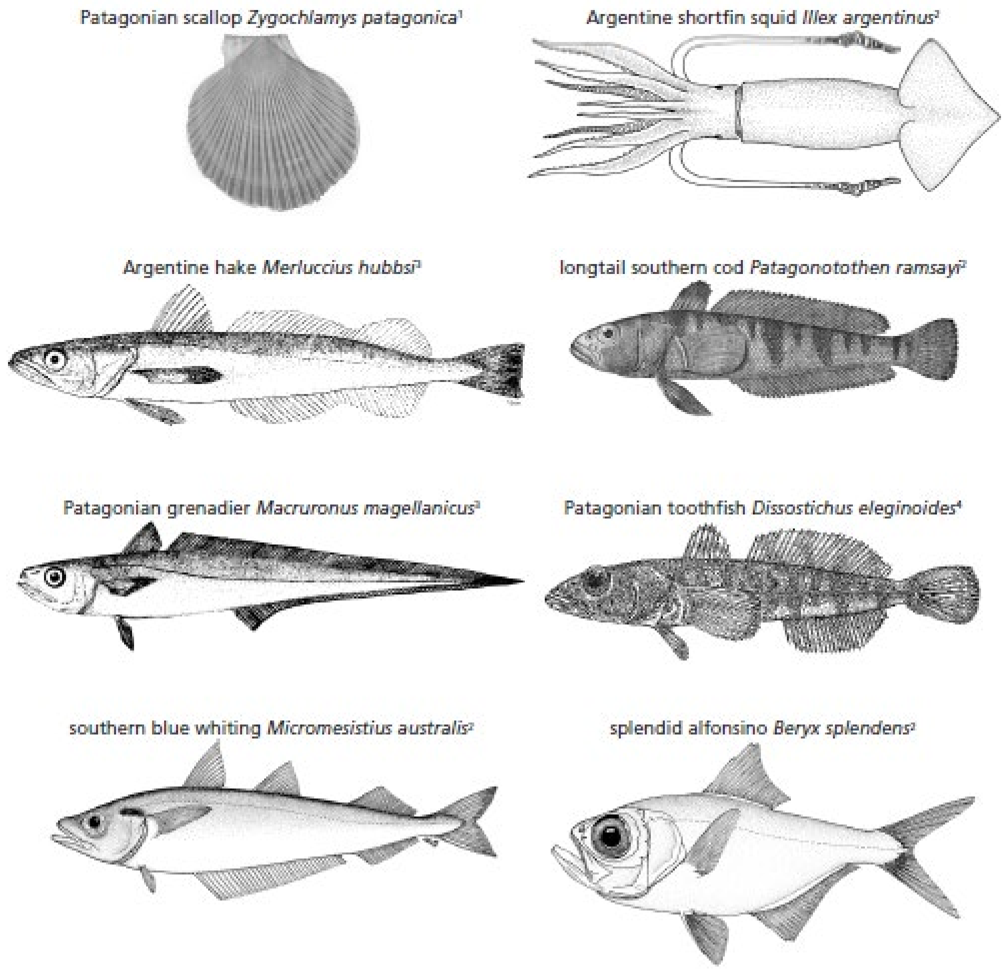

Figure 2. Principal demersal resource species of the high seas of the Southwest Atlantic Ocean (FAO, 2020). [Sources of pictures: [1]Patagonian scallop. Sustainable Fisheries Partnership. (2019). FishSource. Available at: www.fishsource.org; [2]Food and Agriculture Organization of the United Nations, Original Scientific Illustrations Archive; [3]Bensch *et al.*, (2009); [4]Fischer and Hureau (1985)].

The Patagonian Shelf hosts some of the most important fisheries in the world, targeting cephalopods (*Illex argentinus* [Castellanos, 1960] and *Doryteuthis gahi* [D'Orbigny, 1835]), and hakes (*Merluccius hubbsi* [Marini, 1933] *Merluccius australis* [Hutton, 1872]) (Portela *et al*., 2010), (Rodhouse *et al*., 1992), (Ivanovic *et al*., 1994), (Arkhipkin, 2000), (Laptikhovsky, 2002), (Arkhipkin *et al*., 2003), (Barton *et al*., 2004), (Agnew *et al*., 2005), (Waluda *et al*., 2008), (Pierce and Portela, 2014). Most of the exploited demersal stocks on the High Seas are straddling stocks, including Argentine shortfin squid (*I. argentinus*), Argentine hake (*M. hubbsi*) and southern blue whiting (*Micromesistius australis* [Norman, 1937]) (Maguire *et al*., 2006).

Three main fisheries could be defined in the Patagonian Shelf for the Spanish fleet. The first target fishery is that of hakes, comprising *Merluccius hubbsi* and *Merluccius australis*. Although *M. australis* is more appreciated in the market, it is much more scarce and restricted to southern areas. The second fishery is that directed at Illex squid (*Illex argentinus*) and the third one is the Patagonian squid fishery (*Doryteuthis gahi*). The fishing pattern is thought to be directed by a number of fishing market criteria to target one or another species.

There is also a seasonal effect of abundance and fishing aims to take advantage of the seasonal abundance of each group. Depth is a factor clearly affecting distribution and abundance of all fished species.

Information with regard to catches in the high seas is only available for a few of the years in the 2003–2014 period and for a few countries. With information only available for Argentina, Estonia, Republic of Korea, Spain and Uruguay it is difficult to know how representative these catches are. The main countries catching demersal marine fish were: Chile, Argentina, Uruguay, Japan, Portugal, Republic of Korea, Spain, and the United Kingdom of Great Britain and Northern Ireland. The main countries catching Argentine shortfin squid were Argentina, China, Taiwan Province of China, Japan, Republic of Korea, Spain, and Vanuatu (FAO, 2020).

Many distant fleets have in the past been granted licences to fish in national waters, and this adds to the difficulty of separating catches. The distant fleets increased in the early 1980s, especially by the former USSR in 1982–1989, together with Japan, Spain, Poland and Portugal in the mid-1980s (Csirke, 1987; Bensch *et al.*, 2009). The total reported catch for the whole of the Southwest Atlantic in 2014 was 952 000 tonnes of demersal finfish, 976 000 tonnes of cephalopods, 212 000 tonnes of pelagic finfish, plus some 276 000 tonnes of other species groups that are not fished in the high seas (FAO, 2019). Estimated catches in the high seas with bottom trawls and longlines for 2014 amounted to some 58 000 tonnes of demersal finfish and 15 000 tonnes of squid, which is 2–5 percent of the total catch; this suggests the enormity of the catches taken within national waters (Table 2).

Separation of the high seas catches is problematic, as coastal States have commonly issued licenses to distant fleets to fish within their national waters. Detailed and comprehensive information on the fisheries has not been compiled in most cases and there is no forum that compiles data for the high seas (FAO, 2019).

Table 2. High seas bottom fisheries catches (tonnes) in the Southwest Atlantic in 2014 and 2016.

Gear	Principal grounds	Flag states	Target species	2014 catch	2016 catch
Bottom trawl	Patagonian Shelf	Spain	longtail southern cod Argentine hake Argentine shortfin squid other finfish	24 000 19 000 15 000 3 000	10 319 19 000 3 451* 3 000
Bottom trawl	Patagonian Shelf	Republic of Korea	various[1]	< c.7 000	
Bottom trawl	Patagonian Shelf	Argentina	Argentine shortfin squid Patagonian grenadier Argentine hake	23 18 9	
Bottom trawl	Patagonian Shelf	Argentina	Patagonian scallop	26	
Longline	Various deepwater	Republic of Korea	Patagonian toothfish	≤1 800	
Longline	Various deepwater	Ukraine	Patagonian toothfish	141	

[1] Estimated from total southwest Atlantic catch minus squids (mainly jigging), toothfish, large pelagic species, elasmobranchs, other molluscs (FAO, 2019).

Fishing activities of Spanish trawlers in the High Seas is reduced to those portions of the continental shelf and slope sticking out of the Argentinean EEZ, i.e. a small patch around 42º S and a bigger area comprised between parallels 43º 30′ and 48º S, namely “Area 42 and 46” respectively (see Figure 3).

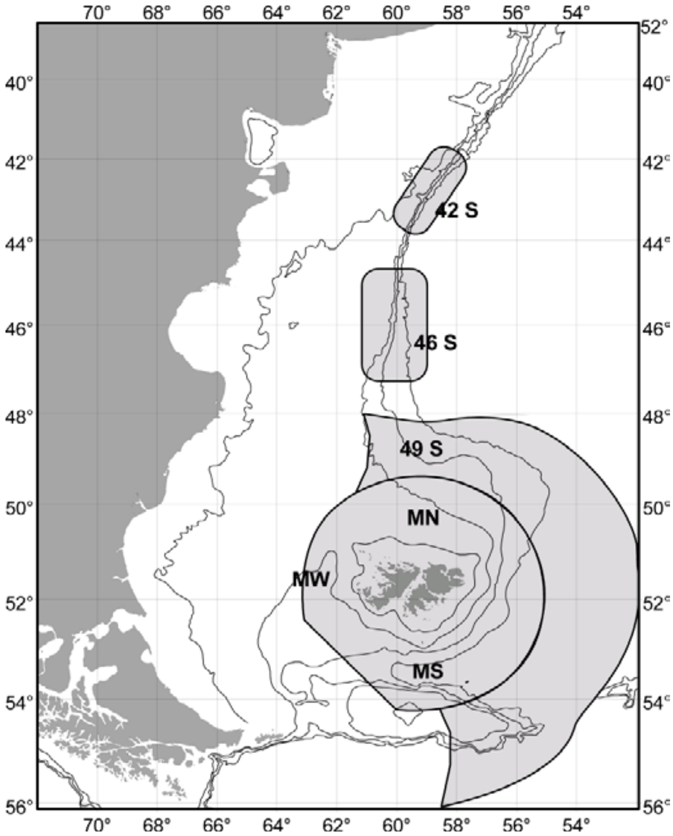

Figure 3. Main fishing areas in the Patagonian Self for the Spanish fishing fleet [Malvinas North (MN); Malvinas West (MW) and Malvinas South (MS)]

The most important by-catch species are patagonian toothfish (*Dissostichus eleginoides*), kingclip (*Genypterus blacodes*), hoki (*Macruronus magellanicus*), red cod (*Salilota australis*) and southern blue whiting (*Micromesistius australis australis*). All these fisheries comprise both retained catch and discard for all species.

Spanish fleet fishing activity strategy and trends in SW Atlantic waters

The Spanish long-distance freezer trawler fleet and longliners are based in Galician ports (mainly in Vigo). These vessels land almost exclusively in Galician ports, either by freezing catches at sea and returning to port at the end of a fishing trip, or trans-shipping catches to be landed directly in Vigo by reefer vessels in more distant fishing grounds (EC, 2008).

The Spanish fleet's fishing strategy was analyzed by Vilela *et al*. (2018), and based on on-board observer data collected from 1989 to 2015 (a series of 27 years), three main fishing seasons were identified: a first season mainly targeting Argentinean squid (*Illex argentinus*) from January to March, a second season targeting hake (*Merluccius hubbsi*) from April to August, and a third season from September to December showing an opportunistic and heterogeneous behavior.

Specifically, most of the catch performed by Spanish freezer trawlers corresponded to only three species: *M. hubbsi*, *I. argentinus* and *Patagonotothen sp.*, the latter being considered as a by-catch because of its high number of discards. Data suggest that this situation has changed in recent years, although the catch of this species still follows an opportunistic strategy, only being retained when catches of the two main target species decrease. The fleet targeted Argentinean squid during the months of January-March, hake during the months of April-August and, finally, adopts an opportunistic fishing strategy from September to December. Even if hake continued to be the main target species during this latter period, although lower and varying yields were observed, together with a reduction of fishing effort, displacement to Malvinas/Falkland waters and a more heterogeneous catch composition.

Vilela *et al.* (2018), showed that vessel characteristics of the Spanish freezing trawlers fishing in Southwest Atlantic waters were relatively homogeneous, bearing in mind the wide temporal range of the series, averaging 63,6 m in length (±8 mSD), 1856 horse power (±322 hp SD) and 1222 Gross Ton (±322 GT SD) with a mean storage capacity of 1337 m^3 (±404 m^3 SD).

Figure 4 illustrates that the annual number of units fishing in SW Atlantic waters reported by ANAMER (Asociación Nacional Armadores Buques Congeladores Pesca Merluza) reached its peak in 1990 with 79 units, although estimations from the IEO would place the real number of Spanish fishing vessels that year at 100 units (Portela, 2009). After 1990, the number of fishing vessels decreased until its minimum in 2001 (18 units), and thereafter steadily recovered until its number stabilized in 2006 at around 23–26 fishing vessels.

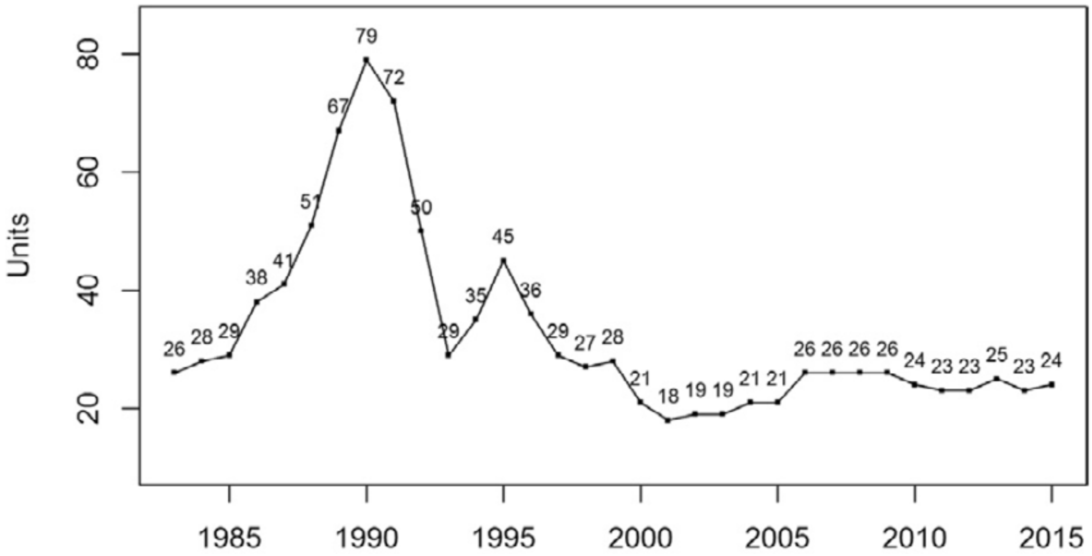

Figure 4. Number of vessels fishing in SW Atlantic waters between the years 1983 and 2015 (Source: Vilela *et al*., 2018).

The evolution of the number of fishing vessels since the 1980s suggests external events (e.g. the opening and closing of foreign fisheries to the Spanish fleet) as the main factors determining the number of fishing vessels in the region. More specifically, the increase in units in 1989 is identified with the closing of the fisheries in Namibia, while the decrease in units after 1990 corresponded to several factors: the development of the Greenland halibut fishery in Newfoundland, the shrinking squid market and the European policy of fleet reduction (Portela *et al*., 1997).

Later, an increase was observed in 1995 when European fishing vessels were forcibly obliged to abandon the fishing grounds of Newfoundland in NAFO waters. Once the issue was resolved, the number of units in SW Atlantic waters decreased again. This effect was boosted by the re-opening of the Namibian fisheries (Portela *et al*., 2002 and Portela, 2009). The stabilization of the number of fishing vessels after 2006 suggests the existence of a specialized segment of the fleet focused on this region.

According to Vilela *et al*. (2018), most of the catch performed by Spanish freezer trawlers in the High Seas above the Patagonian Shelf (HSPS) corresponded to only three species: *M. hubbsi*, I. *argentinus* and *Patagonotothen* sp., the latter being considered as a by-catch because of its high number of discards throughout the year. Most of the fishing activity takes place during daylight periods and a strong daily pattern can be observed in the catch composition, with *I. argentinus* being caught preferentially during the day. This observation is consistent with the typical vertical daily migrations of squids (Roper and Young, 1975), which live near the bottom during the day and ascend to surface waters during the night to feed (Brunetti, 1988).

The HSPS can be described as a transit area with a clear annual fishing pattern, particularly for *M. hubbsi* and *I. argentinus*. The fleet targets short fin squid during the months of January-March, hake during the months of April-August and, finally, adopts an opportunistic fishing strategy from September to December (Figure 5). Even if hake continued to be the main target species during this latter period, lower and varying yields were observed, together with a reduction of fishing effort, displacement to Malvinas/Falkland waters (mainly between August and October) and a more heterogeneous catch composition.

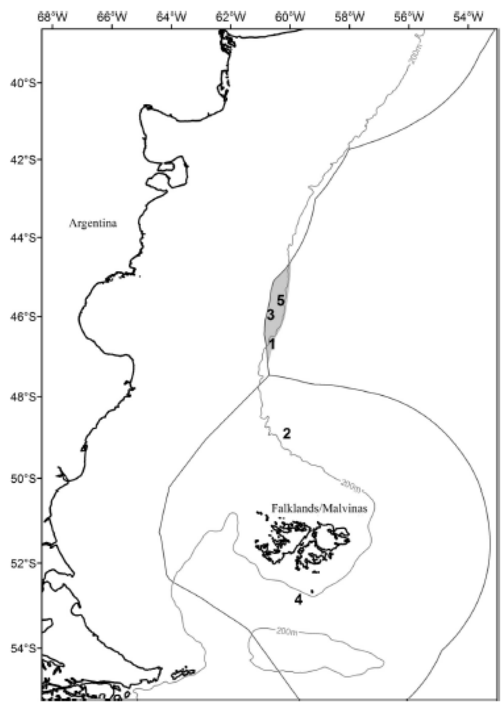

Figure 5. Location of Division 46 (in grey). The 200-meter bathymetric contour, indicating the continental shelf border, and EEZ limits are shown as reference. Overall strategy trends are shown: 1) Fleet targeting *I. argentinus* in the high seas slope between January and March; 2) *I. argentinus* fishing season in Falklands/Malvinas waters between mid-February and May; 3) Fleet targeting *M. Hubbsi* in the high seas continental shelf between April and August; 4) Second fishing season in Falklands/Malvinas waters, mainly targeting the *Doryteuthis gahi* season between July and September and the hake season between August and September; 5) Opportunistic fishing strategy in the high seas continental shelf between September and December, mainly targeting hake at lower yields (Source: Vilela *et al*., 2018).

Jiggers fleet strategy

There are as well fleets from countries such as China, Taiwan and South Korea fishing in the area (FarFish, 2017), but catch statistics from them are lacking. The night time jig fishery, using artificial light, is conducted in the high-seas but there are coastal States that have interest in the fishery, particularly Brazil and Argentina.

Based on previous examination of the fleet distribution (Cozzolino and Lasta, 2016) and a preliminary assessment of an entire mission composite of available radiance data, three regions of interest were differentiated as zones where the jigger fleet tends to cluster in FAO Area 41 (Figure 6). The first region (R1 in Figure 6) includes slope waters just at the border of the Argentine exclusive economic zone (EEZ) between parallels 44º S and 48º S and concentrates the majority of jigger activity. The second cluster of jiggers (R2) concentrates also at slope waters at the border of EEZ between parallels 42º S and 41º S. Another group of vessels operates in slope waters but within the EEZ (R3) (Figure 6).

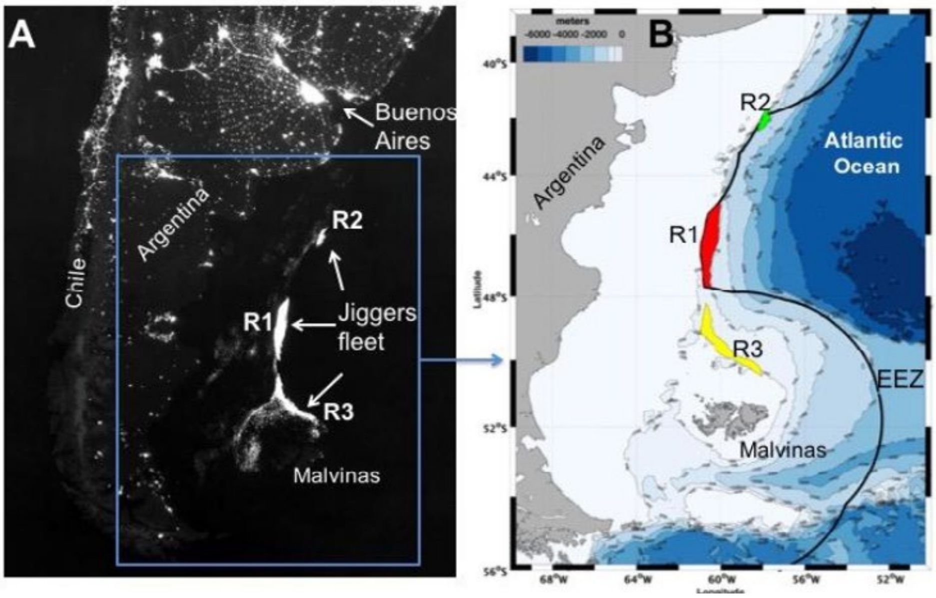

Figure 6. (A) Visible infrared imaging radiometer suite day/night band (VIIRS-DNB) radiance image (entire mission composite 2012–2018). (B) Map showing Southwest Atlantic bathymetry. R1, R2 and R3 (Source: Ruiz *et al.,* 2020) are the regions of interest. The black line shows the exclusive economic zone (EEZ) of Argentina.

5.b. Operative/technical characteristics of the fishing gear

As described previously, the main demersal fisheries in this area are for Argentine hake and Argentine shortfin squid, and are conducted with bottom trawls and jigs on sandy bottoms on the Patagonian Shelf. These species have been targeted by several distant-water fleets in addition to those of South American countries. There is also a significant bottom-set longline fishery for Patagonian toothfish conducted by South American countries and distant-water fleets.

The main fishing gear used by the Spanish long distance bottom trawlers operating in the FAO Area 41 was the "Pedreira" designed to work in contact with the bottom and where the lower edge of the net opening is normally protected by a thick groundrope ballasted with chain sinkers and often covered by rubber, discs, bobbins, etc.

Technical measures and characteristics of this fishing gear (Table 3) were obtained from data compiled through the Spanish program of scientific observers on board commercial vessels on international waters of the Southwest Atlantic during 2020 year.

Table 3. Technical measures and characteristics.

Fishing gear	Bottom trawling "Pedreira"
Bottom trawling net model	Two face and four face bottom trawling
Mesh material	Polyethylene
Average mesh size (mm)	
Trawl Body	195
Side end	135
Codend	115

5.c. Definition of spatial footprint for a typical fishing gear deployment event

There is very little information on fishing effort in the high seas of the Patagonian Shelf. Bensch *et al*. (2009) gave some information for 2003–2006. Spain operated 22–27 bottom trawlers during 2003–2006, and Estonia just one trawler in 2005 and 2006, for 81 and 59 days respectively. The Republic of Korea operated 16 trawlers in 2006, though it is not known whether they were fishing with bottom or deep midwater trawls. Effort and gear were not reported by Uruguay. More recently, Argentina has reported its high seas fishing effort for 2009–2014 for freezer trawlers, longliners, and jiggers. Effort varies tremendously and presumably relates to opportunistic behavior when their large fleet sees fishing opportunities outside of their rich national waters.

In the case of the Spanish trawling fleet operating on the high seas above the Patagonian Shelf, even though long-term fishing effort has fluctuated due to the political context, a clear annual pattern shows three main fishing seasons along the year, driven mainly by two factors: (i) target species migration patterns, and (ii) the delivery of fishing licenses in Falklands/Malvinas waters (Vilela *et al*., 2018).

Since 1991, 97% of the fishing activity in the high seas of the Patagonian Shelf has been per-formed uniquely in 'Division 46'. The remaining 3% belong to isolated hauls performed in 'Division 42' on the way to/from the fishing grounds to the port of Montevideo in Uruguay (Figure 3).

The main fishery area for the Spanish fleet on the high seas is located between 44º S and 48º S (Division 46), where the majority of fishing effort (99.85%) registered by IEO scientific observers between 1989 and 2007 was made in waters of less than 300 m depth (Figure 7). Observer registered data on commercial hauls in Division 42 (1351 hauls) shows a different depth strategy with a considerable proportion of hauls at depths between 500-1000 m (Figure 7).

These data show that most of the fishing effort in this area is carried out mainly in May targeting for *Illex* squid, which in this season is migrating to its spawning grounds in Southern Brazil and is caught at deeper depths than in Division 46. This may explain the different strategy of the fleet concerning the depths of fishing operations. In Division 42, fishing effort declined dramatically after 1992 when Argentina expanded its EEZ several nautical miles eastwards, with the subsequent reduction of the area available for fishing (Del Río *et al.*, 2012; Portela *et al.*, 2015).

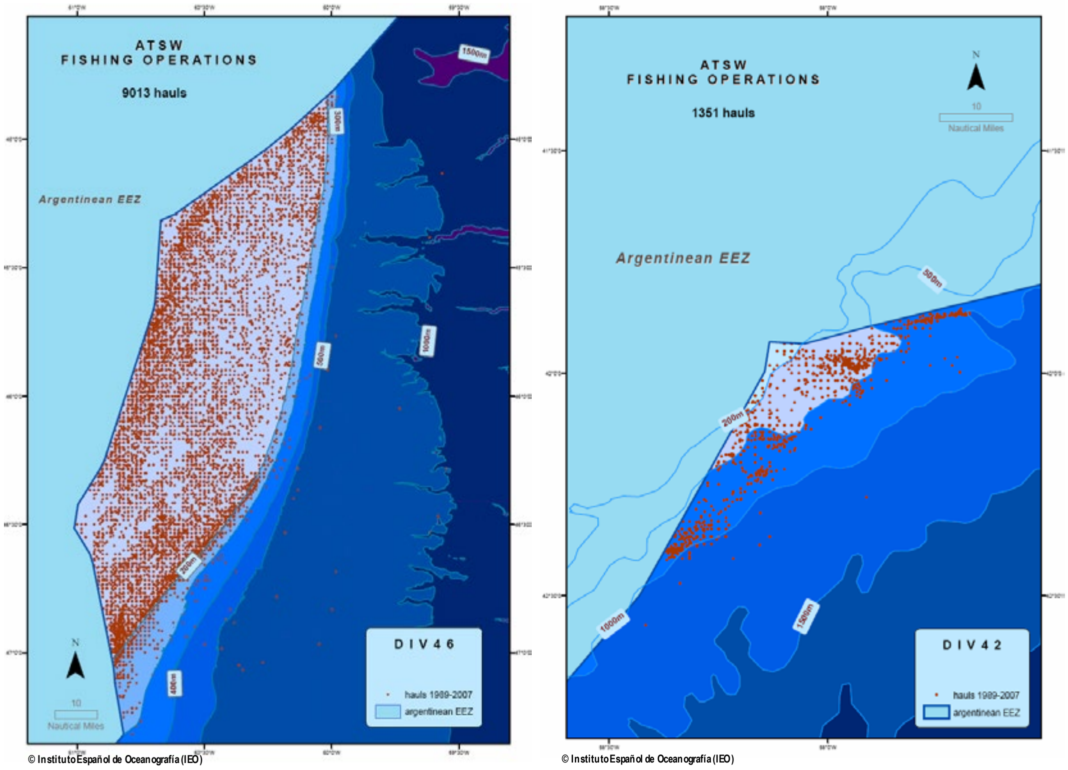

Figure 7. Fishing operations of the Spanish bottom trawl fleet in Divisions 42 (right) and 46 (left) on the high seas of the SW Atlantic (Observer Programme 1989-2007).

According to Vilela (2013), the spatial distribution of the fishing effort recorded by observer's program and VMS data from 2001 to 2008, shows a noticeable seasonality of the fishing activity, with two peaks of activity in February and April after which the activity decreases constantly until the end of the year.

The fishing activity begins in the North and heads south, bordering the Argentinean EEZ, seemingly to follow behind *Illex argentinus* in its migratory route towards the South until March, when most of the fishing activity is located in the southern area over the slope (Figure 8).

From March to April the activity moves from the South towards the middle area of the high seas above the Patagonian Shelf, mainly near the Argentinean EZZ, and from April to July the fishing activity disperses and is shared across the entire study area, the intensity of the fishing activity being the only noticeable difference between months, which reaches its peak in May. There is also a marked concentration of the fishing activity in the South during August. In September, the fishing activity decreases sharply, even though there remains some activity focused in the south area over the slope. During the next three months the activity moves towards the North following the Argentinean EEZ border while fishing intensity reduces progressively until the annual minimum in December.

Three clear fishing seasons were identified by Vilela (2013). The first from January to March, the second between April and August and the third between September to December.

From a spatial point of view (Figure 8), fishing operations during the first fishing season were performed predominantly on the southern slope between 140 and 250 m depth, while fishing operations performed during the second fishing season were more widespread and performed preferentially on the continental shelf between 110 and 150 m depth.

Shorter hauls were performed during the first season (5.13 h on average), whereas average trawling duration during the second season was 6.1 h. The longest fishing operations were found during the third season (6.2 h on average), showing high variability in December.

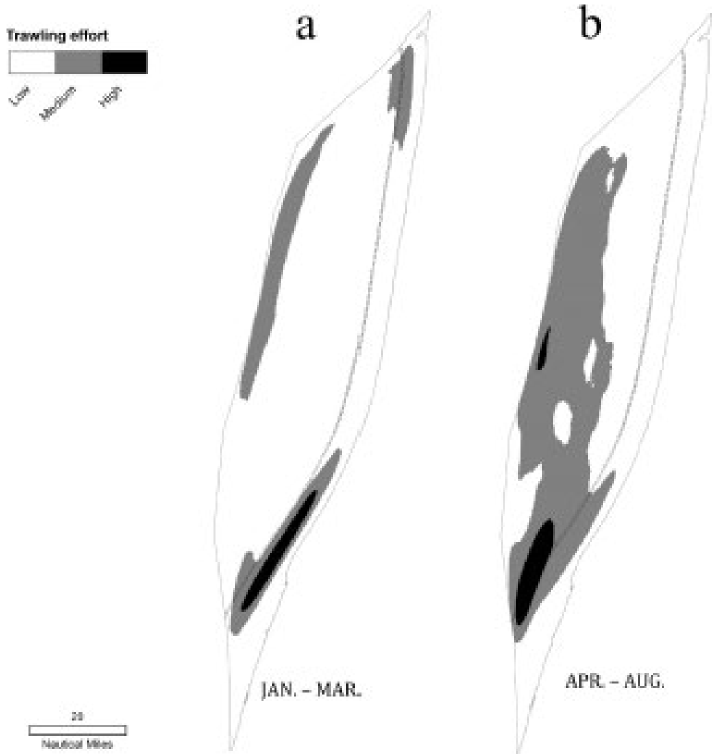

Figure 8. Categorized fishing effort performed between 1989 and 2015 in Division 46 during (a) the *Illex argentinus* fishing season in January- March and (b) the *Merluccius hubbsi* fishing season in April-August. Deep waters are at the right-hand side of the maps. Slope limit is marked with a double dashed line. (Source: Vilela *et al*., 2018).

The analysis of georeferenced information from the IEO Scientific Observers Programme, allowed us to draw a map showing the footprint of the Spanish fisheries in Southwest Atlantic waters, from 1989 to 2007 (Figure 9). This information is the most recent about Spanish “historical footprint” and was analysed in 2008 according the FAO "International Guidelines for the management of deep-sea fisheries in the high seas" in order to assist in the implementation of UNGA Resolution 61/105.

From 1 January 2009, and until presentation of the results of Spanish research to identify vulnerable marine ecosystems in the areas in which the Spanish fleet operates where there are no RFMO, a mitigating measure was adopted in accordance with UNGA 61/105 and Regulation (EC) No 734/2008. The measure restricted Spanish fisheries activities to the area where fisheries took place in the past, according the "historical footprint". This was based on the assumption that it would be improbable that these areas contained vulnerable benthic ecosystems which could be damaged by bottom trawling gears.

The results of the Spanish investigation were made public in 2011 and were utilised as a basis for determining the areas closed to fishing to be protected vulnerable marine ecosystems from the adverse impacts of bottom fishing gears in the high seas of the Southwest Atlantic.

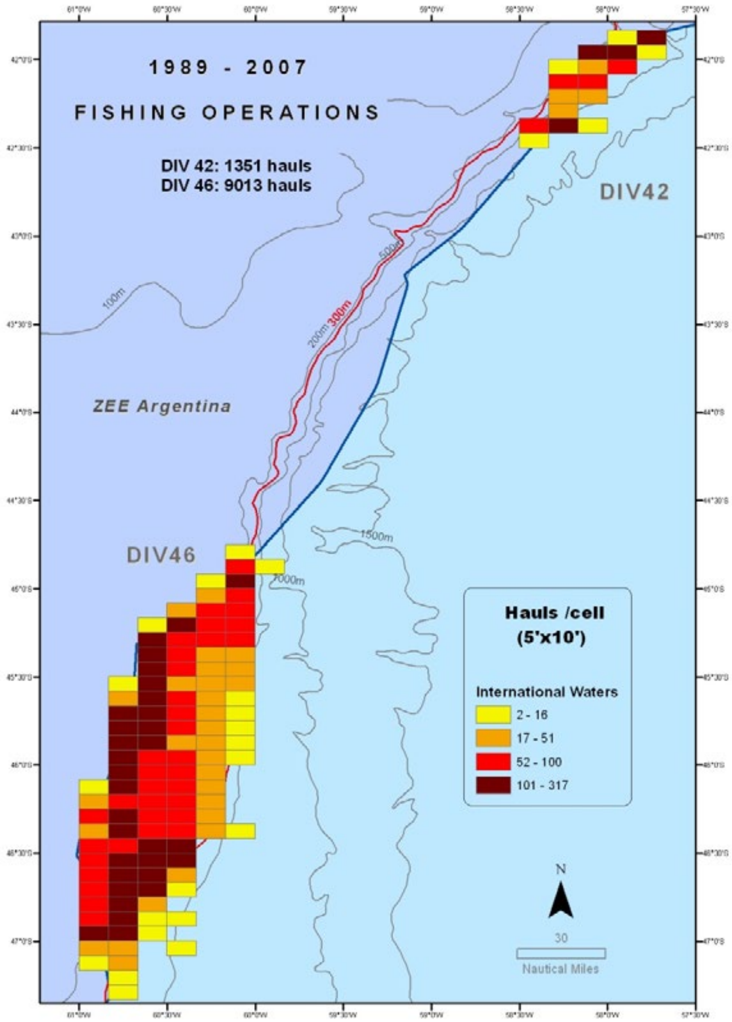

Figure 9. Location of commercial hauls and fishery footprint (5’×10’) of the Spanish bottom trawl fleet on the high seas of the SW Atlantic (Observer Programme 1989-2007).

5.d. Time frame used to calculate the fishing footprint

In the case of Spain, the Dirección General de Ordenación Pesquera y Acuicultura is the unit for control of fisheries and dependent on Secretaría General de Pesca (SGP). VMS annual data for the period 2001-2008 were provided by SGP to IEO researchers for identification of vessels carrying out fishing activities on the high seas of the Patagonian Shelf, after applying several filters such as vessel speed, position, course, etc. Results were mapped to produce the footprint of the fishery and compared to those from the IEO scientific observers programme in order to establish accuracy of the data, coverage rate and gaps of commercial information collected by scientific observers.

Scientific monitoring of the Spanish fisheries on the high seas of the Patagonian Shelf by the IEO began in 1988 analyzing commercial information from fishing companies. In 1989, a programme of scientific observers on board Spanish commercial vessels operating in those fishing grounds was set up, the main objective of this programme being to collect commercial and scientific data for monitoring fishing activities. Observers recorded commercial information such as catch and discards of all caught species, fishing effort, position, depth, Sea Bottom and Surface Temperature (SBT, SST), biological and length frequency samples (for both retained and discarded species) and collected biological samples such as otoliths, scales, stomachs, gonads, etc, for further analysis in the laboratory.

Data on commercial activities recorded by scientific observers included initial and final position for each fishing operation. For the purpose of mapping fishing operations, it was agreed to use the initial position of each haul to represent the footprint of the fishery on an annual basis.

A first step was to debug the database in order to detect and remove outliers by applying different filters such as speed, distance between start/end positions, depth, duration of the haul, etc.

5.e. Spatial resolution of the data used to calculate the footprint

There are two different spatial resolutions depending on the source of information:

i) The results with the footprint of the fishery information from the IEO Scientific Observers Programme from 1989 to 2007 in division 46 and 42 has a spatial resolution of 5 x 10 nm.

ii) According to Vilela *et al*., 2018, the categorized fishing effort was conducted using the Kernel Density tool (ArcGIS 9.3) in standardized values per square km.

The footprint pattern obtained with the two different spatial resolutions was similar and the results showed the same distribution of fishing effort.

5.f. Availability of data and coverage

The high seas bottom fisheries in this area are not subject to any international agreements and not covered by any Regional Fisheries Management Organisation (RFMO). Therefore, the availability of data in HSPS is not subject to any specific regulation or arrangement and this situation makes that available information about fishing fleets operating within this area is scarce and with very limited access. The principal source of information considered as relevant to perform fishing footprint comes mainly from the data provided by the Spanish fleet.

Vessel Monitoring Systems (VMS) are used in commercial fishing to allow Flag States and competent organizations such as RFMOs to monitor, minimally, the position, time at a position, and course and speed of fishing vessels. VMS obligations apply to EU fishing vessels exceeding 15 meters overall length, as from 1 January 2004 (EC, 2003), hence affecting all EU fishing vessels operating on the high seas of the SW

Atlantic. Also, according to the Council Regulation (EC) N° 734/2008 the monitoring of VMEs is carried out with an observer's program and VMS data are recorded.

In the case of Spain, VMS annual data for the period 2001-2008 were provided by Secretaría General de Pesca (SGP) to IEO researchers for identification of vessels carrying out fishing activities on the high seas of the Patagonian Shelf, after applying several filters such as vessel speed, position, course, etc. Results were mapped to produce the footprint of the fishery and compared to those from the IEO scientific observers programme in order to establish accuracy of the data, coverage rate and gaps of commercial information collected by scientific observers.

5.g. Quality of data

VMS requirements for vessels operating in the high seas of the SW Atlantic are covered under the Council Regulation (EC) Nº734/2008. This Regulation established in case of technical failure or non-functioning of the satellite tracking device fitted on-board a fishing vessel, the master shall report its geographical situation every two hours. Also, after returning from the sea trip, the vessel shall not leave the port again the satellite tracking device is not functioning correctly.

No information regarding the quality of VMS data in FAO Area 41 (Southwest Atlantic) was found for this review.

In the case of Spain, the Dirección General de Ordenación Pesquera y Acuicultura, dependent on Secretaría General de Pesca (SGP), is the unit that controls and provides (under request) the VMS data and regular catch report for the Spanish fleet.

5.h. Effort units that are being used

There are two different effort units:

i) Effort units for the footprint of the fishery information from the IEO Scientific Observers Programme from 1989 to 2007 are represented by the number of commercial hauls by cell of 5 x 10 nautical miles.

ii) According to Vilela *et al*., 2018, the categorized fishing effort is given in standardized values per square km.

The footprint pattern obtained in FAO Area 41 with the two different effort units was similar. This information provided by the IEO was used by the Secretaría General de Pesca to establish the fishery footprint of the Spanish fleet in the high seas of the Patagonian Shelf.

5.i. Identify the link between the fishing techniques/gears and the specific challenges/issues related to the definition of the fishing footprint

Absence of an RFMO: Lack of information

Management of the high seas is particularly challenging in FAO Area 41. The absence of an RFMO limits coordinated mechanisms to share and exchange scientific data in order to prepare advice and agree on regulatory measures in Patagonian Shelf, including with regard to the criteria for the establishment of the footprint. Data sharing in this area via research and management agreements is essential.

The bottom fisheries of the Southwest Atlantic were reviewed with information obtained from national questionnaires. Bensch *et al*. (2009) gave some information on fishing effort in the high seas for 2003–2006. Spain operated 22–27 bottom trawlers during 2003–2006, and Estonia just one trawler in 2005 and 2006, for 81 and 59 days respectively. The Republic of Korea operated 16 trawlers in 2006, though it is not known whether they were fishing with bottom or deep midwater trawls. Effort and gear were not reported by Uruguay. More recently, Argentina has reported its high seas fishing effort for 2009–2014 for freezer trawlers, longliners, and jiggers (FAO, 2020).

It was noted that there is a general paucity of information about the high seas fisheries in this region.

Limitations of Scientific Observers Programme data used for the fishing footprint definition (1989-2007)

The data used to define the fishing footprint comes from the analysis of georeferenced information from the IEO Scientific Observers Programme (Spanish fleet) for the 1989 to 2007 period. This information allowed the IEO to draw a map (footprint 1989-2007) showing the spatial distribution of the fishing effort of the Spanish fisheries before the implementation of Regulation (EC) No 734/2008. In addition, the IEO scientific observer program provided footprint data prior to the establishment of the VMS system.

A question that arises naturally when dealing with this type of data is whether the fishing behavior observed from points obtained by the Observer Program can be extrapolated to the general behavior of the different flags in Southwest Atlantic waters. One important aspect of the information collected by IEO Scientific Observers Programme for 1989 to 2007 period, is the lack of a complete spatio-temporal coverage of the fishing area due to the own exploitation pattern of the fleet, which looks for the highest fishing yields, thus not allowing the collection of data/information in all areas and seasons (i.e. vessels frequently concentrate their activity in some specific areas). The result is a patchy sample with spatio-temporal gaps, very frequently biased by the commercial activity.

The fishing strategy of Spanish commercial vessels in this area that operates both within the Falklands Islands Conservation Zone and in the HS as well as the low coverage rate IEO Scientific Observers Programme are responsible for gaps in the information for some years on the HS of SW Atlantic. When the vessels operate within the EEZ around the Falkland Islands, the coverage rate observers in HS decreases. In case the use of observer data was required to calculate the fishing footprint again, a solution could be to increase the number of scientific observers.

In many cases, the observations obtained from observers are applied directly and taken as reliable, although the existence of a bias in the observation by the IEO scientific observers has been recognized (Gillis, 1999; Palmer *et al*., 2009; Sacau *et al*., 2005; Vignaux, 1996). Regarding this, we should remind once again the problem with the spatio-temporal coverage of the information collected by the observers. As explained before, the programme of scientific observers on board of commercial vessels presents two main difficulties affecting the collection of information which produced important gaps:

- The low ratio of IEO scientific observers in relation to the number of fishing boats that occurred in some years.
- The fishing strategy of vessels concentrating their activities in zones of higher catches and hence not covering all the fishing area.

Implementation of VMS data

According to Vilela (2013), one source of bias in the VMS data is the recent (at the time of the study) implementation of this system and its progressive implementation in vessels that operate in this region. In some analyses, such as time series, it has been necessary to undertake a correction of the number of VMS positions based on the number of vessels belonging to Asociación Nacional de Armadores de Buques Congeladores de Pesca de Merluza (ANAMER) that have declared fishing every year in Southwest Atlantic waters.

Data sharing and promote collaborative research

The lack of a competent RFMO for bottom fisheries means that a gap exists in the international conservation and management of fisheries and protection of biodiversity in the marine environment in High Seas of the SW Atlantic. The gap covers the part of the continental shelf and slope that extends eastwards from the Exclusive Economic Zones (EEZs) of South American coastal States, where stocks straddle the High Seas and the EEZs of coastal states.

The area is not covered by an organisation with the competence to establish appropriate conservation and management measures for bottom fisheries. The absence of an RFMO also results in the absence of clearly identifiable multilateral forums, including for providing and debating scientific data (such as the Atlantis project), in order to prepare advice, on which, ideally, in line with UNCLOS, management measures can be adopted at the regional (RFMO) level can be based (Durán Muñoz *et al*., 2012).

One of the main challenges in this area, in addition to the establishment of a competent RFMO, is to promote an increased data sharing and transparency between coastal States and distant water fishing fleet flag states. This would contribute to a better understanding of the situation, both with regard to the status of stocks and VMEs, as well as of fisheries, especially in the high seas.

5.j. Identify strengths and weaknesses of the methodologies used for establishment of historical and cumulative fishing footprint.

Strengths

- The availability of information related to the physical characteristics of the study area obtained as a result of the oceanographic surveys carried out by the Atlantis Project in the international waters of the Patagonian shelf by the IEO and Secretaría General de Pesca (SGP) between years 2007 and 2010 and the availability of analysed data from VMS of the SGP between the period 2001 and 2008, has allowed to advance the knowledge of the Spanish fishing activity in this region.

Weaknesses

- *FAO Area 41 is the only worldwide significant area* for high seas bottom fisheries not covered by any RFMO. The absence of an RFMO limits coordinated mechanisms to manage such fisheries, including establishing areas closed to bottom fisheries prevent impacts on VMEs, and to share and exchange scientific data in order to prepare advice and agree on management measures in this area.

- *Data obtained in Atlantis Project* conducted by Instituto Español de Oceanografía (IEO) is very valuable in an area of relatively poor knowledge. Spain supported the adoption of measures to protect vulnerable marine ecosystems from the impact of bottom fishing activities in the High Seas of SW Atlantic. However, the implementation of similar measures, including area closures, by other non-EU fleets in the area is still lacking.

- *Observer Program Limitations.* The spatial distribution of the fishing effort offered by the IEO Scientific Observers Programme offers a limited representation of the total Spanish fleet throughout the year, and these data is extrapolated to the general behavior of the Spanish fleet in Southwest Atlantic waters.

5.k. Suggest/propose recommendations that could be considered as guidelines for future EU proposals regarding the definition of footprint

- An analysis of the Spanish fleet fishing footprint was conducted in 2008, using available VMS data from 2001 to 2008 (Vilela *et al.*, 2013). The time series analyzed covers a timeframe of 8 years (section 5.c). As this analysis was used to check the reliability of the observer's information on fishing effort distribution, an update of such analysis, including the available VMS data at present, would be desirable to improve the current definition of the footprint.

- To create fishery specific footprint maps (e.g. hake fishery, squid fishery, Illex fishery, etc.), the combination of logbook data and VMS data will be useful.

- In this fishing area, there is a need for international cooperation, including on research including data sharing and management agreements to ensure for example the monitoring of the fleets by scientific observers. A multilateral action plan through a stepwise approach for data collection programmes on fisheries management (fishing effort, presence, flag state and international norms) is recommended.

- It is recommended the use of VMS positions whenever possible as a complement of the observer program data in order to better define a representative general behavior the fleet.

- Additionally, use of remote sensing as a relevant tool to study fishing activities in Southwest Atlantic is considered important to define appropriately the footprint in this area. Most monitoring, control and surveillance systems are based on VMS, but Automatic Information System (AIS) is becoming more frequent to help monitoring the different fleet activities at sea. AIS information is a useful tool to for example validate vessel tracks with VMS data. Moreover, the use of night-time imaging (e.g. Visible Infrared Imaging Radiometer Suite-VIIRS) would be useful to pick up the presence of fishing vessels using lights to attract catch or conduct operations at night. Combination of remote sensing technologies will help to reveal all fleet activities in detail within this area (AIS, optical imagery, radar images and VIIRS).

Other issues to consider

There is no multilateral agreement concerning the high seas bottom fisheries of the Southwest Atlantic. Vessels fishing in the high seas of the Patagonian Shelf are still subject to regulation by their respective flag states. This situation makes that available information about fishing fleets operating within this area is scarce and with very limited access.

The principal source of information considered as relevant to perform this review comes mainly from the data provided by the Spanish fleet together with the analysis conducted by Instituto Español de Oceanografía (IEO). The main objective of the IEO

Atlantis project is the study of fishing activities and marine resources of commercial interest in the FAO statistical subareas 41.3.1 and 41.3.2, within an ecosystem approach, paying particular attention to interactions between fishing activities and Vulnerable Marine Ecosystems, mainly on the high seas of the Southwest Atlantic.

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PACIFIC OCEAN

6. NORTH PACIFIC FISHERIES COMMISSION (NPFC)

6.a. Diversity of fishing fleets, their practices and strategies

NPFC[37] is made up of eight contracting parties (CPs) from Canada, China, Japan, Republic of Korea, the Russian Federation, the United States of America and Vanuatu, although not all parties actively fish.

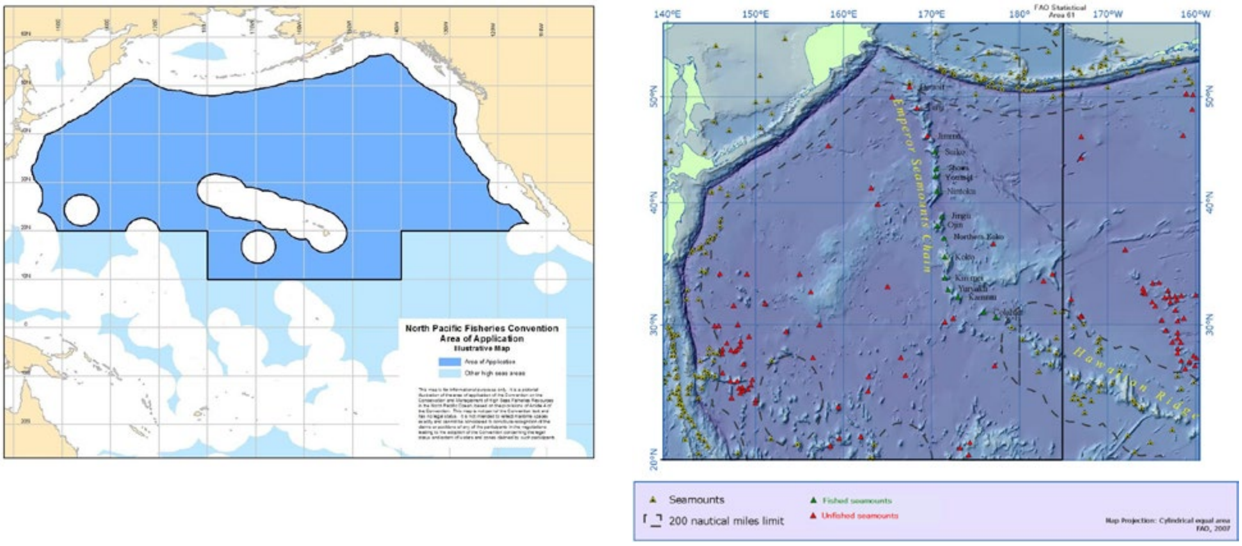

Figure 1. Map of the NPFC Convention Area (Source: NPFC website[38]) (left); Seamounts in FAO Area 61 (Source: Japan (2008), Annex O) (right).

Demersal fisheries operate in the north western Pacific Ocean and are made up of bottom trawlers, bottom gillnets and bottom longlines. The fleet is made up by vessels from Japan, Korea and Russia and operate over the Emperor Seamounts (Figure 1, right). Bottom trawl fisheries primarily target North Pacific armorhead (*Pentaceros wheeleri*) and splendid alfonsino (*Beryx splendens*), while the gillnet fishery targets splendid alfonsino, oreo (*Allocyttus verrucosus*), and mirror dory (*Zenopsis nebulosa*). The fishery is closed from November to December according to Conservation and Management Measure (CMM) 2021-05, which also restricts fishing operations to above 1500m and the areas that can be fished (seamounts south of 45° north). Japan operates two trawlers and one gillnet vessel. Korea currently operate between 1 and 2 trawlers per year, average fishing days have dropped in recent years with an average of 65 days per year between 2015 and 2017. The main fishing months are between March and May.

Demersal fisheries also operate in the north eastern section, which has a seamount longline fishery in operation since the 1970's. They operate over for seamount

[37] The European Union's request to accede to the NPFC was accepted at its sixth annual session, which closed on Thursday 25 February 2021. https://ec.europa.eu/oceans-and-fisheries/news/eu-become-member-north-pacific-fisheries-commission-2021-02-25_es;https://www.npfc.int/news/sixth-commission-meeting-concludes-virtual-meetings

[38] https://www.npfc.int/about_npfc/convention_and_npfc_area_of_application

aggregations (Eickelberg Seamounts, Warwick Seamount, Cobb Seamounts, and Brown Bear Seamounts) and were previously fished by Canada using longline hook and longline trap gear. The primary target species of both these gear types has been sablefish (*Anoplopoma fimbria*). The Canadian fleet currently has no authorised vessels, and previously, between 2012 and 2017, fishing effort was low with only six vessels licensed per year, only one per month, with licenses selected through a 'lottery draw'. During this time there were a total 17 trips, 191 days and 635 fishing events undertaken by Canadian vessels. Impacts to VME species under this fishery are managed under CMM 2019-06.

Table 1. Catches taken in 2020 in metric tonnes (or the last available year where available) by country and gear type (adapted from annual summary footprint report – Bottom fisheries)

Country	Gear	North Pacific armorhead	Splendid alfonsino	Mirror dory	Butterfish	Rockfishes	Crabs	Others	Total	Year
Japan	Trawl	26.4	1,010.4	33.7	5.2	14.2	na	294.0	1,383.9	2020
Japan	Gillnet	54.2	55.3	0	0	8.5	na	542.7	660.7	2020
Korea	Trawl	0	0	0	0	0	0	0	0	2020
Korea	Longline	0.28	0.060	0	0	2.06	0	18.81	21.210	2004
Russia	Trawl	0.025	0.039	0	0	0	na	0.0	0.064	2019
Russia	Longline	0	0	0	0	0	0	0	0	2020
Russia	Pot	0	0	0	0	0	7.6	0	7.6	2003
Russia	Gillnet	0	0	0.7	0	0	na	0.7	1.4	2001

The pelagic fish and squid fisheries account for over 99% of total catch of species covered by the Convention. Many of the species targeted are migratory with a wide geographical distribution, including both EEZs of the North Pacific Rim countries and high seas areas covered by the Commission. This therefore requires close cooperation among CPs concerned to ensure adequate data collection, stock assessment and conservation measures for the species. China, Japan, Korea, Russia, Chinese Taipei and Vanuatu target Pacific saury (*Cololabis saira*) using stick-held dip nets or lift nets (which utilise fishing lamps), Japanese and Russian vessels operate mainly within their EEZs while Chinese, Korean, and Chinese Taipei vessels operate mainly in the high seas. Oher species targeted include Chub mackerel (*Scomber japonicus*), Spotted mackerel (*Scomber australasicus*), Japanese sardine (*Sardinops melanostictus*), neon flying squid (*Ommastrephes bartramii*), and Japanese flying squid (*Todarodes pacificus*).

Figure 2 illustrates the principal demersal resource species of the high seas of the North Pacific.

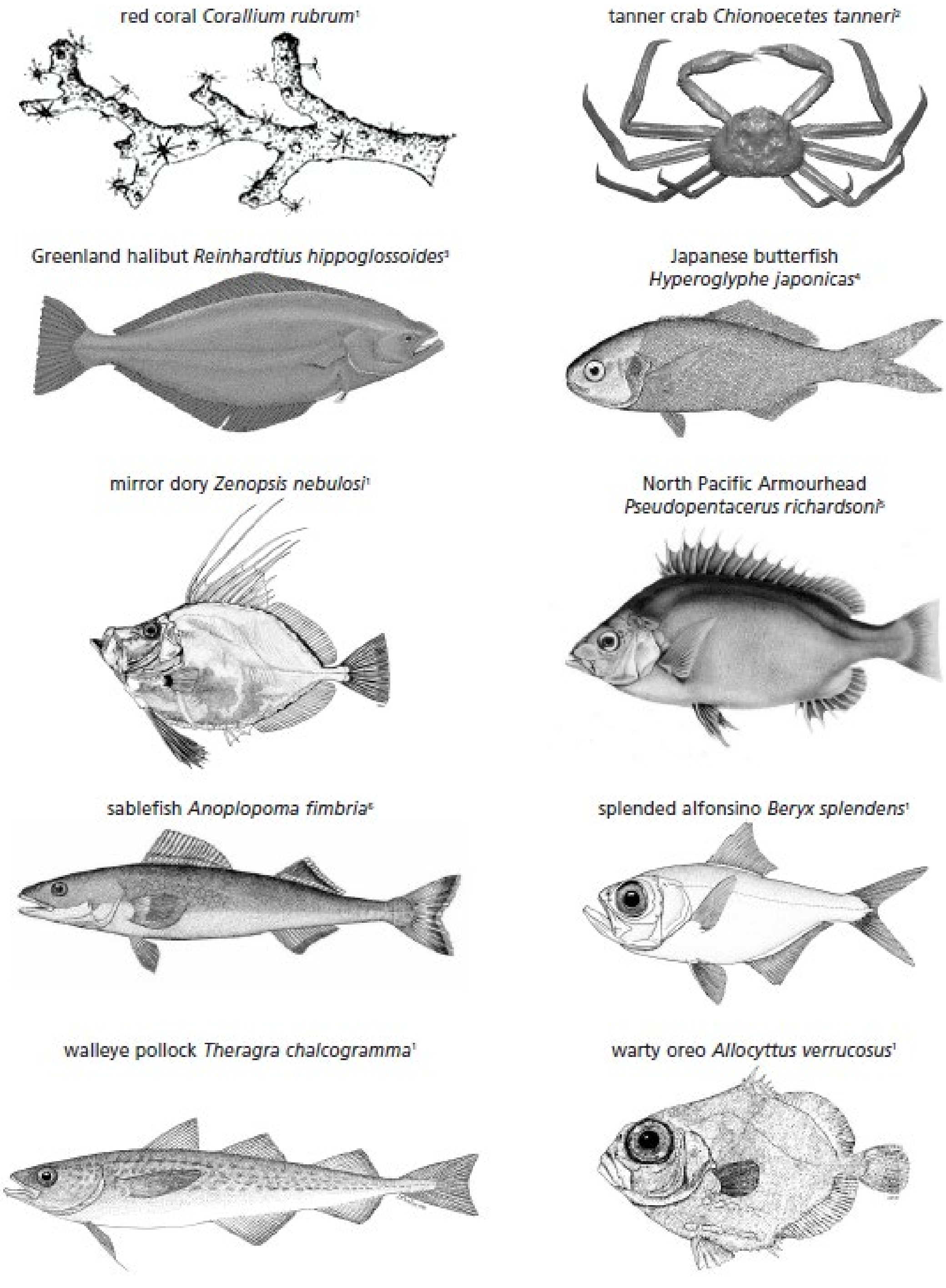

Figure 2. Principal demersal resource species of the high seas of the North Pacific. Source: (FAO, 2020). [Sources of pictures: [1]Food and Agriculture Organization of the United Nations, Original Scientific Illustrations Archive. [2]Photo by A.C. Tatarinov sv.wikipedia.org/wiki/Chionoecetes_tanneri#/media/Fil: Chionoecetes_tanneri.jpg CC BY-SA 3.0. [3] www.fao.org/fishery/species/2544/en. [4]Jordan and Hubbs (1925). [5] Smith (1849). [6]Jordan and Evermann (1900)]

6.b. Operative/technical characteristics of the fishing gear

The breakdown of vessels by gear type, currently authorised to fish in the NPFC area, is given in Table 2.

Table 2. Number of vessels authorised to fish in the NPFC area (source: Member/CNCP Flagged Vessels Register).

Type of vessels	China	Chinese Taipei	Japan	Panama	Russia	South Korea	Vanuatu	Grand Total
Factory mothership					4			**4**
Reefers	47	7	88	11	14	15		**182**
Research, survey and protection vessels			8		3			**11**
Gill netters			1					**1**
Hand liner vessels, vessels not specified	599							**599**
Japanese type liners						2		**2**
Jigger vessels			61			21	4	**86**
Lift Netters		191	3		1	22		**217**
Line vessels nei		6						**6**
Longliners					1	2		**3**
Other fishing vessels	17		1		2			**20**
Purse seiners	100		86		2			**188**
Stern trawlers			6		1			**7**
Stern trawlers freezer	3				7	1		**11**
Stick-held dip netters, Jigger vessels			167			2		**169**
Support vessels			37		8			**45**
Trawlers, purse seiners					21			**21**
Grand Total	**766**	**204**	**458**	**11**	**64**	**65**	**4**	**1572**

Four types of bottom fishing gear have been used by participating states. Mobile gears include bottom trawl, while static gears include bottom gillnet, bottom longline and pot, although no potting vessels are currently registered. A type of gear was also previously used up to the late 1980s, coral drag, and may still be being used by non-members of the Commission. These types of fishing gear are usually used on the top or slope of seamounts, which could contain VMEs.

From **Error! Unknown switch argument.**, active gears can be considered to be lift netters, purse seiners and stern trawlers, the rest can be considered passive.

Canadian fleet operated static gear, 98% of fishing effort is through longline traps with just 2% longline hooks, although it has not had any vessels authorised to fish since 2019, Japan has mobile gear, two trawlers, and static, one gillnet; and Korea has just mobile gear, between 1 and 2 trawlers per year. As can be seen from **Error! Unknown switch argument.**, demersal fishing effort in 2020 was very light, with only two Japanese vessels operating, one operating a bottom trawl, the other a gillnet.

Table 3. Fishing effort (in vessels and days fished) in 2020 (adapted from annual summary footprint report – Bottom fisheries).

	Trawl			Longline		Gillnet		Crab pot
	Japan	Korea	Russia	Korea	Russia	Japan	Russia	Russia
Vessels	1	0	0	0	0	1	0	0
Days	203	0	0	0	0	165	0	0

6.c. Definition of spatial footprint for a typical fishing gear deployment event

Under CMM 2021-05 (CMM 2021-05 Annex 2) and CMM 2019-06 (CMM 2019-06 Annex 2), members are required to submit to the Scientific Committee (SC) an estimate of their impacts on VMEs and the footprint is assessed according to the standards laid out in the Annex 2 'Science-based Standards and Criteria for Identification of VMEs and Assessment of Significant Adverse Impacts on VMEs and Marine Species'.

Specifically, according to CMM 2021-05, the following data shall be submitted:

To facilitate the scientific work associated with the implementation of these measures, each Member of the Commission shall undertake:

A. Collection of information for purposes of defining the footprint.

In implementing paragraphs 4A and 4B, the Members of the Commission shall provide for each year, the number of vessels by gear type, size of vessels (tons), number of fishing days or days on the fishing grounds, total catch by species, and areas fished (names of seamounts) to the Secretariat. The Secretariat shall circulate the information received to the other Members consistent with the approved Interim Data Handling and Data Sharing Protocol. To support assessments of the fisheries and refinement of conservation and management measures, Members of the Commission are to provide update information on an annual basis.

B. Collection of information

(i) Collection of scientific information from each bottom fishing vessel operating in the western part of the Convention Area.

(a) Catch and effort data

(b) Related information such as time, location, depth, temperature, etc.

(ii) As appropriate the collection of information from research vessels operating in the western part of the Convention Area.

(a) Physical, chemical, biological, oceanographic, meteorological, etc.

(b) Ecosystem surveys.

(iii) Collection of observer data by duly designated observers from the flag member shall collect information from bottom fishing vessels operating in the western part of the Convention Area. Observers shall collect data in accordance with Annex 5. Each Member of the Commission shall submit the reports to the Secretariat in accordance with Annex 4. The Secretariat shall compile this information on an annual basis and make it available to the Members of the Commission'.

Over 50kg of VME species in one gear retrieval should be reported to the Secretariat via the Member State within one working day. The Secretariat will then initiate the appropriate management measures appropriate to the site.

In addition, under CMM 2021-05, observers are required to collect data on vulnerable species caught (Annex 5, H2) including species (photographed if possible), the weight and volume of each benthic species caught in the operation, the weight and volume of all invertebrate benthic species and, where possible, keep and preserve whole samples of new of scarce species not identified in any ID guides that can be identified at a later date.

6.d. Time frame used to calculate the fishing footprint

Member states submit the required data on an annual basis, which are then reviewed by the SC to allow them to conduct an assessment of any significant impact on VMEs and review proposed management measures to minimize or prevent them. These data are to be submitted in accordance with Annex 3 of CMM 2021-05, at least 21 days prior to the SC meeting.

6.e. Spatial resolution of the data used to calculate the footprint

Reports on VMEs and assessment of impacts caused by bottom fishing activities have previously been submitted by Canada (March 2013, longline hook and line and pots), Japan (December 2008, gillnet and trawl), Korea (December 2008, trawl), Russia (2008), USA (December 2008). A report submitted by the Deep-Sea Conservation Coalition (August 2012) looked at, among things, measures to reduce impacts to the benthic environment. The Canadian assessment outlined some of the factors related to the fishing gear that may influence the footprint for traps and the connecting groundlines and advocated restricting fishing to good weather months to reduce the gear dragging along the bottom. Other factors included:

- Characteristics of the bottom where sets are made (sediment type, relief and depth);
- Weight, size, and construction material of traps;
- Retrieval methods and sea state (i.e., weather, tides, currents, etc.);
- Type of rope (floatlines are less likely to entangle bottom structures);
- Soak time;
- Use of anchors or weights; and
- String configuration (e.g., length) can affect degree of entanglement on bottom

Currently the annual footprint reports summarize the general footprints from all member States due to fishing for both bottom and pelagic fisheries and gives the activity by seamount by country. In the case of pelagic fisheries these are summaries of catch and effort by area (NW, NE and CN). In the case of the bottom fishing footprint summary, extra data is given with a more detailed breakdown by area fished (seamount). There are more details on the vessels (in accordance with CMMs 2021-05 and 2019-06) involved including gear Gross Tonnage (GT), power, and overall length as well as a summary of the of the number of days each vessel has been fishing. This is used to assess the overall footprint in terms of fishing pressure on different seamounts rather than an actual spatial calculation.

Start and end of hauls are recorded to the nearest minute for all vessels but there is no set requirement for any temporal or spatial resolution of data to be submitted, although this is being considered by the Scientific Committee as part of their workplan. Prior to NPFC-2019-SSC VME04-IP01 a review was conducted by the Secretariat of all the data available for VME assessments, including existing data for potential combined footprint and effort map of all bottom fisheries by gear and time. This also included data from surveys and multibeam data. The fisheries related data is summarised in Table 4, giving the time period over which it is available, as well as the temporal and spatial resolution. It is proposed that this is used for both mapping and conducting Significant Adverse Impact assessments (SAIs). This is a result of recommendations from the NPFC 'Workshop on Data Requirements and Data Sharing for Small Scientific Committees on Vulnerable Marine Ecosystems and Bottom Fish' held 7-9 November 2018 (NPFC-2018-WS DATA01-Final Report). The most relevant recommendations with regards to footprint assessment and resolution of data are reproduced below.

(a) Review the draft list of potentially available data to better identify current and historical bottom fishing grounds in the Convention Area and fishing footprint and effort in relation to assessing SAI in the Convention Area.

(b) Identify appropriate temporal and spatial resolution of data to be shared in order to map a combined fishing footprint and effort to better identify fishing grounds.

(c) Identify appropriate temporal and spatial resolution of data to be shared in order to define the fishing footprint in relation to assessing SAI.

Table 4. Existing data for potential combined footprint and map of all bottom fisheries by gear and time (Adapted from NPFC-2019-SSC VME04-IP01, Table 1).

Gear type	Time period	Temporal resolution	Spatial resolution
Eastern North Pacific			
CANADA			
Longline	Recent/current (1996-2018)	Set by set (1-2 days)	1″ x 1″
RUSSIA			
Bottom Trawl (observer or fishery independent data)	1973- 1985, not annual	Set by set	6″x 6″
Western North Pacific			
JAPAN			
Trawl	Historical (1969-1981) Historical (1989-present) – logbook data Recent/current (from 2009) – scientific observer data	Month Day Haul by haul	1^{O} (long) x 30′(lat) 1^{O} (long) x 30′(lat) 30″ x 30″

Gear type	Time period	Temporal resolution	Spatial resolution
Gillnet	Historical (2000-present) – logbook data Recent/current (from 2009) - scientific observer data	Day Set by set	1^{o} (long) x 30′ (lat) 30″ x 30″
Trawl	Historical (2004-present) Recent/current (from 2014)	Day Haul by haul	20′x 20′ 30″ x 30″
RUSSIA			
Longline (observer data)	Recent/current (from 2014)	Set by set	6″x 6″
Bottom Trawl (observer or fishery independent data)	1969- 2019, not annual	Set by set	6″x 6″

As a result of this analysis, the minimum common resolution for combined fishing footprint and effort mapping and SAI assessments was decided as:

- (1969-1981) temporal resolution – Month, spatial resolution - 1 o (long) x 30′(lat)
- (After 1989) temporal resolution – Day, spatial resolution - 1 o (long) x 30′(lat)
- (Recent) temporal resolution – haul by haul or set by set, spatial resolution – 30″ x 30″

6.f. Availability of data and coverage

The 'Small Scientific Committee on Bottom Fish and Marine Ecosystems' (SSC-BF-ME) of the NPFC summarises VME data through information papers presented by CPs. The first meeting was held 16-18 November 2020 (NPFC-2020-SSC BF-ME01), data from VME bycatch by Korean trawlers was presented in NPFC-2020-SSC BFME01-WP07. The SSC-BF-ME replaced the SSC-VME where reports were previously submitted. These are however summary reports and the data are not publicly available. As part of the workplan of the scientific committee they are looking at developing the data depository and GIS mapping facilities to include VME encounters.

6.g. Quality of data

VMS requirements for vessels operating in the area are covered under CMM 2021-12. They are required to provide accurate VMS data to the Secretariat, through their FMC. In the case of VMS failure vessels shall report manually to the Secretariat every 4 hours and repairs should be carried out within 30 days. Under CMM 2019-13 for the Compliance Monitoring Scheme, Members are required submit Annual Repots summarising their compliance with NPFC CMMs. This is compiled with information from other sources (e.g., reports from observers, Vessel Monitoring Systems, High Seas Boarding and Inspections, high seas transhipments) and presented in the NPFC Annual Compliance report, which is publicly available. There was no record of missing VMS pings or irregularities in the data transmission in the most recent report (NPFC Compliance Monitoring Report – 2019).

6.h. Effort units that are being used

In fisheries in general CPUE is calculated using the following units:

- Bottom longline – Catch / 1,000 hooks.
- Bottom traps – Catch / trap.
- Gillnets – Catch / hour of soak time.
- Trawl – Catch / hour or trawl time.

Specific to VME and cold-water coral species, the impact, in terms of CPUE, is assessed according to the weight of VME species caught in a single fishing operation. If more than 50kg of cold water coral or other indicator species, as identified by the Scientific Committee (cold water species include *Alcyonacea, Antipatharia, Gorgonacea, and Scleractinia* (CMM 2019-06, paragraph 3j) is encountered during a haul, then a move on rule is triggered (CMM 2021-05). The effort is considered to be one fishing operation, there are no gear-specific encounter thresholds which has been recognised as an issue by SSC BF-ME.

6.i. Identify the link between the fishing techniques/gears and the specific challenges/issues related to the definition of the fishing footprint

There is no differentiation made between gears when establishing the fishing footprint.

Japan (2008) stated that the impacts of gillnets on the benthic environment would be minimal due to the arrangement of their gear, i.e. the nets are suspended 70cm above the seafloor (which has been incorporated into CMM 2021-05), although the effects of lost gear on the ecosystem could not be ascertained. To evaluate the spatial extent of the impact relative to the availability of habitat type affected would require a knowledge on the spatial extent of the habitat concerned, which was lacking at the time. U.S.A (2008) highlighted the main impact on benthos through gillnet fishing would be entangling of nets with deepwater corals upon hauling, causing them to dislodge or fragment.

Republic of Korea (2008) took part in large scale coral harvests using coral drag gear during the 1970s and 1980s after which it stopped issuing drag licenses. It is not clear what exactly the corals were used for, although as they were targeting precious corals it was most likely for the aquarium trade. The corals were exported to Japan. There was no assessment of the footprint caused by trawl gear, just that their vessels avoid areas where VMEs are likely to occur and ensure their gear does not come into contact with the sea floor.

Within NPFC the estimation of the footprint is based on catch and effort data as well as details of which areas the fishing took place to examine pressure on individual seamounts. Vessel details are also given.

6.j. Identify strengths and weaknesses of the methodologies used for establishment of historical and cumulative fishing footprint.

Strengths

- Available data, (current and historical) are under review (see "section 6.e") to establish the historical and cumulative fishing footprint and is part of the workplan established by the Scientific Committee. Current work is focused on establishing a time series on when different gear types were used and where they were used to assess the potential long-term effects on any existing VMEs.

Weaknesses

- Under CMM 2021-05 each Member of the Commission undertaking bottom fishing is required to submit a report assessing the impact caused by individual fishing activities on VMEs or marine species, following the template in Annex 2.2, to be reviewed by the Scientific Committee. While there are some reports publicly available, they are outdated, with most being produced in 2008 (Japan, Russia, Korea, U.S.A. and Canada).

- There is currently, or historically, no accounting of the type of gear used when establishing the footprint, just a summary of fishing catch and effort by gear and vessel type on different seamounts so to establish which areas have the greatest fishing pressure and therefore risk to VMEs.

- There is some uncertainty as to what the spatial extent of ecological unit that is potentially being impacted is. Management response may vary depending on its size. In the case of the north western area, fishing is based around the Emperor Seamount and Northern Hawaiian Ridge area (ES-NHR) and the extent of the ecological area has yet to be determined. It could either be the entire Northwest area, the ES-NHR, a group of seamounts within the ES-NHR or each seamount within the ES-NHR.

6.k. Suggest/propose recommendations that could be considered as guidelines for future EU proposals regarding the definition of footprint

Data requirements are under currently review and were discussed at WS-DATA 01. While work is still underway there are a number of recommendations that can be put forward based on "section 6.e" and the outcomes of the 'Small Scientific Committee on Vulnerable Marine Ecosystems' (SSC VME), outlined below.

- Ensure that impact assessments are updated on a regular basis. These should differentiate between the different types of fishing gear used and the subsequent footprint each gear type will make.
- Define the extent of the ecological unit being impacted, that is, is it only the area currently being fished, the total fishable area or the total extent of the fishing grounds.

Other issues to consider

The methodologies for collecting VME data and defining a footprint are still under development within NPFC, the following recommendations were put forward from the 4th meeting of the SSC VME (NPFC-2019-SSC VME04).

The SC reviewed the recommendations of the SSC VME and endorsed the following:

(a) Endorse a plan and timelines to determine the type and resolution of data to be shared for SAI assessment and a map of combined fishing footprint and effort.

(b) Endorse a flowchart for VME post-encounter treatment in the NPFC and continue developing the details of the post-encounter measure intersessionally.

(c) Conduct further research to define the range of the two VME sites identified in NPFC2019-SSC VME04-WP02 and close them to fishing.

(f) Consider using the FAO's publicly-available Vulnerable Marine Ecosystems Map as a template for developing the NPFC's own VME map.

(g) Consider the holding of a course/school on VME indicator taxa identification as a new project.

(h) Endorse the draft guide and a list of specifications regarding the design and content of the common VME taxa identification guide in the western North Pacific Ocean.

(i) Endorse the updated 2017-2021 SSC VME Work Plan (NPFC-2019-SSC VME04- WP05 (Rev. 1)).

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7. SOUTH PACIFIC REGIONAL FISHERIES MANAGEMENT ORGANISATION (SPRFMO)

7a. Diversity of fishing fleets, their practices and strategies

Commission Members of SPRFMO are: Australia; Republic of Chile; People's Republic of China; Cook Islands; Republic of Cuba; Republic of Ecuador; European Union; Kingdom of Denmark in respect of the Faroe Islands; Republic of Korea; New Zealand; Republic of Peru; Russian Federation; Chinese Taipei; The United States of America; Republic of Vanuatu. Additionally, the Commission recognised the status of Cooperating non-Contracting Parties (CNCPs) to: Curaçao; Republic of Liberia and Republic of Panama.

A map of the area of application of the SPRFMO Convention is shown in Figure 1.

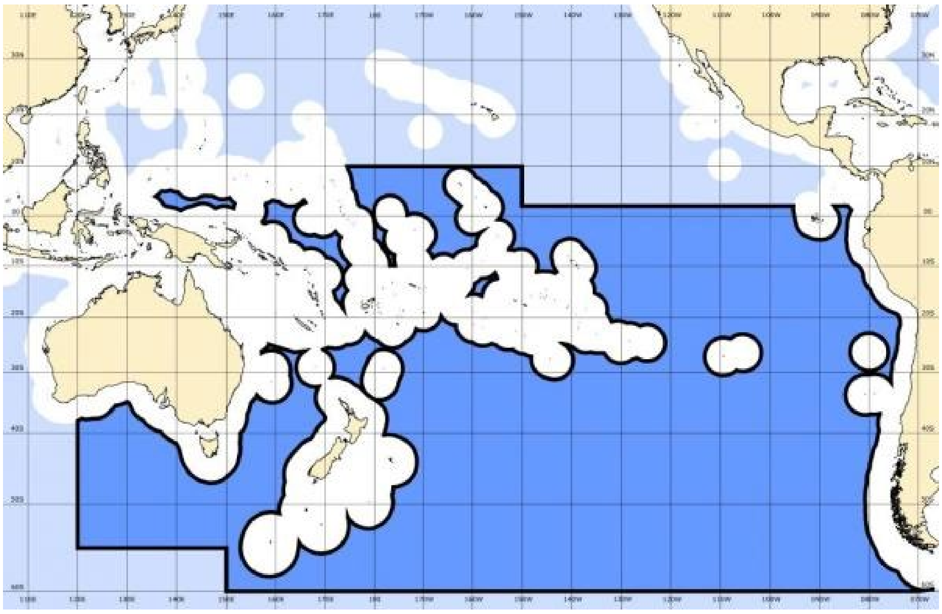

Figure 1. Map of the SPRFMO Convention Area
(Source: SPRFM website: https:// www.sprfmo.int).

Knowledge of the distribution and extent of commercial fishing in the South Pacific Ocean high seas is limited. Seamounts and ridges are also the only places shallow enough to bottom fish. Although there are numerous sea-mounts and ridge systems in the South Pacific high seas, only the prominent ones appear to have been fished to any extent: the Lord Howe Rise, the South Tasman Rise, and the Louisville Ridge. There are closely related fish species, and species in common, across all these features.

South Pacific high seas fisheries can be categorised into benthic (mainly invertebrate species that live on the seafloor), demersal (mainly fish, close to the seafloor), and pelagic (mainly fish and prawns, at the surface and in the midwater). Commercial fishing for benthic and demersal species is restricted to a depth of about 1500 m. Dominant demersal finfish fished commercially include orange roughy, oreos, alfonsino, and bluenose. Pelagic fishing takes place irrespective of depth, but tends to be associated with upwelling of nutrients. The dominant pelagic species fished commercially are jack mackerel and jumbo flying squid, which at the same time are the main high-volume commercial fisheries resources managed by the SPRFMO.

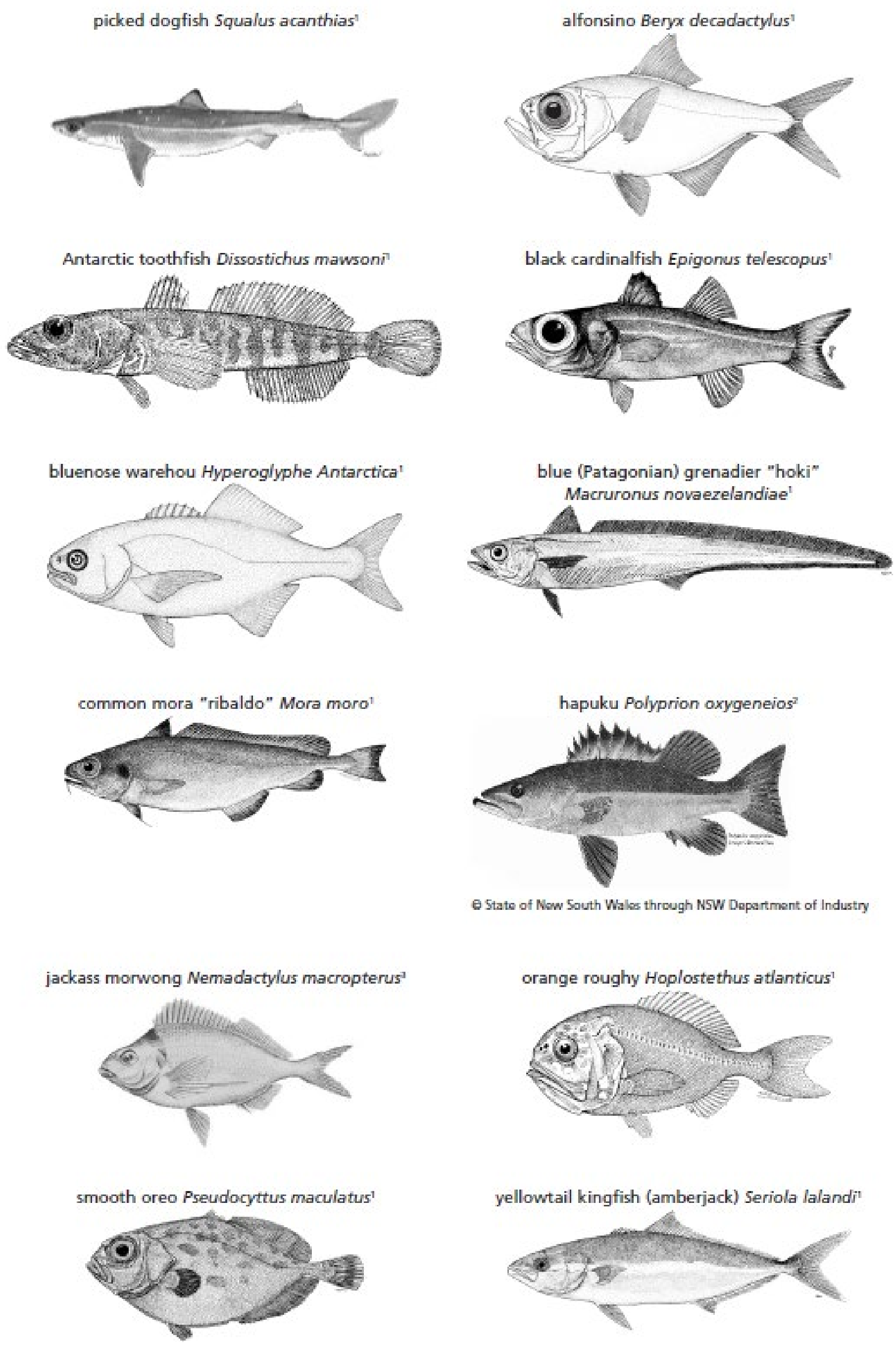

Figure 2. Principal demersal resource species of the high seas of the South Pacific Ocean. Source: (FAO, 2020). [Sources of pictures: [1]Food and Agriculture Organization of the United Nations, Original Scientific Illustrations Archive. [2]NSW (2010).[3]Waite (1921)]

Jack mackerel (*Trachurus murphyi*) are predominantly caught by purse seine and midwater trawl. Generally mono-specific fisheries, minor bycatch of *Scomber japonicus* (commercially important bycatch in that fishery) and *Brama australis*.

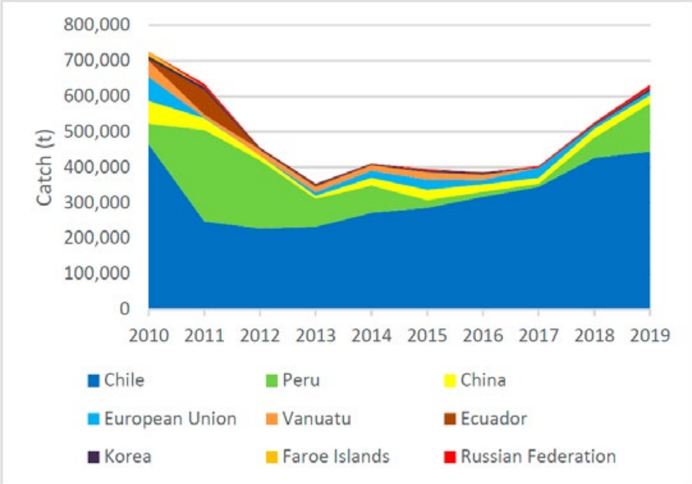

Figure 3. Annual reported catches in the South-East Pacific – Jack mackerel (total range)

Target trawl fisheries for orange roughy (*Hoplostethus atlanticus*) have occurred in the South Pacific since the late 1970's to the present. The Lord Howe Rise and Northwest Challenger Plateau have been the main areas of orange roughy catch in the Tasman Sea outside the New Zealand and Australian EEZs. Often found in association with a large number of other fish species (*Allocyttus niger*, *Pseudocyttus maculatus*, *Neocyttus rhomboidalis*, E*pigonus telescopus*, *Beryx splendens*, *Mora moro*, *Dalatias* spp., and others).

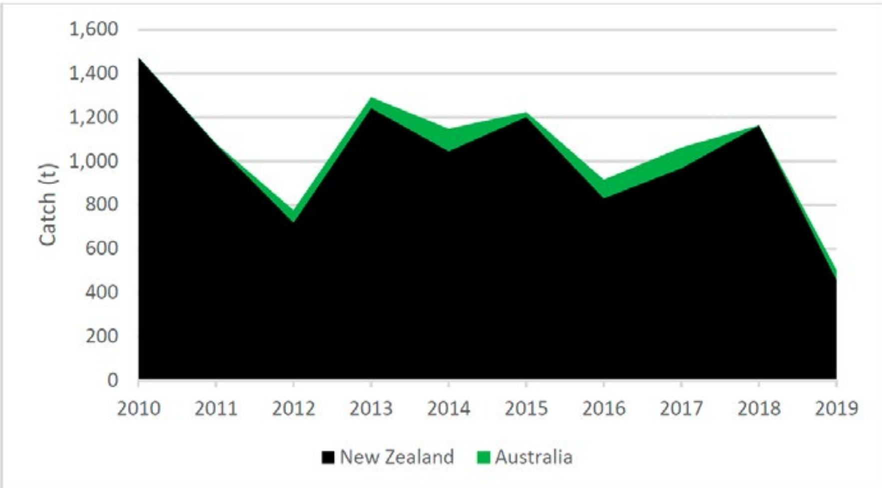

Figure 4. Annual reported catches in the SPRFMO Area – Orange roughy

The main method used to catch the splendid alfonsino (*B. splendens*) is a high-opening trawl generally fished hard down on the bottom, although mid-water trawling is also used.

Target fisheries for bluenose (*Hyperoglyphe antarctica*) have occurred in the South Pacific from the early 1980s to the present day. Several methods are used: Bottom trawling, midwater trawling, bottom longlines, dahn lines, trot lines, and drop lines. Schools of relatively small adults (50–60 cm) are occasionally taken by trawl over smooth, muddy substrates. Trawl fisheries often find *H. antartica* in association with *Beryx splendens*, *Beryx decadactylus*, *Nemadactylus* sp, *Plagiogeneion rubiginosus* and other non-commercial species (congers, sharks and others). NZ and Australia are the only members to have caught alfonsinos and bluenose in the last ten years.

In the South Pacific Ocean, the oreo species complex of three commercial species (*Allocyttus niger*, *Neocyttus rhomboidalis* and *Pseudocyttus maculatus*) occurs primarily along the deeper continental shelves and slopes of southern Australia and New Zealand. *P.maculatus* also occurs off central and southern Chile. Oreos inhabit deep, cold waters, and often form large aggregations over rough ground near pinnacles and canyons. Target trawl fisheries for oreos have occurred in the South Pacific since the early 1980s. Oreos are a major bycatch of the orange roughy fishery. No fishing methods other than trawl have been used successfully to catch oreos.

Black cardinalfish (*Epigonus telescopus*) are widely distributed in the North Atlantic and South Atlantic, Indian, and Southwest Pacific Oceans. They are found at depths of 75–1200 m and caught mainly by deepwater bottom trawl as bycatch of fisheries targeting alfonsino or orange roughy.

The Chilean fishery for Jumbo flying squid (*Dosidicus gigas*) is small and generally the result of bycatch, occurring predominantly within the EEZ. The Peruvian and Korean fisheries are the largest within the South Pacific, starting in 1991 and 1977 respectively. *D. gigas* are mainly caught by jigging at night with large lights to attract the squid. Also, mid-water trawling is used. The Chinese squid jigging vessels operate in the high seas of the South East Pacific. In general, small vessels with hand jiggers catch jumbo flying squid all year round, while the big vessels move to the South East Pacific from the southwestern Atlantic to catch jumbo flying in a few months of the year. Recently, more squid-jigging vessels moved to the equator waters from the traditional fishing ground, high seas off Peru.

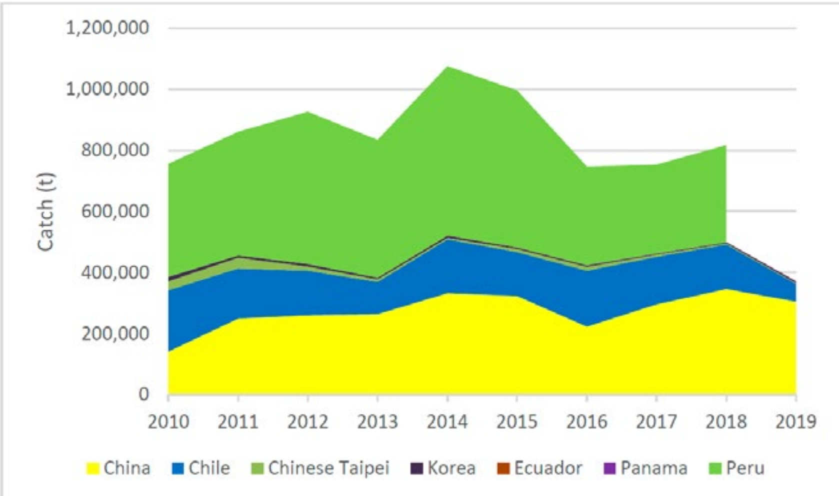

Figure 5. Annual reported catches in the South-East Pacific – Jumbo flying squid

The Cook Islands started an exploratory trap fishing for rock lobster (*Jasus* sp.) and deepwater crab (*Chaceon* sp.) for three year that commenced in 2019.

7.b. Operative/technical characteristics of the fishing gear

Fishing methods currently used include purse seining, pelagic trawling, jigging, bottom trawling and bottom longlining.

Mobile gears:

Australian midwater trawl operations typically use a pelagic net designed for off-bottom fishing, with large meshes (i.e. 20 metre diagonal meshes in the wings of the net). Midwater trawl nets typically have a sacrificial footrope[39] in case the net touches the bottom.

Demersal trawl operations typically use a simple 2-seam 'cut-away' orange roughy demersal trawl net with 80m sweeps and 40m bridles. The headrope and groundrope length is up to 60m and has 12-inch rubber bobbins. Fishing typically occurs in depths from 400–1100 m, depending on the target species. Demersal trawl operations typically fish with the trawl doors just off the bottom.

Chile has both an artisanal and an industrial fleet. The artisanal fleet are vessels of dimensions equal to or less than 18 meters in length and the industrial purse seine fleet operating in the jack mackerel fishery are from 600 to 2100 m^3 hold capacity.

The jumbo squid fisheries from Chile are primarily midwater trawl compared to the Peruvian fisheries which use jigging gear.

The purse seine fishery usually consists in a vertical net 'curtain' that is used to surround the school of fish, the bottom of which is then drawn together to enclose the fish, rather like tightening the cords of a drawstring purse.

Static gears:

- *AUTOLINE or Mustad-autoline System*. *See Annex 1, Paragraph 3.*
- *DOUBLE (SPANISH) LINE SYSTEMS. See Annex 1, Paragraph 1.*
- *DOUBLE (SPANISH) LINE SYSTEMS. See Annex 1, Paragraph 1.*
- *CRAB POT LINES. See Annex 1, Paragraph 4.*
- *DAHN LINES* consist in a surface buoy a with vertical drop line. Catches are taken on the lower part of the line which has numerous baited hooks attached. *See Annex 1, Paragraph 6*
- *SQUID JIGGING* is carried out using mechanically powered jigging machines with 20 to 25 jigs attached to each line. Squid jig vessels operate at night. *See Annex 1, Paragraph 7.*

7.c. Definition of spatial footprint for a typical fishing gear deployment event

The SPRFMO interim measures for bottom fisheries require that participants "*Not expand bottom fishing activities into new regions of the Area where such fishing is not currently occurring."* (SPRFMO bottom fishing interim measure paragraph 2). No definition is provided in the interim measures themselves for areas 'where fishing is not currently occurring'. However, the Benthic Assessment Framework adopted at the 4th SPRFMO International Meeting on the establishment of the South Pacific RFMO (2007) defined the 'currently fished' footprint for bottom fisheries in the SPRFMO Area as follows:

[39] The use of sacrificial ropes protects the integrity of the net

"*This joint footprint map is to be expressed as grid blocks of 20 minute resolution, with a 'fished' block being defined as any grid block partially crossed by at least one trawl track. The period 2002 - 2006 is to be used as the reference period for developing this joint trawl footprint map*".

7.d. Time frame used to calculate the fishing footprint

2002-2006 remains as the historical reference period (SC8-DW07 rev 1).

In the third SPRFMO Deepwater Workshop (2020) an analysis of the bottom fishing footprint for the Evaluated Area has been presented, based on fishing activities by New Zealand and Australian vessels[40]. The footprint, defined as the area of the sea floor potentially contacted by bottom fishing gear, was constructed from reported demersal and midwater trawling, and bottom longlining fishing effort records from 1989 to 2019. These records were dominated by New Zealand fishing, for both trawling and longlining, and for vessels of both nations trawl fishing effort far outweighed longline effort in most years.

7.e. Spatial resolution of the data used to calculate the footprint

Operations represent the unit of logbook recording which is equal to one trawl shot or one longline/dropline set. The standard SPRFMO footprint grid cell is 20' x 20'.

7.f. Availability of data and coverage

All fishing pursuant to CMM03-2020 (bottom fishing) and CMM03a-2020 (deepwater species) requires flag States to provide detailed information on the time and location of each fishing event, the catch of target and non-target species of fish, interactions with marine mammals, seabirds, reptiles and other species of concern, and benthic invertebrates, including VME indicator taxa. There is also a requirement to carry observers, with coverage specified as 100% for trawling and at least 10% for bottom line methods for each fishing year.

In the SPRFMO SCW10-Report[41] that preceded the SC8 meeting, the process of data cleaning was briefly discussed, in particular how to deal with overly long fishing events, the need for jittering of positional data recorded at low precision, and corrections for the gear: ship offset in the trawl records to take into account the location of the trawl in the bottom and not of the ship.

7.g. Quality of data

According to the CMM 06-2020, Members and CNCPs shall ensure that VMS position reports are reported by each of their vessels.

a) at least once every hour if fishing is using benthic or bentho-pelagic trawling bottom long-line gear or potting or if operating within 20 nm of an EEZ boundary;

b) at least once every four hours in other circumstances

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[40] SC8-DW07 rev 1. Cumulative Bottom Fishery Impact Assessment for Australian and New Zealand bottom fisheries in the SPRFMO Convention Area, 2020. https://www.sprfmo.int/assets/2020-SC8/SC8-DW07-rev-1-Cumulative-Bottom-Fishery-Impact-Assessment-for-Australia-and-New-Zealand.pdf

[41] SPRFMO SCW10-Report, 2020. 8th SPRFMO Scientific Committee Meeting (SC8). New Zealand (remotely). https://www.sprfmo.int/meetings/scientific-committee/8th-sc-2020/

In the event that SPRFMO VMS experiences non-reception of four consecutive positions from a vessel (automatic positions), then the missing positions are uploaded manually to the VMS system (SC6-Doc12-VMS Data Collection).

Additionally, the CMM 06-2020 in the ANNEX 4 established the Minimum Standards to prevent tampering with ALC Units Automatic Location Communicators (ALCs).

7.h. Effort units that are being used

- Bottom Longliners: CPUE (catch per thousand hooks, kg).
- Trawlers: ton/hour, number of vessels and tows.
- Squid monthly catch and effort template: catch and effort (number of vessels and number of days fished, catch/day).
- Purse seine fishery: Effort in catch by trip, and length of fishing trips in days.

7.i. Identify the link between the fishing techniques/gears and the specific challenges/issues related to the definition of the fishing footprint

The analysis submitted at the third SPRFMO Deepwater Workshop (2020) described the conversion of fishing events into segments for the calculation of footprint. A table of nominal trawl widths for fishing type (slope, UTF, midwater) and nationality was presented. A further adjustment of the widths according to the varying level of impacts from the fishing types was described.

It was noted that only about 20% of midwater tows touch the seafloor and that any contact with the seafloor was typically of a very short duration. Bearing this in mind, midwater trawling for bentho-pelagic species has been determined to be included within the SPRFMO definition of bottom fishing, but is considered unlikely to cause significant adverse impacts on VMEs.

Bottom longline impact widths were due mostly to the movement of the backbone during line retrieval, and a depth-based formula for calculating this width was presented based on analysis of hauling lateral-movement data.

7.j. Identify strengths and weaknesses of the methodologies used for establishment of historical and cumulative fishing footprint.

There is a concern by fishing industry representatives that the 2002-2006 catch years to establish the footprint were a result of political compromise and were not based on clear scientific findings or on policy stressing that this period is not representing the full history of the fishery.

A progress in this matter has been made in 2020 at the 3rd deepwater workshop where an analysis of the bottom fishing footprint for the Evaluated Area based on fishing activities by New Zealand and Australian vessels- has been discussed. The footprint was constructed from reported demersal and midwater trawling, and bottom longlining fishing effort records from 1989 to 2019.

7.k. Suggest/propose recommendations that could be considered as guidelines for future EU proposals regarding the definition of footprint

A revision of the bottom fishing footprint is being made, initially by Australia and New Zealand. A continuation of this work for the entire SPRFMO CA would be advisable.

Other issues to consider

Nothing more to consider at this stage.

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Sections 7.a and 7.b:

https://www.sprfmo.int/meetings/scientific-committee/8th-sc-2020/

INDIAN OCEAN

8. SOUTHERN INDIAN OCEAN FISHERIES AGREEMENT (SIOFA)

8.a. Diversity of fishing fleets, their practices and strategies

SIOFA has ten Contracting Parties: Australia, China, the Cook Islands, the European Union, France on behalf of its Indian Ocean Territories, Japan, the Republic of Korea, Mauritius, the Seychelles and Thailand, one Participating fishing entity: Chinese Taipei and one cooperating non-Contracting Party: Comoros. Kenya, Madagascar, Mozambique and New Zealand are also signatories to this Agreement but have not ratified it.

SIOFA's area of competence is shown in Figure 1, excluding waters under national jurisdiction

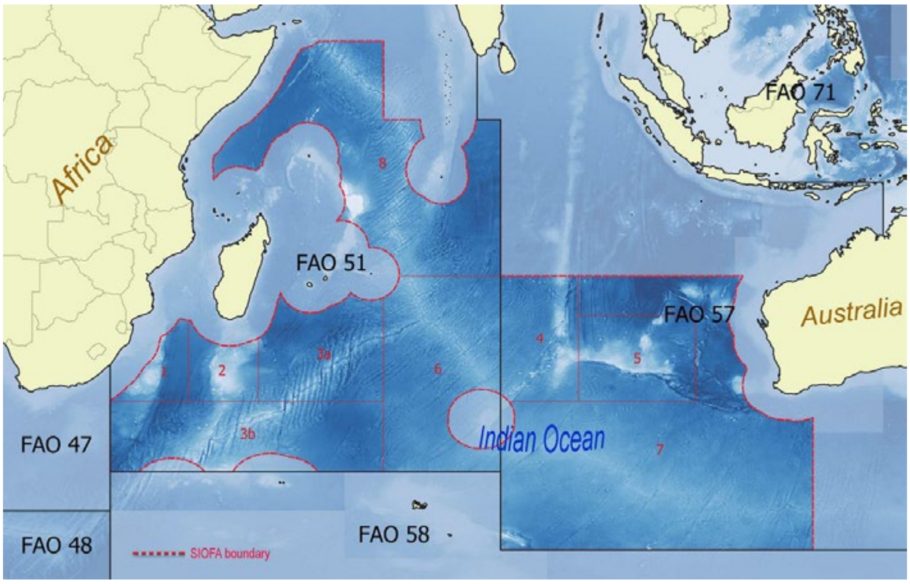

Figure 1. Map of the SIOFA Convention Area (Source: SIOFA website https://www.apsoi.org).

Main targeted species (Figure 2) and the fleet:

Patagonian toothfish: Demersal longline, Traps. EU-Spain, France (Territories), Japan, Korea. Areas 3b and 7.

Orange roughy: Demersal trawl. Australia, Cook Islands, China (2000-02). Associated with seafloor features.

Alfonsino: Midwater trawl. Australia, Cook Islands, Japan, Korea. Associated with seafloor features.

Sauries and scads: Demersal trawl, Traps. Thailand. Area 8, Saya de Malha Bank.

Shallow-water (<200m) snappers, emperors and groupers: Demersal longline, Hook and line, Demersal trawl, Traps. EU-France, Mauritius (no information provided), Thailand, Comoros. Area 8, Saya de Malha Bank.

Deeper water snappers, lutjanids, Hapuku: Demersal longline, Dropline. Australia, China, EU.

Deepwater sharks – Portuguese dogfish: Demersal longline. EU-Spain.

Mackerel and Brama spp: Purse seine with lights. China.

Oilfish: Longline. Chinese Taipei.

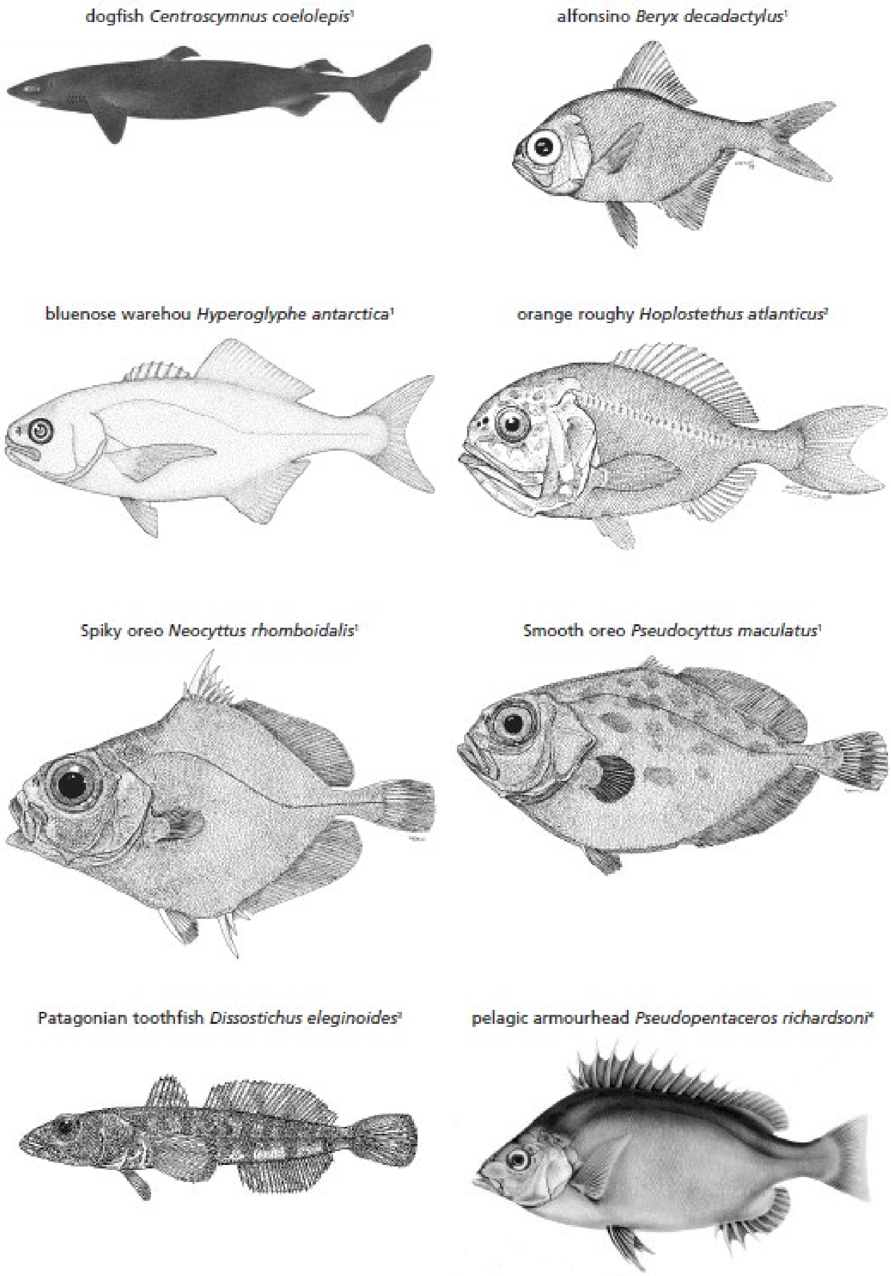

Figure 2. Principal demersal resource species of the high seas of the Indian Ocean. Source: (FAO, 2020). [Sources of pictures: [1]Food and Agriculture Organization of the United Nations, Original Scientific Illustrations Archive. [2]www.fao.org/fishery/species/2249/en.[3] Fischer and Hureau (1985).[4]Smith (1849)].

8.b. Operative/technical characteristics of the fishing gear

The fishing gear types below are those used by fisheries conducted in this area:

Mobile gears:

Australia: most demersal trawling is done with a standard "Heard Island/Champion" net with a minimum bobbin size of 400 mm; but simple two seam 'cut away' demersal trawls with 80 metres sweeps and 40 m bridles have been used for orange roughy fishing. The headline length is 38 meters and the 30 meters footrope has 300 mm rubber bobbins. Two-ton Super-V otter boards are generally used. Polyvalent doors may also be employed for midwater trawling but preference is to not to frequently or routinely change doors around at sea. The vessels typically have several net drums to accommodate multiple trawl nets facilitating a relatively easy change from one net to another taking ~ 1 hour.

Thailand: A major decrease in effort from 2016 (58 otter board trawl and 1 pair trawl) to 2020 (3 and 0 vessels respectively), fishing in the western Indian Ocean.

Demersal Trawl: The pair trawler used net with head rope length 62-76 meters, and the ground rope is 65-82 meters long. For otter-board trawlers, their head rope lengths are between 20-43 meters, and the ground rope lengths are between 22- 46 meters. There are several bobbins at ground rope. Bobbin diameter is between 70-140 mm. Most of the nets are two-seam types with mesh size ranging from 60 to 240 mm for wings and 50 mm for cod-end. The otter boards are made of rectangular wood with the size approximately 1.5x3 meters.

Cook Island: Modern deepwater trawling in SIOFA is an aimed method of trawling, targeting aggregations of acoustically identified fish. This method is completely different to the herding type trawl fishing of species such as North Atlantic cod and haddock, or Southern hemisphere hoki and hake species which are all typically fished using long, un-aimed tows on a relatively flat sandy or muddy seabed, with the trawl doors hard on the bottom throughout the tow. In much of the target bottom trawling in SIOFA, the net is simply allowed to roll down a slope, with the skipper attempting to keep the net on the bottom. The objective is to maintain bottom contact, but this does not always occur, and the net then flies off the bottom. The trawl path is generally a straight line, and often the trawl shot ends when the trawl stops on an obstruction ('fast', 'sticker'). On some bottom trawl grounds, trawl data may suggest longer tows can be carried out, but often during these tows the trawl has to climb over, or be flown over a known piece of rugged and unfishable habitat. Without knowledge of this 'sticker' the trawl would become 'fast'.

China: light Purse-seining.
The typical operation of purse-seining with artificial lights involves a main vessel equipped with powerful lamps and a purse seine net, and a smaller boat equipped with only lamps to attract fish within the fishing area

Static gears:

DOUBLE (SPANISH) LINE SYSTEMS. See Annex 1, Paragraph 1

AUTOLINE or Mustad-autoline System. See Annex 1, Paragraph 3

TROT LINE SYSTEM. See Annex 1, Paragraph 2

POT GEAR.

France Indian Ocean Territories: Uses a pot fishing activity, which are conducted from the mother ship (trawler/potter) or using 2 small boats of 8,20m of length, pulling 1,30m.

Thailand: Portable Trap. Fish traps are made of metal and wood with the size of 3x4x1.6 meters. Mesh size is 3.5 x5 inches. A major decrease in effort from 2016 (1 trap vessel) to 2020 (0 vessels), fishing in the western Indian Ocean.

Vertical longline can be deployed from the trawler/potter or longline vessels.

8.c. Definition of spatial footprint for a typical fishing gear deployment event

'SIOFA bottom fishing footprint' means a map of the spatial extent of historical bottom fishing in the Agreement Area, for all vessels flagged to all Contracting Parties, Cooperating Non-contracting Party (CNCPs) and Participating fishing entities (PFEs) over a period to be defined by the Meeting of the Parties (CMM 2020/01).

A bottom fishing impact assessment method was developed for trawl and longline gears in the SIOFA Area in 2021. Due to the spatial aggregation of a large proportion of these data, the assessment was carried out at a 1°resolution for trawl gear and 20' resolution for longline gear. The proportion of each cell within fishable depths, defined as shallower than 2000m depth, was accounted for. The mapped trawl footprint over time (cells of 1 degree) indicates that the footprint is still expanding. The mapped longline footprint over time (cells of 20') indicates that the footprint is still expanding but at a slower rate than the trawl footprint.

8.d. Time frame used to calculate the fishing footprint

The SC agreed that the maps will include all grid squares in which fishing effort has been recorded between 2000 and 2015. The SC noted the maps are likely to include confidential data and will need to be managed in line with the CMM 2016/03 Data confidentiality.

8.e. Spatial resolution of the data used to calculate the footprint

The SC agreed that the maps will be produced separately for longline, trawl and other gears.

Conservation measure 2020/01: CCPs shall, at least 30 days prior to the commencement of the ordinary meeting of the Scientific Committee in 2018, submit to the Secretariat all relevant data on the spatial extent of its historical bottom fishing effort in the Agreement Area expressed as grid blocks of at least 20 minutes resolution or, if available, a finer scale.

8.f. Availability of data and coverage

The Protected Areas and Ecosystems Working Group (PAEWG) in 2020 noted the need to take into account the fact that CCPs have historically collected data at different levels of resolution from one another and that it may be necessary to use different methods for developing footprints for different objectives.

The data used to establish the SIOFA fishing footprints (SFFPs) are from the Secretariat's haul-by-haul catch and effort and aggregate catch and effort databases. Historical data up to, and including 2015, were used. Data with a coarser resolution than 20 minutes were excluded and only data for gears that may have contact with the sea floor have been used. The historical fishing activities of China, Japan, Korea, Mauritius, and Thailand are not included in the SFFPs because the data are either unavailable or at an insufficiently fine resolution.

The PAEWG in 2020 agreed to hold further discussions on: how to exclude unfished areas from footprints; whether or not to include depth exclusions; how to handle grids with a single fishing event including the need to check the underlying data of these grids to verify they are true fishing events; and specific criteria for determining 'significant intensity'.

8.g. Quality of data

Conservation measure 2019/10:

Each CCP shall ensure that all fishing vessels flying its flag that are operating in the Agreement Area are fitted with an operational automatic location communicator (ALC) unit reporting back to its competent authority.

CCPs shall ensure that ALC units on vessels flying their flag remain operational at all times while in the Agreement Area.

CCPs shall develop, implement and improve systems to maintain a record of all vessel position information reported through VMS and logbooks, in relation to vessels flying their flags while these vessels are in the Agreement Area, such that this information may be used to document vessel activity in the Agreement Area, and to validate fishing position information provided by those vessels.

CCPs are encouraged to share VMS data where it is requested from another CCP in support of patrol or surveillance activities. Each CCP shall not use any information received in accordance with this paragraph for other purposes.

CCPs shall ensure that: VMS position reports are transmitted at least once every 2 hours from each fishing vessel flying their flag and included in the SIOFA Record of Authorised Vessels, while operating in the Agreement Area: (a) under normal satellite navigation operating conditions, positions derived from the data reported shall be accurate to within 100m; (b) VMS position reports include at least the following information regarding category (e.g. vessel information, activity, etc.), Data (e.g. Lat/Lon, etc.) and remarks (e.g. position time, etc.).

The meeting of the Parties (MoP) in 2020 noted that a status of 'not assessed' was assigned to Australia, Cook Islands and Thailand with respect to the submission of VME reports in an electronic format (paragraph 44 of CMM 2019/01). Australia provided VMS data; the Cook Islands and Thailand did not provide VMS data.

At this MoP a controversy arose in the interpretation of this paragraph 44: "Each CCP shall, in respect of each vessel flying its flag which participates in bottom fishing in the Agreement Area, submit VMS reports in an electronic format to the Secretariat in accordance with any VMS CMM and data standards CMM adopted by the Meeting of the Parties".

The EU considered that the paragraph does not require the submission of VMS data by CCPs to the Secretariat so expressed its willingness to consider amending paragraph 44 to establish a clear obligation on all CCPs whose vessels bottom fish in the SIOFA Area to provide VMS data to the Secretariat.

The Meeting of the Parties took note of the different views expressed on the interpretation of paragraph 44 of CMM 2019/01. Noting that there was no consensus on this issue, and in order to avoid future issues arising on this point, the Chair proposed in MoP-07-45 the deletion of Paragraph 44 in CMM 2019/01, so the CMM 2020/01 no longer contains it.

The Meeting of the Parties agreed that CCPs commit to submit comments to the European Union on the proposal for a CMM for the establishment of the Vessel

Monitoring System in SIOFA, outlined in MoP-07-21 and recommended that the European Union, with support from the SIOFA Secretariat, lead the intersessional work on this proposal in advance of the next ordinary Meeting of the Parties (July 2021).

8.h. Effort units that are being used

- Pot lines: Catch/number of pots. Number of/ active vessels.
- Trawl gears: kg/trawl hour. Number of active vessels.
- Bottom longlines: kg/1000 hooks. Number of active vessels.
- Handline effort: kg/fishing days. Number of active vessels.
- Light seining: catch/fishing hours. Number of active vessels.

8.i. Identify the link between the fishing techniques/gears and the specific challenges/issues related to the definition of the fishing footprint

At the moment, only gears which may have contact with the sea floor have been used: trawls (mid-water, bottom and other trawls), longlines (exclusion of drifting and pelagic longlines), handline, nets, traps and pots.

In addition, historical fishing footprint from every bottom gear at 20 minutes resolution were presented at PAE-03-05 as well as all gears merged.

If the objective of the footprint is to prevent significant adverse impacts (SAI), it would be necessary to define the footprint in greater detail with higher resolution and gear-specificity. In this case, grids with a single fishing event should be included.

Gear-specific analyses may be needed when considering depth exclusions to remove unfished areas. As the resolution of the seafloor bathymetry model is 1 minute, potentially some areas could have been removed from the analysis where there could have been some fishing activity around small seamounts with the summit above 2000m but the mean depth of their respective 1-min cell deeper than 2000m.

8.j. Identify strengths and weaknesses of the methodologies used for establishment of historical and cumulative fishing footprint.

Historically, CCPs have collected data at different levels of resolution from one another. This poses a number of technical issues when trying to determine the most appropriate fishing footprint map, such as risking overextending the footprint when using highly aggregated data or excluding the data of CCPs that do not have sufficiently fine data.

Work remains to be done in terms of the establishment of historical and cumulative fishing footprint. At the Sixth Meeting of the SIOFA SC Japan has proposed to adopt a spatial resolution of 1°×1° in order to utilise maximum available historical fishing effort from the majority of CCPs but some CCPs pointed out that they currently map their footprints at a finer scale than 1°×1° and suggested that adopting the coarser scale of 1°×1° as the unified core SIOFA scale would be counterproductive.

Other weakness is the non-availability of usable data for all parties namely the historical activities from Japan and Thailand that are not at fine resolution and do not fit the fine resolution criteria. Data from Korea couldn’t be used either because it is provided only on a FAO-area level. From China no fishing data could be used because no usable spatial information is available. There is also no data from Mauritius.

8.k. Suggest/propose recommendations that could be considered as guidelines for future EU proposals regarding the definition of footprint

The biggest challenge would be to obtain data at an appropriate scale to be used to define a reliable bottom fishing footprint. The resolution of the data available is recognised to be a practical constraint. At the 3rd Protected Areas and Ecosystems Working Group (PAEWG3) held remotely in 2021, Thailand indicated that it can provide finer resolution data (trawl-by-trawl) for its bottom trawl fishery on Saya de Malha Bank for 2015 to 2017 to the Secretariat. Korea indicated that, in addition to the aggregated data it has already submitted, it is currently verifying catch and effort data with at least 10' resolution for longline and trawl fisheries for 2009 to 2013 and will submit those data to the Secretariat in the near future.

Other issues to consider

In 2021, the PAEWG noted that bottom fishing footprints should be used to define the spatial extent of bottom fishing grounds to prevent any expansion of such fishing activities in accordance with SIOFA CMM 2019/01 and 2020/01 (Interim Management of Bottom Fishing), and to define areas that represent "new and exploratory" fishing that may be subject to additional management controls and trigger the need for new research and data collection. For these management purposes, fishing footprints are fixed to a historical fishing period up to year 2015 and not continuously updated and it is desirable that they reflect the best-available spatial resolution.

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Section 8.a: https://www.apsoi.org/meetings/sc6

Section 8.b: http://apsoi.org/bf-impact

Section 8.c and 8.d: Report of the Fourth Meeting of the Scientific Committee of the Southern Indian Ocean Fisheries Agreement (SIOFA) Yokohama, Japan 25 – 29 March 2019.

CMMs: https://www.apsoi.org/cmm.

SOUTHERN OCEAN

9. COMMISSION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES (CCAMLR)

9.a. Diversity of fishing fleets, their practices and strategies

Members of the Commission currently include 25 States (Argentina; Australia; Belgium; Brazil; Chile; China; France; Germany; India; Italy; Japan; Republic of Korea; Namibia; Kingdom of the Netherlands; New Zealand; Norway; Poland; Russian Federation; South Africa; Spain; Sweden; Ukraine; United Kingdom; United States of America and Uruguay) and the European Union. The Status of the Convention is maintained by the Depositary, Australia.

The only bottom fishing undertaken within CCAMLR is done through the demersal longline fishery, with vessels from Australia, Chile, Japan, Korea, New Zealand, South Africa, Spain, Ukraine and United Kingdom. There is also a trawl fishery operating off Heard and McDonald Islands (Within the Australian EEZ) for one vessel. The vessels target toothfish, primarily Antarctic toothfish (*Dissostichus mawsoni*) but also catch Patagonian toothfish (*Dissostichus eleginoides*) when fishing in in lower latitudes. In total, 36 vessels are authorised to fish in the CCAMLR area during the 2020/21 season. These are summarised in Table 1, by country, vessel type and area of operation. Figure 1 shows the Convention Area, along with the Subareas and Divisions within it.

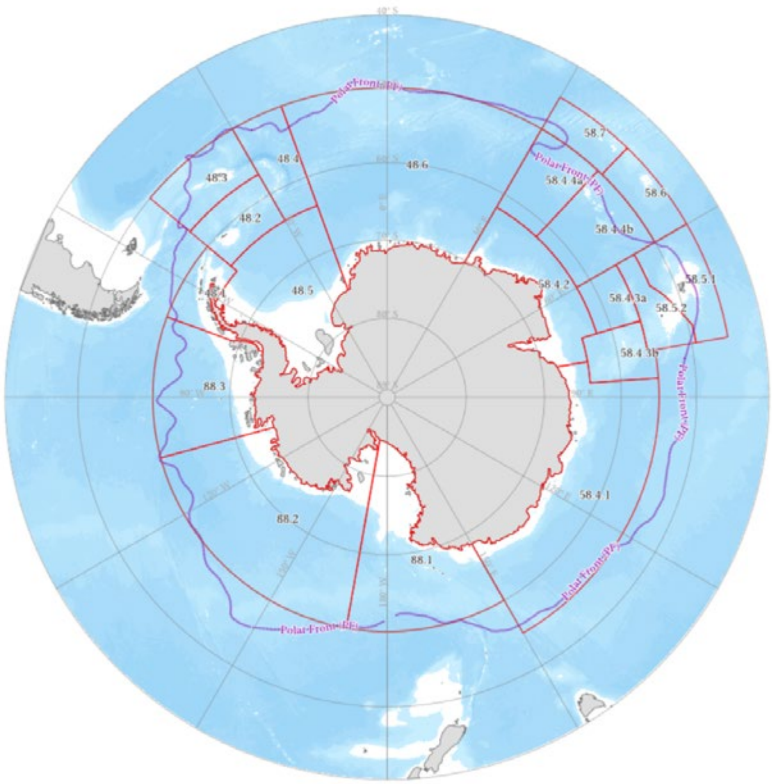

Figure 1. Map of the CCAMLR Convention Area, showing Areas, Subareas and Divisions.

Not all vessels authorised to fish actually fish, decisions may be made due to the market price of the target species, mechanical failure or, for recent seasons, the Covid 19 pandemic. In addition, the Conservation Measure (CM) 22-06 on bottom fishing only applies to exploratory fisheries and vessels fishing in 58.4.1, this is up to 27 vessels and also shown in Table 1. Principal demersal resource species of the Southern Ocean are shown in Figure 2.

Table 1. Vessels authorised to fish in CCAMLR waters in 2020/21 season (based on list of authorized vessels). Number of fishing vessels notified to fish in exploratory fisheries in 2021/22 season are shown in brackets (Based on exploratory fisheries notifications).

Flag	Vessel type	Subareas/ Division	No. of vessels
Australia	Longline	58.4.2 / 58.5.2 / 88.1 / 88.2	5 (2)
Australia	Trawl	58.5.2	1
Chile	Longline	48.1 / 88.1 / 88.2	2
France	Longline	58.4.2b / 58.4.2	4 (1)
Japan	Longline	58.4.4 / 88.1 / 48.6 / 58.4.1 / 58.4.2 / 58.4.3a / 58.4.4	2 (1)
Korea	Longline	88.1 / 88.2	5 (6)*
New Zealand	Longline	88.1 / 88.2 / 88.3 / 48.3 / 48.4	3 (3)
Russia	Longline	88.1 / 88.2	1 (1)
South Africa	Longline	58.7 / 48.6	2 (1)
Spain	Longline	88.1 / 48.6	1 (1)
Ukraine	Longline	48.1 / 88.1 / 88.2 / 88.3	5 (5)
UK	Longline	48.3 / 48.4 / 88.1 / 88.2	3 (3)
Uruguay	Longline	88.1 / 88.2	2 (3)*

* Based on 2021/22 season, authorisation from 2020/21 yet to be updated.

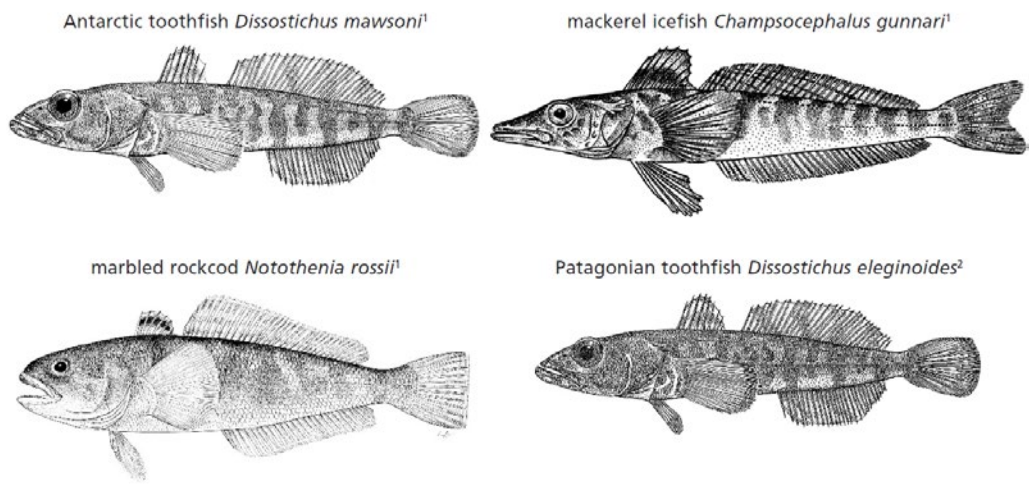

Figure 2. Principal demersal resource species of the Southern Ocean. Source: (FAO, 2020). [Sources of pictures: [1]Food and Agriculture Organization of the United Nations, Original Scientific Illustrations Archive. [2]Fischer and Hureau (1985)].

Catches of toothfish between 2000 and 2018, taken in exploratory fisheries, are given in Figure 3, by flag State, and Figure 4, by Subarea or Division.

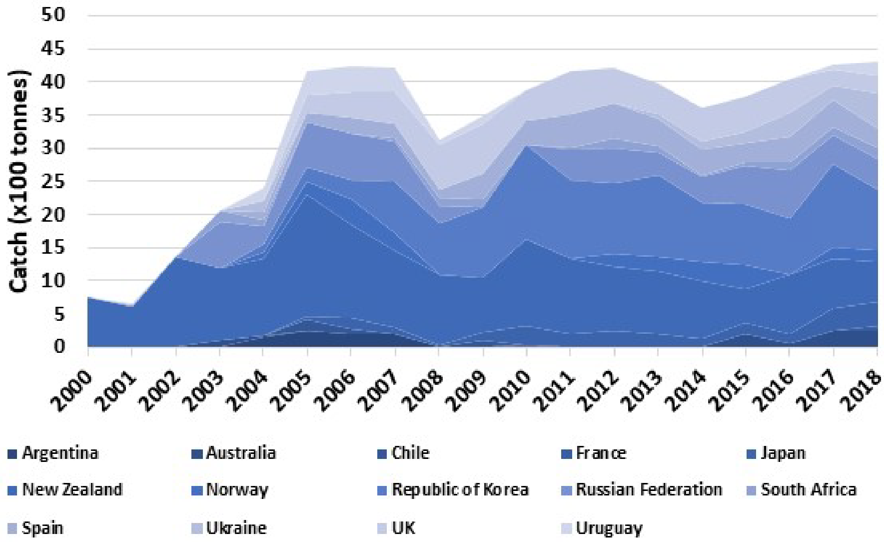

Figure 3. Catches taken by flag State in CCAMLR exploratory fisheries since 2000 (Source: CCAMLR Statistical Bulletin)

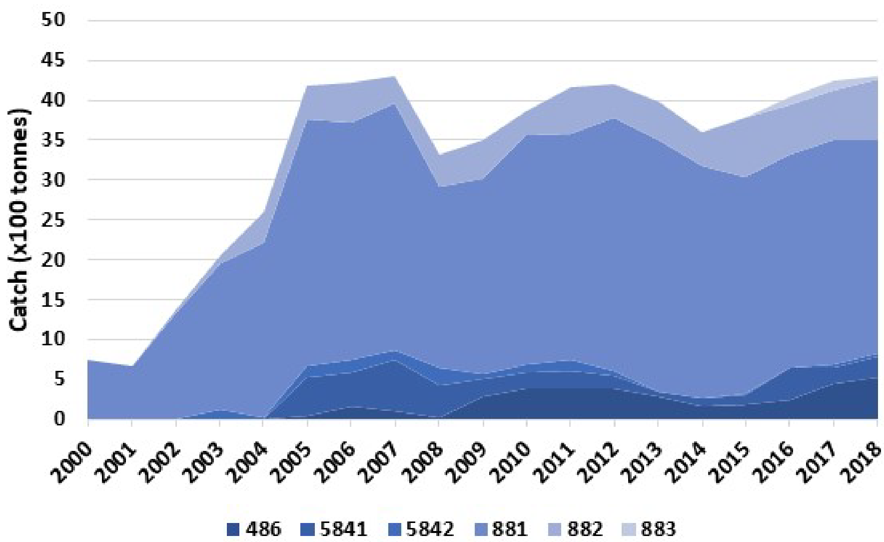

Figure 4. Catches by Subarea or Division in the CCAMLR Convention area since 2000 (Source: CCAMLR Statistical Bulletin)

There three types of longline are used in the Convention Area. To reduce bird mortalities, lines must be correctly weighted to meet the line sink-rates set out in CM 24-02. The integrated weight system (IW) has the weight integrated into the core of the longline, the 'Spanish system' has a double line with weights spaced at prescribed distances and trotlines which use vertical clusters of hooks with the weight at the bottom of the line. There has previously been a demersal pot fishery for crabs (Lithodidae spp.) and toothfish, although this was very small and hasn't been active commercially since 2013. More details of these gear types can be found in the CCAMLR gear library (https://www.ccamlr.org/en/publications/fishing-gear-library) and in Annex 1 – Fishing gear.

Vessels have their preferred fishing grounds in the various Subareas, based on historical information. Lines are set at depth (>550m, as set out in CM 22-08) on the seabed, often setting a longer 'test' line to find the areas of highest target species concentrations which they can then concentrate their fishing effort on. When being hauled, VME indicator taxa (and other benthic taxa) can be caught on hooks or occasionally entangled on the line and brought to the surface. Here the numbers of different taxa are counted, the sample is weighed, or the volume measured, to determine if there is a potential VME in the seabed. Median line length has been calculated at 9.92Km (WG-FSA-2019-67), with a maximum depth of around 2,000m. The length of the line will normally be determined by the topography of the seafloor, the ice conditions and the anticipated catch.

The fishing season, for CCAMLR fisheries, is defined under CM 32-01 and runs from 1st December through to 30th November, unless otherwise specified in a specific CM. In most Subareas it will normally be limited by quota uptake of target species, although occasionally Subareas are also closed after bycatch limits are reached. In addition, to mitigate against bird mortalities, Subarea 48.3 (Figure 1) has seasonal limits from 16th May through to 14th September (although in reality it is 1st May), or as with other areas, until the quota is used up.

9.b. Operative/technical characteristics of the fishing gear

Demersal longline gear is static and is normally left to 'soak' for 8-12 hours prior to hauling, although as it is being hauled it can become mobile causing it to 'sweep' across the seafloor (WG-FSA-08/58). Among other things this movement could be related to depth (WG-FSA-10/31), with deeper lines having less movement when hauled due to the angle of hauling. Other factors that may cause gear to move across the seabed include weather or the surface buoys getting caught in the sea ice and dragged.

9.c. Definition of spatial footprint for a typical fishing gear deployment event

The spatial, or fishing footprint, as defined as part of a VME glossary developed by CCAMLR following a recommendation from the Scientific Committee (WG-FSA-10/28).

> ***Fishing footprint*** – The area of the seafloor within which fishing gear interacts with benthic organisms. Fishing footprint may be expressed per unit of fishing effort for a particular gear configuration (e.g. for longlines, km^2 seabed contacted per km of longline deployed), or as a cumulative footprint when calculated and summed for all fishing gear deployments in a defined period and area. This areal measure does not incorporate the level of impact within the footprint.

This defines both the fishing footprint from an individual fishing event and the cumulative footprint. The footprint just estimates the area covered not the level of impact on VME taxa. The spatial footprint of fishing gear has been defined largely from a methodology Impact Assessment Framework (IAF) developed by New Zealand (WG-FSA-10/31) and adopted by CCAMLR. It was estimated at the time that the impact of fishing gear was low, with a mortality of around 0.01% to 0.03% of the most fragile VME taxa in the most heavily fished bioregions in Subareas 88.1 and 88.2 (for New Zealand flagged vessels). This has recently been re-assessed by the Secretariat with a request to revise the methodology (WG-FSA-2019/67 Proposed revision to the estimation of fisheries footprints). Currently, all vessels submitting an application for fishing need to submit a document outlining the potential impact of their fishing gear, using the form outlined in CM 22-06 Annex A, if they are new to the fishery or have changed their gear from the previous season. This conservation measure only applies to areas south of 60° and Division 58.4.1.

This uses code, developed in 'R' and available on the CCAMLR site (https://cran.r-project.org/web/packages/CCAMLRGIS/index.html). All assessments are available on the CCAMLR site (see for example https://www.ccamlr.org/en/node/109393).

Recognising that since the original VME workshop in 2009 (WS-VME-09), technologies and methods had developed (benthic cameras and electronic monitoring), CCAMLR proposed to review data collected and summarise results. This would contribute towards a VME workplan which would include updating the method for calculating the spatial footprint of fishing gear, the updated method was presented in WG-FSA-2019/67. This method has yet to be endorsed due to the cancellation of the WG-FSA and SAM meetings in 2020. It proposes changing the current index from length of line per area (km of line/km^2) to area proportions (km^2/km^2) using a 10 km^2 grid as the spatial resolution.

9.d. Time frame used to calculate the fishing footprint

The footprint is calculated each year and will be based on the previous season for each Subarea or Division. If the gear is unchanged, it is assumed the footprint will be also unchanged and no new assessment need be submitted provided the vessel fishes in the same Subarea or Division. Vessels new to the fishery must also submit a gear assessment.

CM 22-06 was first adopted in 2007, the methodology outlined in "section 9.c." in 2008 and revised in 2010 and the CM revised in 2019, data have been submitted or held by the Secretariat since then. Data between 2009 and 2019 were used to calculate the revised impact index recommended in WG-FSA-2019/67.

9.e. Spatial resolution of the data used to calculate the footprint

The footprint is currently calculated to the nearest meter, using the length of the line and the potential area impacted by each meter (km/km^2). However, there is a proposed revision of this methodology (WG-FSA-2019/67) Rather than using a linear system from start to end point of the line, the footprint index is calculated as the proportion of an area impacted (km^2/km^2) based on the length of line that passes through each of a series of 10km^2 regular grid squares covering the fishing grounds. This 10km^2 resolution was chosen as it matched approximately the median actual line length (9.92km). While this has yet to be implemented, the revision would have the advantage of simplicity and robustness of the current system. It removes all the uncertainties associated with the prior assumptions required with the calculating the IAF, particularly in regards to the actual start and end locations of the lines when they reach the seafloor (see "section 9.j."). It assumes an impact area of 1m either side of the line, but also places a 'buffer' area on 1nm either side of the line to account for this uncertainty of location.

9.f. Availability of data and coverage

Data are held on the Secretariat's Data Centre, data that are freely available in the public domain include:

- registry of vulnerable marine ecosystems (VMEs) and risk areas
- fishery and trade summaries published annually in the Statistical Bulletin

The fishery catch and effort data are aggregated by area/Member State/month.

More detailed data (fisheries and observer data) are available on request from the Secretariat, following CCAMLR's Rules for Access and Use of CCAMLR Data which require permission from the data owners through a formal request outlining how the data will be used. These data are only released for the purpose of scientific publications. CCAMLR have also developed a data portal (data.ccamlr.org) where data are made available to, or can be submitted by Member States. These data are mainly in support of proposed Marine Protected Areas but also contain catch and effort and observer data which can be requested.

VMS data are not publicly available and can only be requested by Members through the Secretariat to assist with active surveillance operations, support search and rescue activities or to verify the information contained in a *Dissostichus* Catch Document (DCD) (CM. 10-04).

Data on the fishing footprint was most recently analysed by the Secretariat and presented in WG-FSA-2019/67.

9.g. Quality of data

CCAMLR have a centralised VMS system, managed under CM 10-04, where vessels must transmit position data on an hourly basis. The data to be transmitted are defined in Paragraph 1(v) of the CM and include:

(a) the ALC unique identifier;

(b) the current geographical position (latitude and longitude) of the vessel;

(c) the date and time (expressed in Coordinated Universal Time (UTC)) of the fixing of the position of the vessel in paragraph 1(v)(b);

(d) the vessel's speed (calculated based on paragraphs 1(v)(b) and (c));

(e) the vessel's course (derived from paragraphs 1(v)(b) and (c)).

Should the VMS system break down vessels must report manually return to port if the problem has not been resolved after 2 months.

CCAMLR implements an annual Compliance Evaluation Procedure (CCEP) to evaluate Member State implementation of CMs, including VMS transmission requirements. This involves the Secretariat preparing a report and submitting to the relevant Member State for review. These are reviewed by the Standing Committee on Implementation and Compliance (SCIC), a subsidiary body to the Commission. The individual reports are not publicly available; however, the meeting reports are. The latest report did not highlight any issues with VMS reporting (e-cc-38-a6).

9.h. Effort units that are being used

As defined by CCAMLR, a fishing footprint may be expressed per unit of fishing effort for a particular gear configuration, in the case of longlines this will be per km^2 of seabed contacted per km of longline deployed (WG-FSA 10/28), although this methodology is being revised ("see sections 9.c. and 9.e.").

9.i. Identify the link between the fishing techniques/gears and the specific challenges/issues related to the definition of the fishing footprint

The main concern with the current system of defining the fishing footprint for a longline is related to the uncertainty of the actual location of the longline on the seabed (FSA-2019-67). The assumption being made is that the location of the start and end of the line on the seabed corresponds to the start and end of the line as reported, on the surface, in the vessel logbook. However, lines may drift while being set (WG-SAM-2019/22) and vessels may not move in straight line (WG-FSA-2019/01). There is also still some uncertainty about at what point in the operation the start and end of the setting process is recorded (SC-CCAMLR-XXXVI).

In addition, there may be some events when the footprint is much larger than calculated, if the line sweeps across the floor when being hauled or the surface buoys get caught in ice; this was acknowledged in WG-FSA-10/31 but discounted as a rare event to simplify the calculation.

9.j. Identify strengths and weaknesses of the methodologies used for establishment of historical and cumulative fishing footprint.

The current methodologies were developed in 2008 and revised in 2010 and were one of the first to be developed by an RFMO and have been standardised across all Member States. However, it was acknowledged by WG-FSA (e-sc-38, Annex 7) that there had been varying degrees of progress with the VME research plan, including updating the cumulative footprint. It was previously undertaken in 2012 and there had been no updates to it until 2019 when a revised methodology was proposed (FSA-2019/67). Although not formally adopted by CCAMLR the method outlined was applied to longline data between 2009 and 2019, it was acknowledged that this method was more robust through its simplicity, in that it avoids the complexity and prior assumptions required by the IAF. This method does not, however, take into account the fragility of VME taxa.

The revised methodology is largely based on accounting for uncertainties identified around gear locations used in the calculation of the IAF, which are key to the footprint estimation process. The IAF assumes that the location reported at the start and end of each set is the location of the line when it reaches the seafloor. The main uncertainties concern:

- Lines drifting as they are being set (WG-SAM-2019/22).
- Vessels not moving in a straight line between the start and end of each set (WG-FSA-2019/01).
- The actual event at which the start and end locations of a longline set are recorded (i.e. when the marker buoy is deployed or when the anchor is deployed) (SC-CCAMLR-XXXVI, para. 7.6).

Another issue identified is the fact that although longlines are the only fishing gear used within the exploratory fisheries affected by CM 22-06 there are different types of longlines that behave in different ways. Autolines will lie on the seabed, lines used in the Spanish system do not lie on the seabed throughout their length but do have two lines (a main line and a 'backbone') as well at weights spaced evenly apart. Only the weights of trotlines will generally come into contact with the seabed and the effects of pots are largely unknown. The current methodology is only designed to account for autolines, although the Scientific Committee has encouraged member States to develop methodologies for other longlining methods (SC-CCAMLR-XXX, Annex 7).

It has been acknowledged that VME taxa observed on the surface may only account for proportion of those actually impacted and the use of benthic cameras is now encouraged to provide direct observations of interactions between the line and the seabed (WG-SAM-2019/03).

The current methodology only applies to areas within CCAMLR to which CM22-06 applies (areas south of 60° and Statistical Division 58.4.1 north of 60°S), some Members have suggested it should apply to the entire Convention Area.

9.k. Suggest/propose recommendations that could be considered as guidelines for future EU proposals regarding the definition of footprint

All work on developing methodologies for defining footprints within CCAMLR are based around demersal longlining (specifically autolines). CCAMLR had been instrumental in developing VME encounter proposals but has recognised that some of their VME protocols need updating. This is due mainly to the development of new methods and technologies which allowed for developing a range of topics to be considered for the VME work plan. These included 12 recommendations covering a range of aspects related to VMEs. The most relevant to this Sub-task have been summarised below (adapted from e-sc-38-a7, Table 12).

1) Review new methods for assessing fishing footprint and compare with existing methods.
2) Review VME impact mitigation procedures in regional fisheries management organisations (RFMOs) that may inform CCAMLR.

Topic 1 looks at reviewing new methods for assessing fishing footprints for demersal longlines and how they should be defined within CCAMLR. This will be based largely on the methodology outlined in WG-FSA-2019/67 and could be adapted to be used as guidelines for future EU proposals.

Due to the postponement of WG-FSA and WG-SAM in 2020 this has yet to be formalised but mechanisms for addressing this workplan are being developed for 2021. Any Recommendations relevant to the EU from CCAMLR regarding footprint definition should be based on outputs from this workplan.

Topic 2 is also based around a review by CCAMLR of other RFMO procedures for developing mitigation measures for impacts to VMEs, which will also include developing footprint definitions. It has synergies with this Sub-task, coordination with CCAMLR and this particular CCAMLR Topic would be beneficial.

Other issues to consider

Currently longlining is the only type of bottom fishing to be undertaken in CCAMLR and the footprint index has been calculated based around autolining (rather than pots or Spanish System lines) so any definitions or guidelines for calculations of fishing footprints taken from CCAMLR can only be based or adapted from this method.

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GENERAL CONSIDERATIONS AND RECOMMENDATIONS

The concept fishing footprint is not specifically defined in the FAO Guidelines as a "key concept". Nevertheless, in most of the RFMOs the terms "fishing footprint", "bottom fishing footprint", "existing bottom fishing areas", "existing deep-sea bottom fishing areas", etc., generally refer to the same concept (i.e. those locations in which some level of bottom fishing activity has previously been conducted in a reference period). As is widely recognized, the determination of the historical bottom fishing footprint is crucial for the adequate management of DSF, and in particular for the adoption and implementation of appropriate management measures for the protection of VMEs from the impacts of bottom fishing gears, including through the adoption of encounter and/or exploratory fishing protocols. Lessons learnt from the experience in different RFMOs could be useful as a guideline to study the fishing footprint:

Data needs

The following information is considered essential to define appropriately the bottom fishing footprint in the DSF:

1. VMS data collected should include (i) Vessel Identification, (ii) Flag State, (iii) Radio (vessel call sign), UTC date and time of the vessel position, vessel position by latitude and longitude, speed and heading.

2. Catch data for each vessel should be collected in a haul by haul basis, containing: (i) date, (ii) type of gear used, (iii) timestamps and geographic coordinates for gear deployment and retrieval, (iv) catch and (v) discard weight for each species caught, including VME indicator species.

3. Information on technical and operative characteristics (e.g. gear type and typical dimensions, mode of operation, etc.) of the bottom fishing gears used by the different fleets is necessary to improve the footprint definition. Current available information on fishing gear characteristics in some RFMOs is incomplete and should be improved (e.g. bottom longlines in NAFO RA). It is also recommended to improve the gear coding included in the logbooks aiming to give a clear picture of the gear used during each fishing event.

4. The resolution of spatial and temporal data needs to be of a sufficient quality to enable the definition of a reliable bottom fishing footprint. This is still a practical constraint in some RFMOs (e.g. SIOFA). For advice and management purposes, it is desirable, to the extent possible, that the data reflect the best-available spatial and temporal resolution. Moreover, the best possible data resolution allows a finer definition of footprint and therefore a closer analysis of the overlapping between DSF and VMEs, enabling to maintain fishing activity without jeopardizing the environment. The effect of estimation at different spatial and temporal resolutions[42] should be explored. The best scenario should be to have sufficient data frequency to allow detection of different fishing behaviours at appropriate resolution, while minimizing demands for data transmission, storage, and analysis.

[42] Given the range of resolutions of the available data across the RFMOs, it is difficult to identify a generally spatial and temporal level of appropriate resolution to define the footprint. This issue needs to be further explored, case by case.

Data compilation and availability

1. Some RFMOs compile and maintain VMS and logbook data, having the duty to make available such data to be used for scientific purposes (e.g. assessment of SAIs on VMEs, fish stock assessment, and reassessment of bottom fisheries). As a result, an essential amount of information is available for the reconstruction of fishing effort in space and time. However, in some other RFMOs VMS is recently operational (e.g. NPFC officially launched its regional VMS on 10th of August 2021 and GFCM is still in a less evolved step).

2. Data compilation and availability, as well as the definition of footprint are recognized as essential steps in DSF management. Although, the footprint definition is still under development within some RFMOs (e.g. NPFC, GCFM), it is advised that this exercise be based on already formulated rules on RFMOs with advanced experience (e.g. NAFO, NEAFC and CCAMLR). Moreover, the footprint should be defined by gear type and, if possible, in a dynamic way (i.e. shall be regularly updated to better understand if and how fishing effort intensity and distribution is changing over the years).

3. In case that above information is not easily available, it is recommended to endorse a plan and timelines to determine the type and resolution of data needed to define fishing footprint (e.g. NPFC).

Data quality

1. The accuracy of fishing effort estimation is primarily linked to the quality of the input data and influenced by the cumulative effect of linking different datasets with difference level of accuracy together (e.g. some quality issues were identified in the NAFO VMS and logbook data, related with human and technical errors). These errors may have an impact on the subsequent footprint related analysis.

2. Therefore, it is recommendable to develop further studies on the problems detected, (including an implementation of an improved quality control (QC) check process) with the aim to propose measures to solve such issues (e.g. RFMOs could implement a QC procedure similar to the one used by ICES when receiving VMS and logbook submissions from countries). This would ensure feedback to data submitters, allowing them to become aware of errors and re-submit the corrected data.

Data sharing and cooperation

1. In areas where RFMOs have not been established (e.g. FAO Area 41), available information about fishing fleets is scarce and with very limited access. Thus, there is a need for international cooperation on research including data sharing and management agreements to ensure the monitoring of the fleets. Taking into account this particular situation, it is recommended a multilateral action plan (e.g. involving organizations such as FAO) through a stepwise approach for data collection programmes (fishing effort by flag State, observer programmes, etc.). These potential actions could contribute to setting the basis for going forward in the process of establishing RFMOs or Agreements.

2. Memoranda of Understanding (MoUs) between organizations have proven to be useful tools to favour the advice on matters of mutual interest (e.g. fishing footprint), draw questions of concern to attention and foster a closer relationship (e.g. ICES provides NEAFC with scientific information and advice,

which is independent and free from political influence and subject to best international quality procedures for research and research based advice).

Methodology

1. This report gives an overview of the approaches used to define fishing footprints in the RFMOs, highlighting that there is a very wide variety of methodologies in use.

2. Given the existence of various approaches to define the fishing footprint, with different resolutions, it is recommended to conduct a review of potential new methods and compare with the existing ones (e.g. "simple speed filter" *vs* "coupling VMS with logbook" as was analysed in NAFO) in order to improve the footprint definition (i.e. finer resolution, etc.). Particularly, this review is a matter of interest in CCAMLR.

3. In RFMOs where bottom longline fishery footprint is still not well defined (e.g. NAFO) it is recommended to explore the implementation of the methods used by RFMOS with advanced experience (e.g. CCAMLR).

Complementary/potential useful data sources and approaches

1. Although most RFMOs do not have experience with AIS, this data source could be used as supporting information for the spatial analysis of fisheries as a complementary source (e.g. https://globalfishingwatch.org/ and www.fao.org/3/ca7012en/ca7012en.pdf). Exploration of the utility of AIS data is recommended as potential data source.

2. Tracking devices (e.g. VMS, AIS) usually allow monitoring of the largest fishing vessels (e.g. NAFO high seas bottom fisheries), whereas small vessels do not usually carry specific systems which may allow the determination of fishing footprint (e.g. Mediterranean Sea small-scale fisheries). As a consequence, the footprints of these small-scale fisheries cannot be directly quantified. Implementation of tracking devices in small vessels is a challenging issue due to its technical and operative characteristics, so it is recommended to develop and test alternative approaches[43] to predict fishing effort allocations for vessels without tracking devices.

3. Moreover, the use of night-time imaging (e.g. Visible Infrared Imaging Radiometer Suite-VIIRS) would be useful to pick up the presence of fishing vessels using lights to attract catch (e.g. jigger activity in Southwest Atlantic Ocean) or conduct operations at night. Combination of remote sensing technologies could help to reveal all fleet activities in detail in different areas (AIS, optical imagery, radar images and VIIRS).

4. Regarding catch reporting of VME indicator species, the image recognition technology/software (on-board cameras) is not fully developed in comparison with fish identification. VME indicators are more difficult to identify by image recognition. It is recommended to undertake research studies to determine the feasibility of VME indicator species image recognition systems.

[43] Russo *et al.* (2019) Predicting Fishing footprint of trawlers from environmental and fleet data: An application of artificial neural networks. Front. Mar. Sci. 6:670. doi: 10.3389/fmars.2019.00670. Available at: https://www.frontiersin.org/articles/10.3389/fmars.2019.00670/full

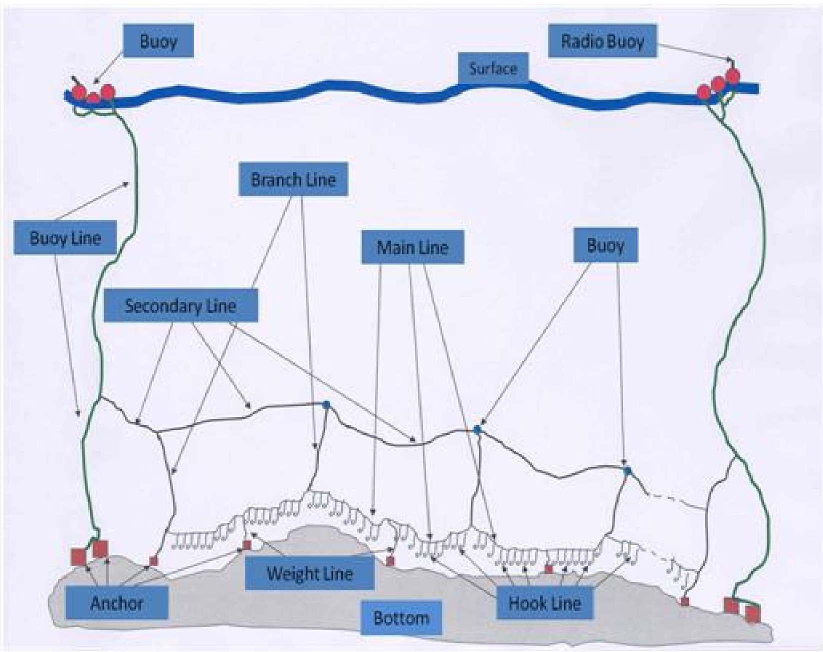
Funding

1. Adequate funding (e.g. NEREIDA EU Programmes) has been crucial to continue with the analysis of the fishing footprint, allowing the improvement of its knowledge and resolution. Additionally, it has a direct beneficial impact on the subsequent analyses conducted using these data (e.g. SAI assessment, fishing overlap with VMEs, etc).

ANNEX 1- FISHING GEAR

1. DOUBLE (SPANISH) LINE SYSTEMS

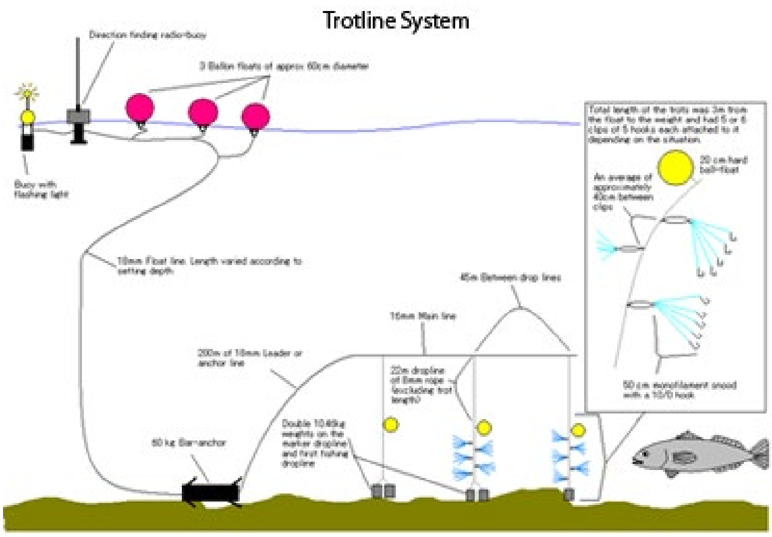
The double line system uses two lines set in parallel: main line and fishing (bottom) line. The main line is thicker (18mm to 22mm in diameter) and usually made out of a floating polypropylene rope. There are a number of terms used to describe this rope: main line, floating topline or top rope. The objective of the floating rope is to keep it clear of any obstruction on the seabed. The fishing line has the hooks attached and is weighed down at specific intervals to keep it on or close to the seabed. There are a number of terms that can be used to describe this line, fishing line, bottom line or hook line. The line material can be rope or cord that is either negatively buoyant or floating, and is always thinner than the mainline (6 mm to 8 mm in diameter). The hooks are attached to the fishing line with snoods that are either a monofilament nylon line (1mm in diameter or 2mm cord 2mm in diameter). The snoods are regularly spaced at intervals ranging from 120cm to 180 cm along the fishing line. The main line and fishing line are connected by branch lines (droppers) that are attached to the main line at fixed intervals that can range from 25m to 100m depending on the longline setup. The branch lines are usually also a floating polypropylene rope (12mm to 14mm in diameter) and approximately 25m long. The overall objective of the double line system is that if the fishing line gets snagged on the seabed the vessel can continue hauling on the mainline, breaking off the fishing line and recovering the broken fishing line when hauling up the next branch line. The advantage of the double line is that it can be set over foul grounds where single lines cannot be used, however they cannot easily be automated and are labour intensive, requiring more crew.



2. TROT LINE SYSTEM

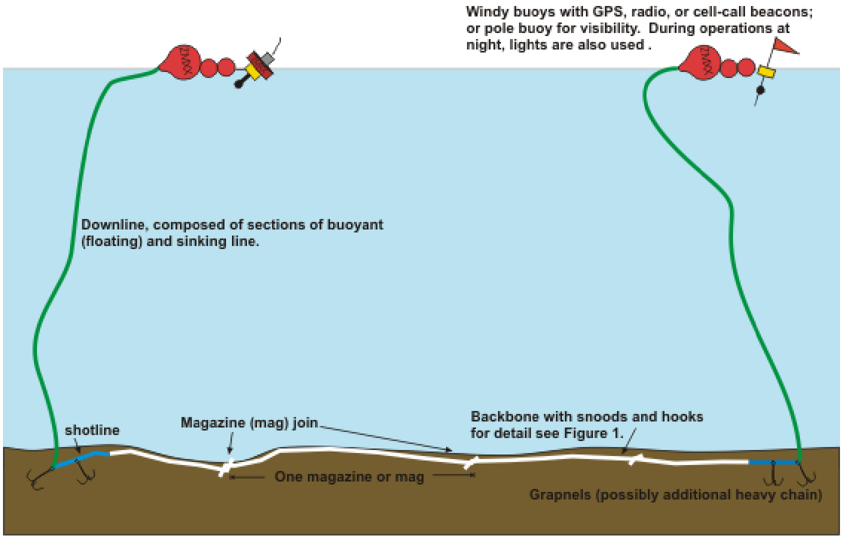
The trotline is a modification of the Spanish (double) line system that uses a floating main line (topline) and has similar branch lines attached at intervals, usually 25m or 50m apart. At the end of each branch line a length of hook line is attached with hooks or "trots of hooks' attached. At the bottom of the hook line a weight is attached to weigh it down. The hooks are therefore set vertically above the seabed. A small high pressure float may be attached above the hook line to tension it vertically. The distance of the hooks off the seabed is determined by the length of the hook line and the spacing of the hooks and normally is not more than 3 to 4 meters. This system can be set over rugged seabed with less chance of being fouled. It is labour intensive and cannot be automated.

The trot line has an advantage in that it allows for the addition of cetacean mitigation device (CED) to prevent marine mammal predation.



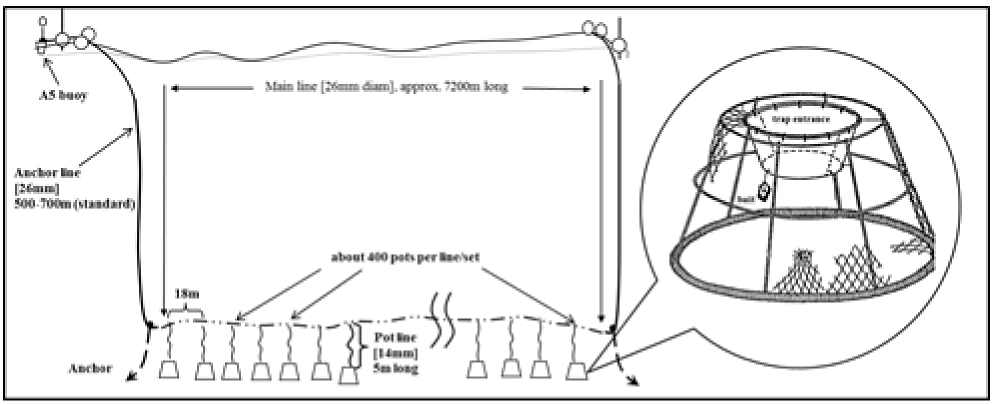
3. *AUTOLINES*

Auto-longline equipped vessels use technology that allows semi-automated setting of large numbers of hooks in a short time. Part of the gear is an auto-baiter that can bait around two hooks per second while the mainline is shot from the stern of the vessel. Currently, auto-longline vessel uses a bottom set mainline of 7–10 mm in diameter and can be weighted. Snoods of ~300-400mm length with a 12/0 or 13/0 hook are spaced between 1 and 1.4 m apart along the mainline. The longline is set with a 75 kg weight at each end and, depending on the target species, either floated up off the seabed using midwater floats that are clipped onto the line during deployment, or allowed to settle onto the seabed, sometimes with a weight midwater along to prevent dragging. Droplines are set vertically with a single weight of ~40 kg at the bottom and a large float at the surface with around 100–200 hooks attached to the bottom part of the vertical line.



4. *CRAB POT LINES*

Trap or pot fishing is a passive fishing method in which multiple baited pots are set in strings along an anchored bottom long-line called long-line trap-fishing. The beehive pots are conical metal frames covered in fishing net with an inlet shoot at the trap entrance on the upper side of the structure and a catch retention bag on its underside. When settled on the seabed the upper side of the trap are roughly 50 cm above the ground ensuring easy access to the entrance of the trap. The trap entrance is baited with a net "bait bag" fixed below the conical entrance that ensures all crabs end up in the bottom of the trap. The mainline is a continuous floating polypropylene rope 22mm in diameter. The pots are attached to a mainline at approximately 18 m intervals with a rope of approximately 14mm in diameter. On each end of the line (set) is an anchor and a buoy line leading to the surface where it is buoyed off with a series of 2 –"A5" plastic floats. Each end of a set is visible at the surface of the water that allows the vessel to retrieve the line from the opposite end in the event the line on the seabed gets snagged. One pot line (or set) can consist of up to 400 or more beehive pots on a line of approximately 7440 meters long, depending on the vessels capabilities.

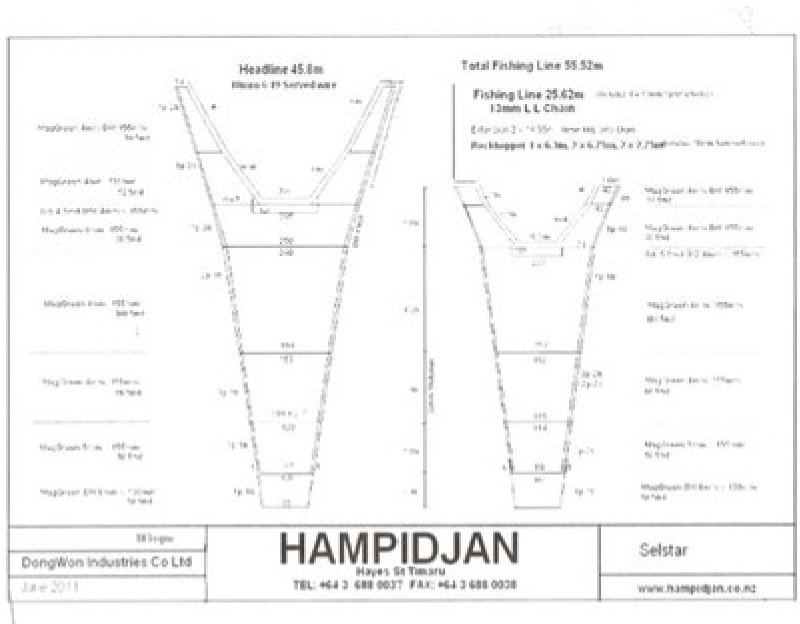


5. *TRAWL FISHERIES (DEMERSAL AND MID-WATER)*

Trawling is an active fishing method that involves towing a net through the water behind a fishing vessel. Demersal trawling targets fish and invertebrates on the seabed. Midwater (or pelagic) trawling targets pelagic fishes in the water column. A range of net designs and configurations exist depending on the target species, fish behaviour and the areas being fished. Trawl systems can be divided into two main categories: (i) Conventional trawls that use otter boards or trawl doors to open the net, (ii) Beam trawls that use a solid beam or frame to maintain the net opening. Fish are herded into the net opening by the wings while trawling, and they are retained in the codend.

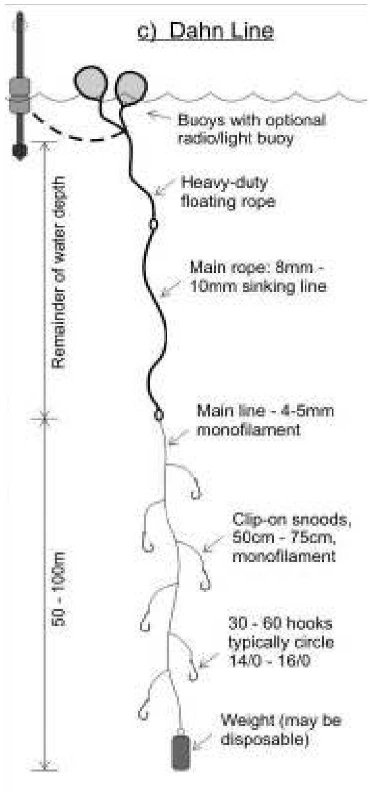
TRAWL GEAR

Bottom trawls (otter trawl): Shaped like a long triangle with the widest part forming the net opening and tapering down to a narrow bag (or "codend"). Towed along the seabed and kept open by two "trawl doors". Mid-water trawls: Similar to bottom trawls but it is towed in the mid-water, between the surface and seabed. Trawl doors are also used to open the net.



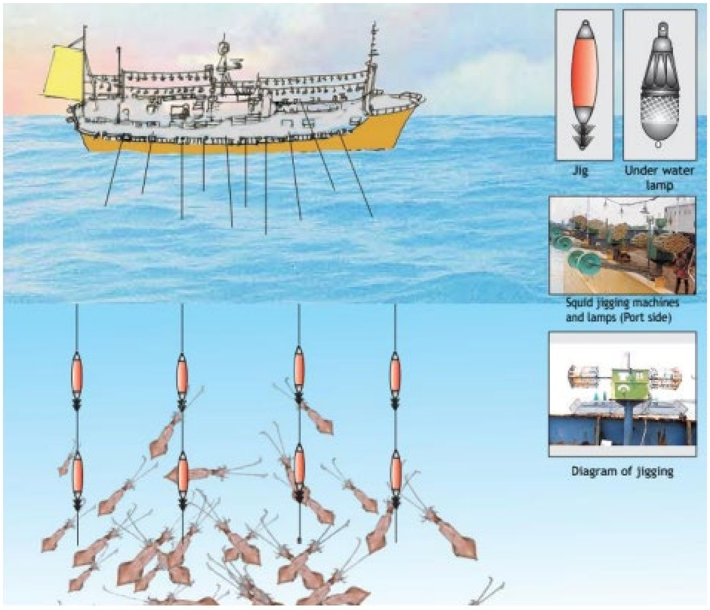
6. *DAHN LINE GEAR*

Dahn lines are a form of drop-line, vertically deployed between surface buoys and a seabed weight, with a bottom section rigged with hooked snoods to fish a specific depth range above the seabed. A vessel will usually deploy a number of Dahn lines in a specific area during a day's fishing, and the number of hooks reported per day over 2002 - 2006 averaged 864 (s.d. 469), with a maximum reported daily effort of 1,920 hooks. These drop line systems were initially implemented to target for hapuku/bass on flanks and summits of steeper seabed features, with the length (fished depth range) of the hooked section being adjusted to target bluenose swimming higher off the seabed.



7. JIGGING GEAR

Jigs can be deployed off the bow or on one side. It is kept steady in the water with the help of a sinker and float along with bridle using additional warp. Size of sea anchor depends on the size of boat. In large vessels, the structure may have 20-30 feet diameter. The vessels use array of incandescent lights to attract squids at night, and some may use underwater lights also. The light arrangement can be lowered and hauled slowly to concentrate schools near to surface. The manuals quid jigging is performed by hand-driven rollers which drops the jig. Later with mechanization, automated rollers used for lowering the jigs to about 30-140 m. The line is lowered to the desired depth by unwinding the reel. The machine makes jerking movements during retrieval of line facilitated by oval or elliptical shape of reel.



SUB-TASK 4.2 – APPROACHES FOR "*EXPLORATORY FISHERIES*" AND OPTIONS

1. EXISTING APPROACHES FOR "*EXPLORATORY FISHERIES*"

According to Caddell (2018), the first formal recognition of the need to regulate new and exploratory fisheries can be traced back to 1989, under the auspices of CCAMLR. The emerging CCAMLR policies influenced the elaboration of a specific provision addressing new and exploratory fisheries within the 1995 United Nations Fish Stocks Agreement (UNFSA), which was negotiated at a similar time. Moreover, the UNFSA inspired a varying degree of recognition of new and exploratory fisheries within the constituent treaties of RFMOs.

More recently, exploratory fisheries involving fishing gears that are likely to contact the seafloor during the normal course of fishing operations have received further attention by the UN General Assembly (UNGA) Resolution 61/105 on sustainable fisheries (UNGA, 2006). In paragraph 83, this Resolution calls upon RFMOs or arrangements (As) with the competence to regulate bottom fisheries, "*to identify VMEs and determine whether bottom fishing activities would cause significant adverse impacts to such ecosystems and the long-term sustainability of deep sea fish stocks, inter alia, by improving scientific research and data collection and sharing, and through new and exploratory fisheries*".

Later in 2009, the FAO adopted the International Guidelines for the Management of Deep-Sea Fisheries (DSF) in the High Seas (FAO, 2009), which were developed to assist States, RFMOs and As in the implementation of the various commitments established under paragraphs 76–95 of UNGA Resolution 61/105, which included provision for new and exploratory bottom fisheries. The FAO DSF Guidelines in paragraph 23 indicates that "*DSF should to be rigorously managed during all the stages of their development: experimental, exploratory and established*" (FAO, 2009).

In consequence, exploratory bottom fishing has been subject to an increased volume of regulation by RFMOs in the framework of UNGA Resolution and drawing upon the technical advice of the FAO. The process is exemplified by the practice of NAFO, NEAFC, SEAFO, NPFC, SPRFMO and CCAMLR, which, adopted regulations on bottom fishing, incorporating relevant elements from the UNGA resolution 61/105, and the FAO DSF Guidelines, including the adoption of an exploratory fishing protocol.

Table 1 summarizes the existing approaches for "*exploratory fisheries*", emphasizing their main elements. This information will be used as a base to bring options for establishing a framework for "*exploratory fisheries*" in relevant RFMOs and where, in accordance with international law as reflected in the UN Convention on the law of the Sea, the responsibility lies with the flag State (FAO Area 41).

Legal Framework

Individual RFMOs have adopted different approaches to address the particular conditions and circumstances through which new and exploratory fisheries are conducted under their regulatory purviews. In this aspect, CCAMLR is the most prominent regulator of exploratory fisheries, GFCM does not have a specific legal framework and NAFO and NEAFC have amended their exploratory fishery protocols several times.

Definition

The concept of a "new" or an *"exploratory"* fishery is not elaborated further within the United Nations Fish Stocks Agreement (UNFSA), and indeed its definition remains inconsistent across a range of regulatory bodies.

Process

In general terms, RFMOs follow similar specific procedures where they are expected to apply the precautionary approach in the hopes of anticipating, monitoring, preventing and mitigating potential threats. Members of RFMOs are required to provide information in accordance with guidelines and criteria to assess potential SAIs on VMEs. Before any exploratory fishing could be conducted, a plan and an assessment of any anticipated impacts must be submitted in advance for review. If the plan is approved, the exploratory fishing would be permitted and closely monitored, with all vessels involved in exploratory fisheries required to carry a scientific observer on board. On the contrary, for the time being, SIOFA has not clearly defined what an "Exploratory fishery" is, although there are a number of measures aiming to protect the ecosystem for potential impacts in existing and new fisheries. A draft was presented by the EU at the meeting of the parties in 2019 (MoP6-Prop08). The Meeting of the Parties Agreed to progress the work on the proposal to establish a Framework for New and Exploratory Fisheries in the SIOFA Area based in this document.

Preliminary assessment/bottom fishing impact assessment (BFIA)

As a general rule (e.g. NAFO, NEAFC, SEAFO, NPFC, etc.) contracting parties proposing to undertake exploratory bottom fishing activities shall submit a preliminary assessment and a notice of intent of the known and anticipated impacts on VMEs. The notice of intent should provide information on: the harvesting plan; the mitigation plan, the catch monitoring plan, the data collection plan, etc. On the other hand, however, GFCM has not adopted any preliminary assessment requirements.

Conservation and management measures to prevent SAIs

Most of the RFMOs (NAFO, NEAFC, SEAFO, NPFC, SPRFMO and CCAMLR) have implemented specific conservation and management measures to prevent Significant Adverse Impacts (SAIs) on VMEs. In the GFCM, no specific conservation and management measures applied to the exploratory fishing activities. Nevertheless, according the *2018 Encounter reporting protocol*[1], all encounters with VME indicator taxa shall be reported. Provisions in case of encounters with VME indicator species and threshold levels have been implemented in most RFMOs.

Exploratory fisheries monitoring

Monitoring of exploratory fishing activities through an observer on board is mandatory in most RFMOs. Moreover, some kind of exploratory fishery data collection protocol has been established to collect data on VME indicator species. In the case of GFCM, data should be collected according to the "Exploratory deep-sea bottom fishing protocol"[2], but the use of scientific observers to assist in data collection and reporting is "highly desirable" according to the "Data Collection Reference Framework".

[1] https://www.fao.org/gfcm/technical-meetings/detail/en/c/1142043/
[2] https://www.fao.org/3/ca4047en/ca4047en.pdf

Experience with exploratory fishery protocols

Before 2009 (when the FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas were adopted), several cooperative research activities were carried out in different RFMOs (e.g. Spanish experiences). In the Atlantic Ocean, there are few experiences using the protocols established following the FAO Guidelines. In NAFO only one exploratory fishing was conducted (2012). In NEAFC, no exploratory fishing using bottom fishing gears has been conducted since the first exploratory fishing protocol entered into force in 2009, although three "Notices of Intent" were submitted by the EU for crab exploratory fisheries (see an example in Supplementary information). They were not approved by NEAFC due to jurisdictional issues. No new proposals have been presented since that date. In SEAFO, there are some exploratory fisheries conducted by Japan. With respect to the Pacific Ocean, no exploratory fisheries were conducted in the NPFC Area, but there are several experiences in the SPRFMO Area. In the case of SIOFA, this RFMO is working into the definitions of protocols (not yet implemented). In the case of the Southern Ocean, CCAMLR have experience with exploratory fisheries (e.g. Exploratory fisheries targeting toothfish in Areas 48, 58 and 88).

Table 1. Existing approaches for *"exploratory fisheries"* in the RFMOs.

	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
	NAFO	**NEAFC**	**SEAFO**	**GFCM**	**NPFC**	**SPRFMO**	**SIOFA**	**CCAMLR**
Legal framework	• Exploratory fishery protocol since 2009 (NAFO CEM (2008). It has been amended several times to date, in order to refine some of its elements: • NAFO CEM (2021) Chapt. II, Art. 18 to 21 (Art. 24: review process, no later than 2022)	• Exploratory fishery protocol since 2009. • NEAFC Recommendation 19:2014. It has been amended several times to date, in order to refine some of its elements: • NEAFC Recommendation 10:2021, Art. 6 to 9 (Art. 10: review process every 5 years)	• SEAFO Convention, Art. 20 text states that contributions to new or exploratory fisheries should take into account article 6.6 of the 1995 UN Agreement. • SEAFO CM 30/15 Art. 2 and 4	There is not specific legal framework, except the adoption of REC.CM-GFCM/29/2005/1 forbidding the use of towed dredges and trawl nets at depths beyond 1000 m (up to 58% of the area), acting on UNGA Res 64/72.	Two Conservation Management Measures (CMMs): 2021-05 and 2019-06. CMMS includes (Annex 1) protocols for Exploratory Fisheries (EF).	Conservation and Management Measure for the Management of New and Exploratory Fisheries (CMM 13-2021). Articles 3 (1)(a) and 3(1)(b) of the Convention; UNGA Res. 61/105; 64/72; 71/123 and 72/72	• SIOFA Agreement signed in 2006. • First time addressing the term "Exploratory Fisheries" was in 2018. • Conservation Management Measures (CMM) was drafted in 2019	Adopted under Article 6 (6) of the 1995 UN Fish Stocks Agreement (UNFSA)
Definition	NAFO CEM (2021): *"Bottom fishing activities conducted outside the footprint or within the footprint with significant changes to the conduct or in the technology used in the fishery".*	NEAFC Recommendation 10:2021 *"All commercial bottom fishing within "restricted bottom fishing areas" or if there are significant changes to the conduct and technology of bottom fishing within "existing bottom fishing areas".*	SEAFO CM 30/15, Art. 2c: *"Those fisheries in which all commercial bottom fishing activities outside area closures and existing bottom fishing areas, or fisheries within existing bottom fishing areas when a new fishing method and/or strategy are attempted to be used".*	• GFCM WGVME (2017) *"Those activities conducted: i) on VME indicator features; ii) outside existing mapped bottom fishing areas, or iii) within existing bottom fishing areas when significant changes in the fishing patterns or in the technology used in the fishery occurred".* • GFCM WGVME (2017, 2018) *"Exploratory (or new) deep-sea bottom fishing" occurs during the initial development phase of a DSF when operates in areas that have not been previously fished or in fished areas following significant changes in the gear or effort"*	CMMs (Annex 1): All bottom fishing activities in new fishing areas and areas where fishing is prohibited in a precautionary manner or with bottom gear not previously used in the existing fishing areas	CMM 13-2021: EF is a fishery that has not been subject to fishing in the previous 10 years; not subject to fishing by a particular gear type/technique in the previous 10 years; undertaken in the previous 10 years pursuant to CMM, and decision has not yet been taken (paragraphs 25 and 26); kind listed in paragraph 15	CMM (UE, 2019): The term "new fishery" encompasses both "new" and "exploratory" fisheries. PAEWG in 2021 noted that new and exploratory fisheries are to be defined by the SC.	CM 21-02: Fishery that was previously classified as a 'new fishery' (defined in CM 21-01 as *"a fishery targeting a species where no information or catch and effort data has been submitted to the Commission) as there still remains insufficient information on the distribution, abundance and demography of the target species".*
Process	NAFO CEM (2021) Chapt. II: • Notice of intent • Preliminary Assessment • Evaluation, advice, management measures and authorization (or not) • Observer onboard • Monitoring • Results report • Circulation of documents and reports • Advice and decision on bottom fishing activity within the exploratory area	NEAFC Recommendation 10:2021 • Gather relevant data for the assessments. • Notice of intent • Preliminary Assessment, • Evaluation, advice, management measures and authorization (or not) • Observer onboard • Monitoring • Results report • Circulation of documents and reports • Advice and decision on bottom fishing activity within the exploratory area	SEAFO CM 30/15 • Gather relevant data for the assessments. • Notice of intent • Preliminary Assessment, • Evaluation, advice, management measures and authorization (or not) • Observer onboard • Monitoring • Results report • Circulation of documents and reports. • Advice and decision on bottom fishing activity within the exploratory area	"*Management elements for the establishment of an exploratory deep-sea bottom fishing protocol in the GFCM area of application*" (WGVME, 2017, 2018): • Geographical coverage: Mediterranean Sea (GSAs 01 to 28) • All fishing vessels above 15 m (LOA) operating with bottom contact gears are considered undertaking Exploratory (or new) deep-sea bottom fishing when operating: i) On VME Indicator Features ii) Outside of the existing bottom deep-sea fishing areas; iii) Inside of existing bottom fishing areas with bottom-contact fishing gears not previously used or when significant increases of	• Circulate information and the impact assessment to SC and Commission members for review. • Assessment conducted with care in the evaluation of risks of the SAI on VMEs (precautionary approach) • Permit only conduct the EF where assessment concludes that there are no SAIs on VMEs. Determinations available in the NPFC website.	CMM 13-2021: The process shall consider: Requirements for EF; Scientific Committee Considerations; Compliance and Technical Committee Considerations; Commission Considerations ; Specifications of the Fishing activity and Review of the Measure	No measures, only a draft presented in the MoP6 in 2019	There are two key stages: Notification Phase and Assessment Stage. Once approved, vessel(s) will have access to fish within the TAC limits set.

	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
	NAFO	NEAFC	SEAFO	GFCM	NPFC	SPRFMO	SIOFA	CCAMLR
				effort are planned or when a new fishery is developing. • Exploratory (or new) deep-sea bottom fishing requires to complete the "*Exploratory deep-sea bottom fishing protocol*", including: i) the start and end point of each tow or set; ii) the fishing characteristics of the vessel including the gear used; iii) the GSA area and the Statistical Grid where the exploratory deep-sea fishing occurred; iv) catch, bycatch, discards, and effort; v) VME Indicator Taxa (if any) through the *VME Encounter Protocol*. • Reporting to GFCM Secretariat. Upon notification by the vessel captain, as described above, relevant CPCs shall forward, within 30 days, the exploratory protocol form reported by the vessel captain, to the GFCM Secretariat, including by electronic means. • Review of the information gathered through the exploratory protocol. • The GFCM Secretariat shall compile the data received with the exploratory protocol and shall regularly inform the SAC. The SAC shall review this information.				
Preliminary assessment/ bottom fishing impact assessment (BFIA)	NAFO CEM (2021) Chapt. II: Art 19: Any Contracting Party proposing to participate in exploratory bottom fishing activities shall submit a preliminary assessment of the known and anticipated impacts on VMEs of the proposed bottom fishing activity: • Harvesting plan: Vessels, gears, areas, target and by catch species, effort, and duration. • Best available baseline information (ecosystems, habitats, communities).	Recommendation 10:2021, Art. 7: Each Contracting Party proposing to undertake exploratory bottom fishing shall submit, in addition to the Notice of Intent, a preliminary assessment of the known and anticipated impacts of the proposed bottom fishing: • Harvesting plan: Vessels, gears, areas, target and by catch species, effort, and duration. • Best available baseline information (resources ecosystems, habitats, communities).	SEAFO CM 30/15, Art. 7: Each Contracting Party proposing to undertake exploratory bottom fishing shall submit, in addition to the Notice of Intent, a preliminary assessment of the known and anticipated impacts of the proposed bottom fishing: • Harvesting plan: Vessels, gears, areas, target and by catch species, effort, and duration. • Best available baseline information (resources ecosystems, habitats, communities). • Identification, description and	No preliminary assessment required.	Members of the NPFC are required to provide the following information of each CMM before EF commences: Harvesting plan; Mitigation plan; Catch monitoring plan and Data collection plan	Updated BFIAS approved in October 2019 (7th meeting of the Scientific Committee). This BFIAS goes beyond the issue of VMEs. Assessments shall follow procedures outlined in CMM 03-2021. Content of BFIAS in line with FAO Guidelines. CPs shall submit: (i) description of fishing activities; (ii) mapping and description of fishing areas; (iii) risk and impact assessment framework.	CMM 2020/01:CCPs that have fished more than 40 days in a year. SC considers all BFIAs received and provides advice about impacts of bottom fishing activity. BFIAs shall: (i) follow FAO guidelines; (ii) meet the standards; (iii) take into account areas with VMEs; (iv) take into account relevant information provided in paragraphs 20, 18. 21 and 22; (v) be	Required under CM 22-6 (paragraph 7). The assessment must include info on the fishing activity, as well as mitigation measures to prevent impacts. Must be submitted to the SC and the Commission by 1 June prior to the season in which it intends to fish.

	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
	NAFO	**NEAFC**	**SEAFO**	**GFCM**	**NPFC**	**SPRFMO**	**SIOFA**	**CCAMLR**
	• Identification, description and mapping of VMEs; Identification, description and evaluation of likely impacts, including cumulative impacts. • Consideration of VME elements known to occur in the fishing area • Data and methods used to identify, describe and assess the impacts; data gaps; evaluation of uncertainties. • Risk assessment of likely impacts to determine which impacts on VMEs are likely to be significant adverse impacts. • Mitigation and management measures to be used to prevent significant adverse impacts on VMEs; Measures to be used to monitor effects.	• Identification, description and mapping of VMEs; Identification, description and evaluation of likely impacts, including cumulative impacts. • Data and methods used to identify, describe and assess the impacts; data gaps; evaluation of uncertainties. • Risk assessment of likely impacts to determine which impacts on VMEs are likely to be significant adverse impacts. • Mitigation and management measures to be used to prevent significant adverse impacts on VMEs; Measures to be used to monitor effects.	mapping of VMEs; Identification, description and evaluation of likely impacts, including cumulative impacts. • Data and methods used to identify, describe and assess the impacts; data gaps; evaluation of uncertainties. • Risk assessment of likely impacts to determine which impacts on VMEs are likely to be significant adverse impacts. • Mitigation and management measures to be used to prevent significant adverse impacts on VMEs; Measures to be used to monitor effects.			Appendix D identify exceptions in the content of BFIA.	updated; (vi)assess historical and cumulative impact and (vii) be made available on SIOFA website.	
Conservation and management measures to prevent SAIs	NAFO CEM (2021) Chapt. II: Art 20: Conservation and management measures to prevent significant adverse impacts. Art. 22: Provisions in case of *Encounter with VME indicator species* defined as catch per set (e.g. trawl tow, longline set, or gill net set) of more than 7 kg of sea pens and/or 60 kg of other live coral and/or 300 kg of sponges.	NEAFC Recommendation 10:2021 Art. 5: Exploratory bottom fishing is prohibited in area closures for protection of VMEs. Art. 6: Considered: (i) area and (ii) effort restrictions, (iii) include a mitigation plan; preference shall be given to (iv) the use methods with the least bottom contact, (v) in well-mapped areas and (vi) at times when impacts are likely to have the least adverse effects. Art. 8 and 9: *Encounter protocol* containing: (i) rules for encounters with possible VMEs; (ii) threshold levels (kg) for VME indicators (aggregated corals and aggregated sponges. Trawl tow, and other fishing gear than longlines: more than 30 kg of live coral and/or 400 kg of live sponge of VME indicators; Longline set: VME indicators on 10	SEAFO CM 30/15, Art. 6: Preference shall be given by the relevant Contracting Party to exploratory bottom fishing using fishing gear and methods with the least bottom contact, in well-mapped areas and at times when impacts are likely to have the least adverse impacts on organisms other than the target species. Art. 8: Provisions in case of *Encounter with VME indicator species*. Annex 6: Definition of encounter and threshold levels. Trawl tow – more than 600 kg of live sponges and/or 60 kg of live coral in existing fishing areas and more than 400 kg of live sponges and/or 60 kg of live coral in new fishing areas; Longline set – at least 10 VME-indicator units (1 unit = 1kg or 1 litre of live coral and/or live sponge) in one 1200m section of line or 1000	No specific conservation and management measures applied to the exploratory fishing activities. Nevertheless, according the *2018 Encounter reporting protocol*, all encounter with VME indicator taxa shall be reported	Implementation of the precautionary approach shall include: Precautionary effort limits; precautionary limits; regular review of indices of stock status; measures to prevent SAIs on VMEs and; monitoring of all fishing effort, capture of all species and interactions with VMEs.	• Use of large scale pelagic driftnets and all deepwater gillnets (CMM-08-2019) has been prohibited. • Seabird mitigation measures (CMM-09-2017). • *Encounter protocol and move on rule for VME indicator taxa in bottom fisheries* (CMM-03-2021) • Specific management measures indicated in the correspondent CMM	CMM 2020/01: Interim Protected Area Designation with 5 areas. Threshold levels for encounters with VMEs by gear type and the extension of the fishing ban when exceeded.	Commission will adopt conservation measures taking into account the SC advice and recommendations: (i) allow/prohibit or restrict bottom fishing activities; (ii) require mitigation measures; (iii) allow/prohibit or restrict bottom fishing with certa gear types and (iv) other restrictions to prevent SAIs to VMEs

	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
	NAFO	**NEAFC**	**SEAFO**	**GFCM**	**NPFC**	**SPRFMO**	**SIOFA**	**CCAMLR**
		hooks per caught per 1000 hook segment or per 1200 m section of long line, whichever is the shorter); (iii) associated move-on rules by gear type, as well as procedures for (iv) reporting the encounter and (v) implementing temporary area closures.	hooks, whichever is the shorter, in both existing and new fishing areas; Pot set – at least 10 VME-indicator units (1 unit = 1kg or 1 litre of live coral and/or live sponge) in one 1200m section of line in both existing and new fishing areas.					
Exploratory fisheries monitoring	NAFO CEM (2021) Chapt. II: Contracting Parties whose vessels wish to engage in exploratory bottom fishing activities shall require that an observer with sufficient scientific expertise be deployed who shall: (a) identify corals, sponges and other organisms to the lowest possible taxonomical level, using the NAFO "*Exploratory Fishery Data Collection Form*"; and (b) deliver the results of such identification to the master of the vessel to facilitate quantification.	NEAFC Recommendation 10:2021 Monitoring of fishing is mandatory. Art. 6: Scientific observer on board according the NEAFC "*VME Data Collection Protocol*", catch recording and reporting system, gear monitoring (if practicable) and data collection from mapping programmes. Report of the results. Art. 8: quantify catch of VME indicators.	SEAFO CM 30/15, Art. 6: Contracting Party shall ensure that vessels flying their flag conducting exploratory fishing have a scientific observer on board. Observers shall collect data in accordance with the SEAFO "*VME Data Collection Protocol*"	Data should be collected according to the "*Exploratory deep-sea bottom fishing protocol*" above mentioned. Additionally, the use of scientific observers to assist in data collection and reporting is highly desirable according to the "*Data Collection Reference Framework*" (GFCM, 2018).	• All vessels conducting EF must be equipped with satellite monitoring device and have an observer onboard (100% coverage). • All species landed must be identified and recorded to the lowest taxonomic level. Detection of fishing in association with VMEs • Data collection plan • SC must develop: Guideline; species list and ID guide for benthic species. Provide them to all observers on vessels.	• CMM-13-2021: Data Collection Plan is crucial and mandatory. Vessels must have one or more independent observer to collect data. Data from Data Collection Plan must be submitted to the Commission. • CMMs 14a-2019; 14b-2021; 14d-2020; 14e-2021: Specific data collection requirements • CMM-02-2021: Data Standards • CMM 06-2020: (Commissions VMS) • CMM-03-2021 (Bottom fishing)	• CMM 2020/01: Scientific observer coverage (100% coverage for trawl gear and 20% for other bottom fishing gears) • CMM 2020/15 (demersal stocks): 100% observer coverage for toothfish in the DelCano and Wiliams ridge areas.	• CM 21-02 (paragraph 13). Scientific observers: collect data (Data Collection Plan), assist in collecting biological and other relevant data and annually submit data to CCAMLR. • CM 22-06 (paragraph 13). Members: submit data on VME in the Convention Area. • CM 10-04 (paragraph 11). Longline fisheries: each CP shall forward VMS reports to Secretariat. • CM 21-02. Fishing vessels shall report cach and effort data according to CM 23-04 and biological data according to CM 23-05.
Experience with exploratory fishery protocols	• Before the entry into force of the NAFO 2009 Protocol, several cooperative research activities were carried out (e.g. Spain, using the IEO exploratory fishing protocol that included mandatory monitoring through scientific observers on board). • In July 2012, under the 2009 protocol, an experimental fishery was conducted by EU-Spain on board a trawler in Corner Rise Smts. (NAFO Division 6G). • No more exploratory fisheries were invoked since then.	• Before the entry into force of the NEAFC 2009 Protocol, several cooperative research activities were undertaken by EU-Spain, using the IEO exploratory fishing protocol that included monitoring (mandatory) through scientific observers on board. • No exploratory fishing using bottom fishing gears has been conducted since the first exploratory fishing protocol entered into force in 2009. • In 2015, three "Notices of Intent" were submitted by the EU for crab exploratory fisheries under the specifications of the	• There is only Japan's notice of intent for exploratory fishing targeting Patagonian toothfish and they present them almost every year from 2012. Japan presented results for the 2014 exploratory fishing conducted on the Discovery Tablemount seamount in Sub-Area D in the SC meeting in 2015. The SC agreed that the experiments (2012-2014) fulfilled the requirements of the rules & procedures of CM 29/14 for opening new fishing areas therefore advises that the Commission consider converting an specific area into an existing fishing area, and amends CM 29/14	An *Exploratory deep-sea bottom fishing reporting protocol* was agreed in WGVME 2017 and reviewed in 2018.	No exploratory fisheries since it was established in 2015.	• New Zealand: exploratory bottom longlining for Toothfish in the mid-Pacific (CMM 14a-2019) • Cook Islands: Exploratory Potting Fishery (CMM 14b-2021) • Chilean-Flagged Vessels: Exploratory Fishing for toothfish (CMM 14d-2020) • European Union: Exploratory Fishing for Toothfish (CMM 14e-2021) • In year 2018, SC developed a summary table to assess exploratory fishing applications.	Working into the definitions of protocols. Not yet implemented.	Seven

	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
	NAFO	NEAFC	SEAFO	GFCM	NPFC	SPRFMO	SIOFA	CCAMLR
		Recommendation 09:2014 amended (see Supplementary information). They were not approved by NEAFC due to the opposition from Norway and Russia (jurisdictional issues). No new proposals have been presented since that date.	accordingly. The Japanese proposal for 2019 is to continue the exploratory activity in the same geographical area.					

References

Caddell, R. (2018). 'Precautionary Management and the Development of Future Fishing Opportunities: The International Regulation of New and Exploratory Fisheries'. *The International Journal of Marine and Coastal Law. 33(1).* pp. 199–260. doi:10.1163/15718085-13310013.

FAO (2009) International guidelines for the management of deep-sea fisheries in the high seas. Rome: Food and Agriculture Organization of the United Nations, 73 pp.

UNGA (2006) *Resolution adopted by the General Assembly. 61/105. Sustainable fisheries, including through the 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, and related instruments. Ref.: A/Res/61/105*. United Nations, New York, 2006.

Strengths and weaknesses identified on the exploratory fishery protocols

A review of strengths and weaknesses concerning the exploratory fisheries approaches in the different RFMOs (and FAO Area 41) was done. The following text contains a summary of strengths and weaknesses that were identified:

Strengths:

In general terms, there are well defined protocols to assess the exploratory fishery proposals in line with the precautionary approach. In this regard, some RFMOs as **NAFO** can be considered as a front-runner in introducing measures to regulate and monitor bottom fisheries. Some other RFMOs such as NEAFC and the **SEAFO** have adopted the VME encounter protocols and thresholds introduced by NAFO. Moreover, NAFO achieved great progress in adopting various measures to decrease by-catch through gear modifications and put in place observer codes for VME indicator species to facilitate the reporting of encounters. All exploratory fisheries in NAFO require prior approval and are conducted under strict controls, which is crucial to make a good assessment of the possible impacts and for the development of appropriate management measures. Furthermore, NAFO has a working group of fishery managers and scientists on VMEs that was created to examine scientific advice and evaluate risks.

In the case of **NEAFC**, mandatory preliminary impact assessment is required before exploratory fisheries can commence. Moreover, PECMAS and ICES (if required) provide scientific advice to the Commission as to whether the proposed exploratory bottom fishing should be approved, or on the mitigation measures needed. For this RFMO, it is mandatory to have scientific observers on board that conduct the monitoring of the exploratory bottom fishing and collect key information. **CCAMLR** has also implemented the presence of scientific observers on-board all exploratory fisheries to undertake data collection plans and has a Scientific Committee to review and advise the Commission on appropriate fishery management and approval of Member applications. Since 2003, 100% observer coverage across all toothfish vessels is mandatory.

Several strengths of the exploratory fishing process have been identified in **SPRFMO**, as it has a "*checklist for assessment of exploratory fisheries proposals"* that is a useful tool that guarantees an efficient scientific assessment and advice where all proposals for new exploratory fisheries available publicly. Moreover, new/exploratory fishery within this area can only commence if cautious preliminary conservation and management measures have been adopted and decisions shall be based on the best scientific and technical information available. In addition, fishing Operation Plans requires information on "*the anticipated cumulative impact of all fishing activity in the area of the exploratory fishery if applicable*". Even there is always room for improvement, this process provides an excellent framework for the development of proposals for new and exploratory fisheries.

Weaknesses:

Some RFMOs, such as **GFCM**, do not have specific conservation and management measures applied to the exploratory fishing activities to prevent significant adverse impacts (e.g. Exploratory Fishery Protocol adopted by NAFO and NEAFC). A different case concerns that of those areas with absence of an RFMO (e.g. **Southwest Atlantic**), where the unilateral fishery protocols adopted by a particular flag State are not effective as they apply only to vessels of that particular flag. In addition, **SIOFA** is still working to create protocols with respect to exploratory/new and research fishing and there is a lack of definition between "*Exploratory*", "*New*" and "*Research*" fishing. Draft Conservation Measures still need to be further discussed among SIOFA members.

Other RFMOs, such as **NPFC** have Interim Measures that are voluntary and there is no penalty for violations. Absence of Technical Guidelines and no specific reporting requirements during and after the proposed exploratory fisheries, together with the lack of detail in the procedures to evaluate impacts on VME based on post-fishing reports is considered as a big weakness to be taken into account.

In **NEAFC**, with the exception of vessels carrying out exploratory fishing in new bottom fishing areas, vessels in the remainder of the Regulatory Area are under no obligation to carry observers.

Other particular weakness concerning the exploratory fisheries is that **SPRFMO** does not specify that a proposal for exploratory fishery should be rejected if there is a shortage of information and as in other RFMOs, impact assessments are only required for proposed bottom fisheries. Additionally, some authors consider that the adopted thresholds levels, the incomplete list of VME indicators, the procedures for scientific assessment of the encounters and the provision of advice on encounters, are matters of concern in SPRFMO.

SEAFO has a well-defined protocol to assess exploratory fishery proposals, with detailed information about how to present the preliminary assessments and notices of intent to undertake exploratory fishing, with a defined deadline. Therefore, no relevant weaknesses were identified in this aspect.

CCAMLR, in its second performance review in 2017, recommended better coordinating research activities among Members. In order to promote and ensure that the data collected and analysed are suitable to provide the best advice to the Commission, research should be coordinated across multiple management areas rather than fragmented within each management area.

2. LESSONS LEARNED FROM THE RFMOs: RECOMMENDATIONS ON POTENTIAL ELEMENTS NEEDED FOR DEVELOPING A FRAMEWORK FOR EXPLORATORY FISHERIES

Taking into account the diversity of approaches in the RFMOs (and FAO Area 41) regarding the particular conditions and circumstances through which new and exploratory fisheries are conducted, as well as their weaknesses and strengths, a number of recommendations on potential elements needed for developing a framework for exploratory fisheries have been identified:

- Carry out robust environmental assessments to avoid that an initially small exploratory fishery, approved with minimal environmental assessment, could quickly expand, increasing the potential for significant adverse impacts. These assessments are a core tool for ensuring precaution in the development of new fishing activities.

- Expand the impact assessments to all fishing activities and other elements of the marine ecosystems.

- An Integrated approach to environmental assessments is needed to address global conservation concerns and to contribute to the development of regional cooperation, coordination and capacities. Enhanced cooperation includes improved access to information, better alignment of conservation objectives, more participatory decision-making, and improved integration of biodiversity considerations and cumulative impacts.

- Continue to support the undertaking and completion of exploratory fisheries using precautionary conservation and management measures until there is sufficient data to allow the assessment of the impact of the fisheries on the long-term sustainability of the stocks and on VMEs.

- Enhanced cooperation between RFMOs (e.g. NAFO and NEAFC) based on the fact that some species of fish are so wide-ranging that they are found in the regulatory areas of more than one RFMO and the fact that modern-day fishing fleets are highly mobile and may well target similar stocks in adjacent regions almost simultaneously.

- In certain RFMOs, such as SEAFO, there does not seem to be much interest from countries in submitting exploratory fishing proposals. In such cases, it is recommended to analyze the reasons why this is happening, whether it is due to scarce fish stocks, over-legislation, too many restrictions on commercial fishing, or others.

- Update protocols in those RFMOs, such as GFCM or NPFC, where they are still in a very preliminary stage or need to develop detailed technical guidelines for preparation and submission of notifications of exploratory fisheries that qualify the information required. Development of Guidelines about the methodology of the assessment could help contracting parties to prepare the assessments in a more standardized way. This should be done according to the requirements of FAO DSF Guidelines, and taking advantage of the experience with exploratory fishery protocols and impact assessments in other more advanced RFMOs (e.g. NEAFC).

- Furthermore, in the absence of a RFMO, as occurs in the High Seas of SW Atlantic, all States fishing in the area should implement appropriate protocols for exploratory fisheries and impact assessments (including mandatory observer programmes and *ad hoc* mitigation and management measures), based on FAO

DSF Guidelines and considering the progress in the RFMOs and their scientific bodies.

- Update and review periodically the list of VME taxa and their threshold levels of as necessary when better information on the taxa become available, so that taxa can be assessed against more VME criteria. Updating this list must help to prevent significant damage to all VMEs impacted by bottom fishing and will ensure that the encounter protocol designed to be established when a VME is like to be encountered is including all VME taxa.

Baseline information on approaches for "*exploratory fisheries*"

For each RFMO/Fishing area, information on the following topics was compiled:

a. Legal framework and implications.

b. Definition/meaning of the concept "*exploratory fisheries*".

c. Description of the "*exploratory fisheries*" process and steps.

d. Existence of a preliminary assessment, or bottom fishing impact assessment (BFIA): description of the content.

e. Review of conservation and management measures to prevent SAIs.

f. Exploratory fisheries monitoring.

g. Experience with exploratory fishery protocols.

h. Strengths and weaknesses of the exploratory fishery protocols

i. Recommendations.

j. Other issues that could be useful for providing options for a framework for "*exploratory fisheries*".

- References

CONTENTS

NORTHWEST ATLANTIC FISHERIES ORGANIZATION (NAFO)

Partner short name: IEO

a. Legal framework and implications

Deep-sea bottom fisheries, just like some other human activities carried out in the high seas (e.g. hydrocarbon exploration and exploitation, seafloor mining, etc.) may produce disturbance and potential significant adverse impacts (SAI) on cold-water corals and deep-sea sponges, being a matter of concern (NAFO, 2016) for the regional fisheries management organisations (RFMOs). Since 2006, several United Nations General Assembly (UNGA) Resolutions on sustainable fisheries (UNGA, 2006; 2009; 2012) have called states to adopt urgent measures, either through RFMOs or by themselves, in order to protect VMEs in areas beyond national jurisdictions (ABJN), with special reference to preserve cold-water corals and deep-sea sponges. According to the United Nations Food and Agriculture Organisation (FAO) International Guidelines for Management of Deep-sea Fisheries on the High Seas (FAO, 2009), the most vulnerable ecosystems are those that can be easily disturbed and which either recover very slowly or never recover at all. Both, cold-water corals and deep-sea sponges were considered by the FAO as examples of VMEs indicator species. Moreover, the Guidelines provide tools and guidance to the sustainable use of marine living resources and the prevention of SAI on VMEs.

From 1 January 2009, all NAFO bottom fishing activities in new fishing areas or with bottom gear not previously used in the area concerned, shall be considered as exploratory fisheries and shall be conducted in accordance with the exploratory fisheries protocol that was adopted by the Fisheries Commission in 2008 (NAF0, 2008)

According to this protocol, before any exploratory fishing could be conducted, a plan and an assessment of any anticipated impacts must be submitted advance to NAFO for review. If the plan is approved, the exploratory fishing would be permitted for two years, during which it would be closely monitored, with all vessels involved in exploratory fisheries required to carry a scientific observer. A further review would then be conducted, and a decision taken as
to the future of the exploratory fishery. This protocol was rolled over from 2009–2011, but with more details in the annexes on the information required in the plan and for recording information, including an Exploratory Fishery Data Collection form added in 2010.

In 2012, this protocol was reviewed by the Fisheries Commission Working Group of Fishery Managers and Scientists on Vulnerable Marine Ecosystems (WGFMS-VME), particularly the provisions in Chapter II (Articles 18.2 and Annex I.E Part IV of the NCEM) due to some ambiguities with regards to requirements for Contracting Parties and their vessels intending to engage in exploratory fisheries (NAFO, 2012a). It was not clear whether exploratory fisheries could proceed without prior assessment by the Scientific Council (SC) and the Fisheries Commission (FC).

The WG noted that the intention of the Chapter II provisions is the requirement of prior assessment. In this regard relevant articles and some definition of terms were revised. It was agreed that these will be forwarded to FC with a recommendation for adoption. The clarified process, from the application of Contracting Party (CP) to engage in exploratory fisheries to the submission of the exploratory fishing report, and their assessment by FC and SC, is illustrated in Figure 1.

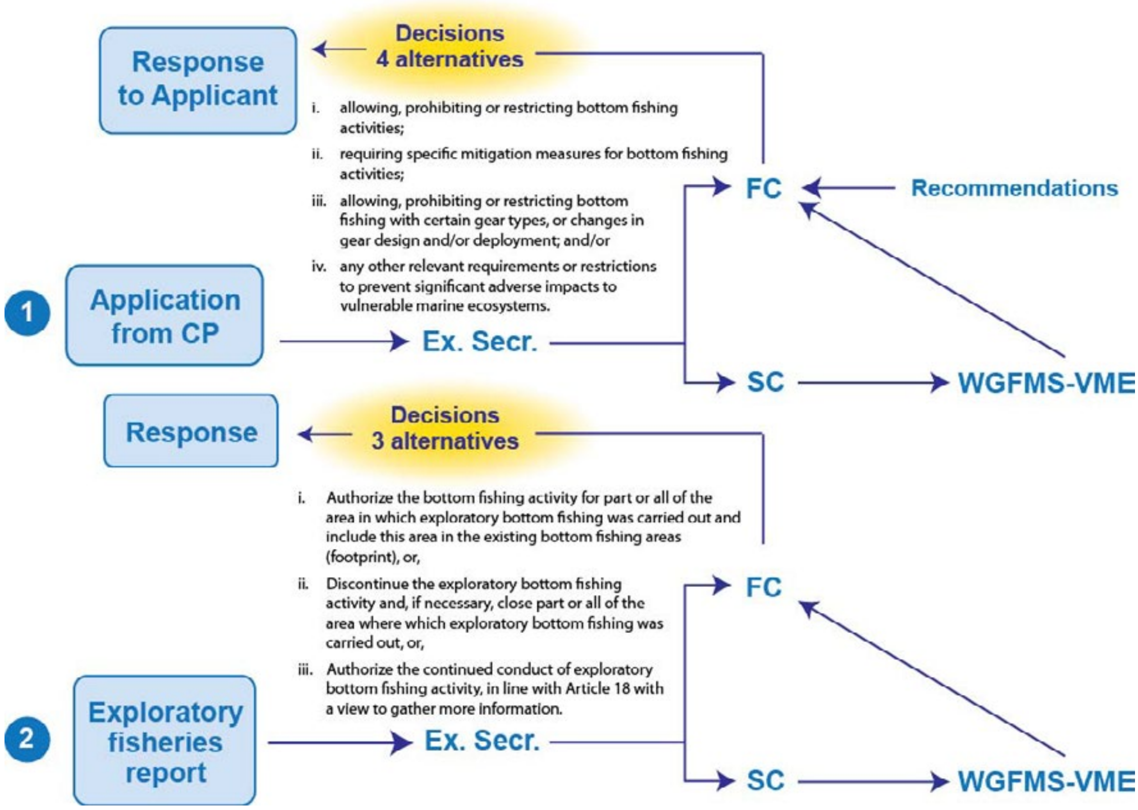


Figure 1. Flowchart describing the Exploratory Fisheries process. Source: NAFO (2012a)

Management measures for the Exploratory Bottom Fishing Activities are currently outlined in Chapter II, Articles 18 to 21 of NAFO (2021). It includes:

a) allowing, prohibiting or restricting bottom fishing activities;

b) requiring specific mitigation measures for bottom fishing activities;

c) allowing, prohibiting or restricting bottom fishing with certain gear types, or changes in gear design and/or deployment; and

d) any other relevant requirements or restrictions to prevent significant adverse impacts to vulnerable marine ecosystems.

According to Article 24 in Chapter II (NAFO, 2021) the provisions of this Chapter shall be reviewed by the Commission at its Annual Meeting no later than 2022. This review was discussed at the WG-EAFFM meeting in July 2021.

b. Definition/meaning of the concept "*exploratory fisheries*"

According to NAFO (2021), "*Exploratory bottom fishing activities*" means bottom fishing activities conducted outside the footprint[3], or within the footprint with significant changes to the conduct or in the technology used in the fishery.

[3] "Footprint", otherwise known as "Existing bottom fishing areas", means that portion of the Regulatory Area where bottom fishing has historically occurred (NAFO, 2021)

c. Description of the "*exploratory fisheries*" process and steps

Exploratory bottom fishing within the NAFO Regulatory Area shall follow the procedures outlined in Chapter II of NAFO (2021):

Article 18- Exploratory Bottom Fishing Activities

1. Exploratory bottom fishing activities shall be subject to a prior exploration conducted in accordance with the exploratory protocol set out in Annex I.E (see details below).

2. Contracting Parties whose vessels wish to engage in exploratory bottom fishing activities shall, for the purpose of the evaluation referred to in Article 20:

   (a) communicate to the Executive Secretary the "*Notice of Intent to Undertake Exploratory Bottom Fishing*" in accordance with Annex I.E together with the assessment required under Article 19.1;

   (b) require vessels entitled to fly their flag to start exploratory bottom fishing activities only after they have been authorized in accordance with Article 20;

   (c) have an observer with sufficient scientific expertise on board for the duration of the exploratory bottom fishing activity; and

   (d) provide to the Executive Secretary an "*Exploratory Bottom Fishing Trip Report*" in accordance with Annex I.E. within 3 months of the completion of the exploratory bottom fishing activities.

3. The Executive Secretary shall:

   (a) promptly forward the documents referred to in paragraph 2(a) of this Article to the Scientific Council and to the Commission; and

   (b) circulate the "*Exploratory Bottom Fishing Trip Reports*" to the Scientific Council and to all Contracting Parties.

Annex I.E Templates for the Conduct of Exploratory Bottom Fishing Activities

1. Notice of Intent to Undertake Exploratory Bottom Fishing

The Exploratory Protocol shall consist of:

- A harvesting plan which outlines target species, dates and areas. Area and effort restrictions should be considered to ensure fisheries occur on a gradual basis in a limited geographical area.

- A mitigation plan including measures to prevent significant adverse impact to vulnerable marine ecosystems that may be encountered during the fishery.

- A catch monitoring plan that includes recording/reporting of all species caught, 100% satellite tracking and 100% observer coverage. The recording/reporting of catch should be sufficiently detailed to conduct an assessment of activity, if required.

- A data collection plan to facilitate the identification of vulnerable marine ecosystems/species in area fished.

2. Exploratory Fishing Trip Report

This Report must include, *inter alia*, information regarding: name of the vessel; flag state; anticipated location(s) of exploratory fishing activities (include lat/long); anticipated dates; information on any previous fishing undertaken in adjacent areas; depths expected; habitat maps of the area; availability of taxonomic keys identifying potentially vulnerable species; vulnerable marine ecosystems (VMEs); mitigation measures to prevent significant adverse impact to VMEs, if encountered; existence of bathymetric maps; existence of fisheries scientific information; target species; gear type(s) to be used in what areas.

3. Exploratory Fishery Data Collection Form

This Form must include: fishing information trip (e.g. flag state, vessel name, etc.); gear and fishing information (e.g. trawl, gill net, hook and line, gear size, etc) and catch information (e.g. live corals/sponges total weight in the haul, etc).

Article 19 – Preliminary Assessment of Proposed Exploratory Bottom Fishing Activities (see details in "section d")

Article 20- Management of Exploratory Exploratory Bottom Fishing Activities (see details in "section e")

Article 21 – Evaluation of Exploratory Bottom Fishing Activities

1. The Commission will request the Scientific Council to:

   (a) evaluate the exploratory bottom fishing activities at its meeting immediately following the reception of the "*Exploratory Bottom Fishing Trip Report*" circulated in accordance with Article 18.2; and

   (b) in line with the precautionary approach, provide advice to the Commission on the decision to be taken in accordance with Article 21.3, taking account the risks of significant adverse impacts on VMEs.

2. The Joint Commission-Scientific Council Working Group on Ecosystem Approach Framework to Fisheries Management shall examine the advice of the Scientific Council delivered in accordance with Article 21.1 and shall make recommendations to the Commission in accordance with its mandate.

3. The Commission shall, taking account of advice and recommendations provided by the Scientific Council and the Joint Commission-Scientific Council Working Group on Ecosystem Approach Framework to Fisheries Management either to:

   (a) authorize the bottom fishing activity for part or all of the area in which exploratory bottom fishing was carried out and include this area in the footprint, or

   (b) discontinue the exploratory bottom fishing activity and, if necessary, close part or all of the area where which exploratory bottom fishing was carried out, or

   (c) authorize the continued conduct of exploratory bottom fishing activity, in line with Article 18 with a view to gather more information.

d. Existence of a preliminary assessment, or bottom fishing impact assessment (BFIA): description of the content

Article 19 of NAFO (2021) includes a Preliminary Assessment of Proposed Exploratory Bottom Fishing Activities. According to this:

1. Any Contracting Party proposing to participate in exploratory bottom fishing activities shall submit, in support of their proposal, a preliminary assessment of the known and anticipated impacts of the bottom fishing activity, which will be exercised by the vessels entitled to fly its flag, on VMEs.

2. The preliminary assessment referred to in paragraph 1 of this Article shall:

   (a) be sent to the Executive Secretary no less than two weeks in advance of the opening of the June meeting of the Scientific Council;

   (b) be in accordance with guidance developed by the Scientific Council, or, in the absence of such guidance, to the best ability of the Contracting Party; and

   (c) address the elements in accordance with Annex I.E (see below).

3. The Commission will request the Scientific Council to:

   (a) undertake an analysis of the preliminary assessment submitted in accordance with Article 19.1 at its meeting immediately following the submission by the Contracting Parties, according to procedures and standards it develops, and taking into account the risks of significant adverse impacts on VMEs;

   (b) consider any available additional information, including information from other fisheries in the region or similar fisheries elsewhere; and

   (c) in line with the precautionary approach, provide advice to the Commission on possible adverse impacts on VMEs and on the mitigation measures to prevent them.

4. The Joint Commission-Scientific Council Working Group on Ecosystem Approach Framework to Fisheries Management shall:

   (a) examine the advice of the Scientific Council delivered in accordance with Article 19.3; and

   (b) make recommendations to the Commission in accordance with its mandate.

Annex I.E. Assessment of Bottom Fishing Activities

Assessments should consider the best available scientific and technical information on the current state of fishery resources.

Assessments should address, *inter alia*:

1. Type(s) of fishing conducted or contemplated, including vessels and gear types, fishing areas, target and potential bycatch species, fishing effort levels and duration of fishing (harvesting plan);

2. Existing baseline information on the ecosystems, habitats and communities in the
fishing area, against which future changes are to be compared;

3. Identification, description and mapping of VMEs known or likely to occur in the fishing area;

4. Identification, description and evaluation of the occurrence, scale and duration of likely impacts, including cumulative impacts of activities covered by the assessment on VMEs;

5. Consideration of VME elements known to occur in the fishing area;

6. Data and methods used to identify, describe and assess the impacts of the activity, the identification of gaps in knowledge, and an evaluation of uncertainties in the information presented in the assessment;

7. Risk assessment of likely impacts by the fishing operations to determine which impacts on VMEs are likely to be significant adverse impacts; and

8. The proposed mitigation and management measures to be used to prevent significant adverse impacts on VMEs, and the measures to be used to monitor effects of the fishing operations.

e. Review of conservation and management measures to prevent significant adverse impacts

Article 20 of NAFO (2021) includes a set of conservation and management measures to prevent significant adverse impacts of the exploratory fishing activities:

1. The Commission shall adopt conservation and management measures to prevent significant adverse impacts of the exploratory fishing activities on VMEs, taking account of advice and recommendations provided by the Scientific Council and the Joint Commission-Scientific Council Working Group on Ecosystem Approach Framework to Fisheries Management, including data and information arising from reports pursuant to Article 22. These measures may include:

    (a) allowing, prohibiting or restricting bottom fishing activities;

    (b) requiring specific mitigation measures for bottom fishing activities;

    (c) allowing, prohibiting or restricting bottom fishing with certain gear types, or changes in gear design and/or deployment; and

    (d) any other relevant requirements or restrictions to prevent significant adverse impacts to vulnerable marine ecosystems.

Article 22 of NAFO (2021) describes the Provisions in Case of Encounter with VME indicator species defined as catch per set (e.g. trawl tow, longline set, or gill net set) of more than 7 kg of sea pens and/or 60 kg of other live coral and/or 300 kg of sponges.

In this regard, it is necessary to take into consideration the following issues:

Duties of the Master such as reporting quantity of VME indicator species, position, cease fishing and move away at least 2 nm from the endpoint of the tow/set in the direction least likely to result in further encounters.

Duties of the observer such as identification of the corals, sponges or other organisms to the lowest possible taxonomical level and delivers the results of such identification to the master of the vessel.

Duties of the Contracting Party such as forward the encounter information to the Executive Secretary, issue an alert to all fishing vessels entitled to fly its flag, consider temporarily closing a 2-mile radius around reported VME encounter locations and reopen them upon notification from the Executive Secretary.

Duties of the Executive Secretary such as archiving of incident information reported by masters, reporting relevant information, etc.

Duties of the Scientific Council such as analyzing the information received from the Executive Secretary, examining temporary closures, providing advice to the Commission on whether a VME exists following encounters with VME indicator species on a case-by-case basis and on the appropriateness of the temporary closures or other measures, etc.

Duties of the Commission such as considering the advice provided by the Scientific Council and adopt conservation and management measures.

f. Exploratory fisheries monitoring

Contracting Parties whose vessels wish to engage in exploratory bottom fishing activities shall require that an observer with sufficient scientific expertise be deployed in accordance with Article 18.2 (c) of NAFO (2021), (see "section c") for the areas outside the footprint who shall: (a) identify corals, sponges and other organisms to the lowest possible taxonomical level, using the "*Exploratory Fishery Data Collection Form*" in accordance with Annex I.E (NAFO, 2021); and (b) deliver the results of such identification to the master of the vessel to facilitate quantification.

The "*Exploratory Fishery Data Collection Form*" includes four sections that must be completed with the following information:

a) Fishing trip information such as flag state, vessel name, call sign and date of encounter.

b) Gear and Fishing information such as fishing gear, gear details (e.g. type, size), tow or set start and end, start latitude/longitude and end latitude/longitude, start and end depth.

c) Catch information: Live corals and sponges total weight in the haul (kg); Organisms identified to the lowest taxonomic unit as possible[4] (including fish and invertebrates); Biological Samples Taken; Biological Samples of Vulnerable Indicator Species Taken; Total weight (kg) in catch, etc.

d) Comments about the exploratory fishery activities.

[4] Refer to Annex I of the *FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas*. Also, use *NAFO Coral and Sponge Identification Guides as appropriate* (Kenchington *et al.*, 2015)

g. Experience with exploratory fishery protocols

Before the entry into force of the Exploratory Fishery Protocol in 2009, several cooperative research activities were carried out on board commercial Spanish vessels.

On this regard, a research activity was conducted in NAFO Subarea 1 from October to December, 2003 (Del Río *et al*., 2004) to search for cephalopods species concentrations inside the territorial waters of Greenland, according to the Fourth Fisheries Protocol between the European Community and the Government of Denmark with the Local Government of Greenland (COM, 2002). During the research activity a scientific observer stayed on board the bottom trawler C/V *Iván Nores* to collect effort data, catches and yields by haul and Division, strata and gear. Additionally, from July to December, 2004, another research activity was carried out in the same area with three Spanish commercial bottom trawlers (C/V *Villa de Hío*, C/V *Farruco* and C/V *Villa Nores*) and targeting cephalopods species concentrations inside the territorial waters of Greenland (Del Río *et al*., 2005). In both research activities Greenland halibut was the main species caught and the cephalopods, target species, were not found in the experimental fishing.

Moreover, in year 2004, before the NAFO closure enforcement to all fishing activities involving demersal fishing gears (NAFO, 2006) in several seamounts located in North-west Atlantic, including New England and Corner Rise Seamounts, an Experimental Trawl Survey was carried out in fishing grounds (NAFO Regulatory Area: Div. 6EFGH and 4XWVs) considered non-habitual for the NW Atlantic Spanish fleet. A scientific observer was on board to collect the information on fishing activity (effort, depth, etc.) and biological data (length distributions, length-weight relationships, etc.). Samplings were conducted in a wide geographical and bathymetrical range. During the survey, Alfonsino (*Beryx splendens*) was the main caught species. This kind of cooperative surveys (Durán Muñoz and Román, 2000) are research initiatives carried out in collaboration with the fishing industry, with the aim to obtain data on distribution and biology of fisheries resources and to study the interactions between commercial fishing, gears and habitats (Durán Muñoz *et al*., 2007). Results from this survey were presented to the 2005 NAFO Scientific Council Meeting (Durán Muñoz *et al*,. 2005) focused on fish resources and including brief results on benthic invertebrate by-catch, contributing to improve the knowledge on the effects of fishing in the seamounts within NAFO regulatory Area. Additionally, in May 2008, Murillo *et al*., (2008) presented during the Scientific Council Working Group on the Ecosystem Approach to Fisheries Management (currently renamed as NAFO Scientific Council Working Group on Ecosystem Science and Assessment), detailed information on By-catch of cold-water corals from the Experimental Trawl Survey in three seamounts within NAFO Regulatory Area (Divs. 6EFG) during year 2004. The results indicated that the impact of trawling on seamounts could be important and that the closed area agreed in 2007 to protect the bottom habitats of the seamounts within NAFO Regulatory Area (Divs.6EFG) should be maintained and improved, contributing also to improve the knowledge on the effects of fishing in the seamounts.

Based on the information collected in the 2004 experimental survey, a directed commercial fishery had been conducted since 2005 by Spanish vessels. Two different fishing operations have been carried out in this area by these vessels: One was a pelagic trawl over the peaks called "*cucharada*" with the trawl gear "*Pedreira*" (OTB) used in the NAFO Regulatory Area (NRA), the other was a normal pelagic trawl with a pelagic trawl gear (OTM). Both gears with 130 mm cod-end mesh size (González-Costas and Lorenzo, 2007). Since 2007 virtually all the effort has been made with pelagic trawls with "*Pedreira*" gear.

From 1 January 2009, all NAFO bottom fishing activities in new fishing areas or with bottom gear not previously used in the area concerned, shall be considered as exploratory fisheries and shall be conducted in accordance with the exploratory fisheries protocol adopted by the Fisheries Commission in 2008 (NAF0, 2008).

In July 2012, an experimental fishery was conducted by EU-Spain on board the trawl vessel *Esperanza Menduiña* in Corner Rise Seamount complex, located in a small area of the NAFO Regulatory Area Division 6G. Some fishery information about this area was available from the previous research activity carried out by Spain in 2004 (Durán Muñoz *et al.,* 2005) and from the commercial fishery (González-Costas *et al*., 2007; Thompson *et al*., 2007). The aim of the experimental fishery was to explore the use of the bottom trawl gears in the area. No mitigation measures were applied during the fishery since VME were not found. This exploratory fishing was done in accordance with Article 18, Chapter II of the NCEM (NAFO, 2012b). The corresponding Exploratory Fishing Trip report was submitted to the NAFO Secretariat.

Only the above exploratory fishery was invoked in 2012. No more exploratory fisheries were invoked since then.

h. Strengths and weaknesses of the exploratory fishery protocols

Strengths:

- According to Large *et al*., 2013, NAFO has been a front-runner in introducing measures to regulate and monitor bottom fisheries. Some other RFMOs such as NEAFC and the South-east Atlantic Fisheries Organisation (SEAFO) have adopted the VME encounter protocols and thresholds introduced by NAFO.

- NAFO's prohibition of bottom trawling on seamount habitats until fishing impacts are better understood is an example of adequate assessment of the impacts and development of appropriate management measures.

- NAFO made a great progress in adopting various measures to decrease bycatch through gear modifications, imposing minimum size limits and mesh requirements and adopting by catch limits that, when reached, result in the closure of fishing areas or a relocation of fishing effort. Additionally, NAFO put in place observer codes for VME indicator species to facilitate the reporting of encounters; and adopting a Bycatch Action Plan requiring haul-by-haul data.

- All exploratory fisheries in this RFMO require prior approval and are conducted under strict controls. They are subject to a detailed prior exploration conducted in accordance with the exploratory protocol, including: (i) an Exploratory protocol; (ii) a Notice of Intent; (iii) an Exploratory Fishing Trip Report, etc. All these requirements are considered a useful tool to conduct a good assessment of the possible impacts and for the development of appropriate management measures.

- NAFO has a working group of fishery managers and scientists on VMEs that was created to examine scientific advice and evaluate risks and recommend mitigating measures to avoid significant adverse impacts on VMEs in the NAFO Regulatory Area.

Weaknesses:

NAFO has had an encounter protocol in place since 2009. This protocol requires the vessel master to report encounters above the threshold,[5] but there is no guarantee that the observer who is most likely to record VMEs will transmit this information to the vessel master. These thresholds were adopted using information available through a GIS framework model developed by the NAFO Working Group on Ecosystem Approaches to Fisheries Management (WGEAFM). This model estimates commercial catches under various management scenarios (Kenchington *et al*., 2011) by using research vessel catches and VMS data.

i. Recommendations

It is recommended to perform a robust environmental assessment in order to avoid that an initially small exploratory fishery, approved with minimal environmental assessment, could quickly expand, increasing the potential for significant adverse impacts. The environmental assessment provisions should reflect the need to avoid significant adverse impacts, build resilience, ensure application of a precautionary principle, use the best available knowledge (including science and traditional knowledge) and contribute to human well-being. Robust environmental assessments are a core tool for ensuring precaution in the development of new fishing activities. The assessment process can reveal the range of potential effects on multiple components of an ecosystem (including direct, indirect and cumulative effects) and possible ways to mitigate predicted impacts. This recommendation is based on the belief that high seas governance can be strengthened through the implementation of enhanced environmental assessment processes. Moreover, an integrated approach to environmental assessments is needed to address transboundary and global conservation concerns and to contribute to the development of regional cooperation, coordination and capacities. Benefits of enhanced cooperation in the conduct of environmental assessments include improved access to information, better alignment of conservation objectives, more inclusive and participatory decision-making, and improved integration of biodiversity considerations and cumulative impacts into decision-making.

Continue to support the undertaking and completion of exploratory fisheries using cautious conservation and management measures (including, inter alia, catch limits and effort limits) until there are sufficient data to allow the assessment of the impact of the fisheries on the long-term sustainability of the stocks and on VMEs, whereupon conservation and management measures based on that assessment shall be implemented. The latter measures shall, if appropriate, allow for the gradual development of the fisheries. Such measures shall remain in force until there is sufficient data to allow for a proper assessment of impacts.

Finally, there is a need for enhanced cooperation between RFMOs (e.g. NAFO and NEAFC) that arises from the fact that some species of fish are so wide-ranging that they are found in the regulatory areas of more than one RFMO and the fact that modern-day fishing fleets are highly mobile and may well target similar stocks in adjacent regions almost simultaneously.

[5] Originally, these thresholds were set on a provisional basis and were adjusted as experience was gained in the application of the measure. Current encounter thresholds (NAFO, 2022) are defined as catch per set (e.g. trawl tow, longline set, or gill net set) of more than 7 kg of sea pens and/or 60 kg of other live coral and/or 300 kg of sponges

j. Other issues that could be useful for providing options for a framework for "*exploratory fisheries*"

As above (see section i).

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NORTHEAST ATLANTIC FISHERIES COMMISSION (NEAFC)

Partner short name: IEO

a. Legal framework and implications

Exploratory bottom fishing has been subject to an increased volume of regulation by RFMOs – including NEAFC – in the framework of UNGA Resolution and drawing upon the technical advice of the FAO. The process is exemplified by the practice of NEAFC (Cadell, 2020), which in 2008, adopted a new Recommendation on bottom fishing, incorporating all the relevant elements from the UNGA resolution 61/105, and the FAO DSF Guidelines, including the adoption of a first exploratory fishing protocol for "*new bottom fishing areas*" (i.e. outside the "*existing bottom fishing areas*"). Further improvements have been implemented in subsequent years[6,7] (FAO, 2021).

In this regard, since 1 January 2009, all bottom fishing activities within the NEAFC Regulatory Area, in "*new bottom fishing areas*" (this term is no longer used[8]), or with bottom gear not previously used in the area concerned, are considered exploratory fisheries (see updated definition on "section b") and must be conducted in accordance with an "*Exploratory Bottom Fisheries Protocol*". An interim protocol was adopted as part of that measure, and established that exploratory fisheries cannot commence unless a set of mandatory documents (see "section c") have been submitted (FAO, 2016a). A new comprehensive and consolidated Recommendation on the protection of VMEs entered into force in 2014 (Recommendation 19:2014 on area management measures for the protection of vulnerable marine ecosystems in the NEAFC Regulatory Area). This regulation has been amended several times to date, in order to refine some of its elements (e.g Recommendation 10:2021 – NEAFC, 2021). This management measure includes all the general rules regarding the protection of VMEs, including rules and procedures for the assessment of exploratory bottom fishing.

It is worth to note that within the NEAFC Regulatory Area, current commercial bottom fisheries are only allowed in areas where they were active within the reference period 1987-2007, and are thus classified as "*existing bottom fishing areas*". However, closures can be implemented within these areas as well if VMEs are identified as occurring or likely to occur, under a precautionary approach. The closures are found both within and outside "*existing bottom fishing areas*" so preventing existing bottom fishing in some cases and preventing exploratory fisheries in other cases – which can be seen also as a precautionary measure. Thus, NEAFC has confined bottom fisheries to those areas where the best available scientific information, based on ICES advice[9], indicates that there are unlikely to be significant adverse impacts by bottom fishing on VMEs: that is "*inside existing fishing areas*", but outside closed areas (NEAFC, 2020). All other areas outside closed areas and "*existing bottom fishing areas*" are classified as "*restricted bottom fishing areas*" (new terminology, according to NEAFC, 2021) where only exploratory fisheries may take place under various conditions and limitations, including an impact assessment process (FAO, 2021).

[6] e.g. 2012 PECMAS Symposium on NEAFC's Review of its Bottom Fishing Regulations (https://www.neafc.org/pecmas/symposium).

[7] In 2019, NEAFC conducted a five-year review of the consolidated bottom fisheries regulation it had adopted in 2014 and amended in 2015 and in 2018.

[8] The current measures do not define or use the term "new fishing area".

[9] Following its most recent Performance Review (NEAFC, 2014), the NEAFC Commission agreed *"that the clear separation between the scientific role of ICES and the policy and management role of NEAFC should be maintained"*.

b. Definition/meaning of the concept "*exploratory fisheries*"

In the context of NEAFC (2021), "*Exploratory bottom fishing*" means all commercial bottom fishing within "*restricted bottom fishing areas*", or if there are significant changes to the conduct and technology of bottom fishing within "*existing bottom fishing areas"* (see definitions in "section a").

c. Description of the "*exploratory fisheries*" process and steps

Exploratory bottom fishing within the NEAFC Regulatory Area shall follow the procedures outlined in Article 7 (and Annex 4) of Recommendation 10:2021 (NEAFC, 2021):

1. Each Contracting Party (CP) proposing to undertake exploratory bottom fishing in the NEAFC Regulatory Area shall submit to the NEAFC Secretary, in addition to the <u>Notice of Intent</u> (see "section d"), a <u>preliminary assessment of the known and anticipated impacts of the proposed bottom fishing</u>. Assessments should address, inter alia:

    a. Type(s) of fishing conducted or contemplated, including vessels and gear types, fishing areas, target and potential by catch species, fishing effort levels and duration of fishing (harvesting plan).

    b. Best available scientific and technical information on the current state of fishery resources and baseline information on the ecosystems, habitats and communities in the fishing area, against which future changes are to be compared.

    c. Identification, description and mapping (geographical location and extent) of VMEs known or likely to occur in the fishing area; Identification, description and evaluation of the occurrence, character, scale and duration of likely impacts, including cumulative impacts of the proposed fishery on VMEs in the fishing area.

    d. Data and methods used to identify, describe and assess the impacts of the activity, the identification of gaps in knowledge, and an evaluation of uncertainties in the information presented in the assessment.

    e. Risk assessment of likely impacts by the fishing operations to determine which impacts on VMEs are likely to be significant adverse impacts.

    f. Mitigation and management measures to be used to prevent significant adverse impacts on VMEs and the measures to be used to monitor effects of the fishing operations.

2. The Secretary shall promptly forward the assessment to all CPs and to Permanent Committee on Management and Science (PECMAS). The elaboration of the assessment shall be carried out in accordance with guidance developed by ICES, or, in the absence of such guidance, to the best of the ability of the CP concerned.

3. PECMAS shall, either at its next session or through correspondence, undertake an evaluation, in accordance with the precautionary approach, of the submitted documentation, taking account of the risks of significant adverse impact on VMEs. Such evaluation shall take place no later than three months following the date of submission of the Notice of Intent. It shall be undertaken according to procedures and standards developed by PECMAS (NEAFC,

2015a), which shall use any other information required, including information from other fisheries in the region or similar fisheries elsewhere and, in particular, any advice provided by ICES.

4. PECMAS shall subsequently provide advice to the Commission as to whether the proposed exploratory bottom fishing should be approved, or would have significant adverse impacts on VMEs and, if so, on the mitigation measures to prevent such impacts. The Commission shall, within 30 days of receiving this advice, either give or withhold its approval for the proposed bottom fishing.

d. Existence of a preliminary assessment, or bottom fishing impact assessment (BFIA): description of the content

According to the Recommendation 10:2021, Article 6 (NEAFC, 2021), the assessments of exploratory bottom fishing within the NEAFC Regulatory Area, shall include the following information and data:

1. Prior to proposing to undertake exploratory bottom fishing, CP shall gather relevant data to facilitate assessments of exploratory bottom fishing by the PECMAS and ICES (e.g. data from echo-sounders, if practicable multi-beam sounders, and/or other data relevant to the preliminary assessment of the risk of significant adverse impacts on VMEs).

2. The relevant CP shall forward to the Secretary a Notice of Intent to undertake exploratory bottom fishing at least six months prior to the proposed start of the fishing. The Notice of Intent shall be accompanied by the following information:

    a. Harvesting plan, which outlines target species, proposed dates and areas and the type of bottom fishing gear to be used. Area and effort restrictions shall be considered to ensure that fishing occurs on a gradual basis in a limited geographical area.

    b. Mitigation plan, including measures to prevent significant adverse impact to VMEs that may be encountered during the fishery.

    c. Catch monitoring plan, including recording/reporting of all species caught.

    d. A sufficient system for recording/reporting of catch, detailed to conduct an assessment of activity, if required.

    e. Fine-scale data collection plan on the distribution of intended tows and sets, to the extent practicable on a tow-by-tow and set-by-set basis.

    f. Data collection plan to facilitate the identification of VMEs in the area fished; (vii) plans for monitoring of bottom fishing using gear monitoring technology, including cameras if practicable.

    g. Monitoring data obtained pursuant to paragraph 1.

3. The Notice of Intent, along with the accompanying information, shall be forwarded by the Secretary to all CPs as well as to PECMAS for review. The relevant CP shall also provide an assessment of the proposed exploratory bottom fishing in accordance with Article 7 of Recommendation 10:2021 (see “section c”).

4. Exploratory bottom fishing shall only commence after having been assessed by PECMAS and approved by the Commission.

5. Preference shall be given by the relevant CP to exploratory bottom fishing using fishing gear and methods with the least bottom contact, in well-mapped areas and at times when impacts are likely to have the least adverse impacts on organisms other than the target species.

6. The relevant CP shall ensure that vessels flying its flag and conducting exploratory bottom fishing have a scientific observer on board. Observers shall collect data in accordance with the VME Data Collection Protocol as set out in Annex 3 of Recommendation 10:2021.

7. The relevant CP shall provide a report of the results of such activities to the Secretary for circulation to ICES and to all other CPs. It shall ensure that the data, which derives from exploratory bottom fishing, will be made available to ICES.

8. The Commission shall review the assessments undertaken in accordance with Article 7 of Recommendation 10:2021 and the results of the fishing protocols implemented by the participating fleets. The Commission may decide to authorise new bottom fishing based upon the results of exploratory bottom fishing conducted in the previous two years. Areas where such new bottom fishing are authorised shall be defined as "*existing bottom fishing areas*" pursuant to Article 4 of Recommendation 10:2021.

e. Review of conservation and management measures to prevent significant adverse impacts

Mitigation measures, applicable to exploratory bottom fishing, are given in several Articles of the Recommendation 10:2021 (NEAFC, 2021):

- Exploratory bottom fishing, as a commercial fishing using fishing gear that is likely to contact the seafloor during the normal course of fishing operations, are prohibited in area closures established by NEAFC for protection of VMEs (Article 5).

- Exploratory bottom fishing shall to considered (i) area and (ii) effort restrictions to ensure that fishing occurs on a gradual basis in a limited geographical area; (iii) shall to include a mitigation plan, including measures to prevent significant adverse impact to VMEs; preference shall be given to (iv) the use of fishing gear and methods with the least bottom contact, (v) in well-mapped areas and (vi) at times when impacts are likely to have the least adverse effects on organisms other than the target species (Article 6).

- A VME encounter protocol has been implemented by NEAFC for all fishing vessels using bottom fishing gears, including those vessels involved in exploratory bottom fishing. The protocol is described in the Recommendation 10:2021, Articles 8 and 9 (NEAFC, 2021). It contains (i) rules for encounters with possible VMEs; (ii) threshold levels (kg) for VME indicators (aggregated corals and aggregated sponges[10]) and the (iii) associated move-on rules by gear type, as well as procedures for (iv) reporting the encounter and (v) implementing temporary area closures.

[10]. Trawl tow, and other fishing gear than longlines: more than 30 kg of live coral and/or 400 kg of live sponge of VME indicators; longline set: VME indicators on 10 hooks per caught per 1000 hook segment or per 1200 m section of long line, whichever is the shorter.

f. Exploratory fisheries monitoring

Monitoring of fishing is mandatory for vessels conducting exploratory bottom fishing in the NEAFC Regulatory Area. The specifications are given in Articles 6 and 8 of the Recommendation 10:2021 (NEAFC, 2021):

Article 6

The relevant CP shall ensure that vessels flying its flag and conducting exploratory bottom fishing have a scientific observer on board. Observers shall collect data and samples in accordance with the "*VME Data Collection Protocol*" (e.g. identification of VME indicator species, characteristics of the vessel, gear, location and depth of the fishing operations, collection of samples of VME indicator species, etc.).

Any exploratory bottom fishing requires the implementation of (i) an appropriate system for detailed catch recording and reporting of all species caught on a tow by tow and set by set basis, including the identification of VMEs, and, if practicable; (ii) gear monitors technology, including cameras, and (iii) data collection from sea-bed mapping programmes (i.e. echo-sounders, multi-beam sounders).

The relevant CP shall provide a report of the results of the exploratory bottom fishing to the Secretary for circulation to ICES and to all other CPs.

Article 8

Fishing vessels conducting exploratory bottom fishing shall quantify catch of VME indicators.

g. Experience with exploratory fishery protocols

No exploratory fishing using bottom fishing gears has been conducted by CPs in the Regulatory Area since the first exploratory fishing protocol (NEAFC, 2009) entered into force in 2009 (FAO, 2016a).

It is worth to note that before 2009, several cooperative research activities with the fishing industry were undertaken by EU-Spain (Durán Muñoz *et al.* 2011, 2012a), using the IEO exploratory fishing protocol that included monitoring (mandatory) through scientific observers on board (FAO, 2016b, Durán Muñoz, 2015a). Data from these activities (Durán Muñoz *et al.,* 2009, 2012b), contributed significantly to identify and protect large areas of cold-water coral habitats and deep-sea sponge aggregations in the Hatton and Edoras Banks (e.g. ICES, 2008; 2011).

The more recent preliminary assessments of proposals to undertake exploratory bottom fishing were presented in 2015, corresponding to three "*Notices of Intent*" submitted by the EU, under the specifications of the new Recommendation 09:2014 amended, which was adopted at that time (NEAFC, 2015b). In March 2015, EU-Spain submitted the first preliminary impact assessment report for exploratory bottom fishing in a new fishing area of the Barents Sea (Loophole) targeting the invasive species snow crab and red king crab, using pots. This extensive report (Durán Muñoz, 2015b, see Supplementary Information) was prepared by the IEO in the framework of the Recommendation 09:2014 (amended). The PECMAS of NEAFC assessed the report pursuant Article 7 and agreed that it fulfilled all the conditions established in the Recommendation and that the proposed exploratory bottom fishing should be approved. Nevertheless, the NEAFC Commission did not approve the exploration due the opposition from Norway and Russia. Both CPs objected based on the claim that crabs are considered as sedentary species, and since the fishery was to take place on their extended continental shelf beyond 200nm, the NEAFC does not have the legal authority to grant permission to fish crabs (according to UNCLOS, coastal States have exclusive rights over the exploitation of sedentary species on their continental shelves). Two additional assessments reports were submitted (EU-Lithuania and EU-Latvia), but the exploratory fishing was not approved either, for similar reasons. No new proposals have been presented by CPs since that date.

The exploratory fishing for crabs rejected by the NEAFC Commission, revealed an issue of contention, summarized by Fuller *et al.* (2020). The CPs Norway and Russia asserted that NEAFC bottom fishery regulations should not apply in areas of their extended continental shelf in the Barents Sea (i.e. the Loophole). Nevertheless, in the Loophole, within the NEAFC Regulatory Area and outside of the NEAFC existing bottom fishing area, a new bottom fishery for invasive crabs (not regulated by NEAFC) was established recently, despite the fact that Norway and Russia neither conducted prior impact assessments nor applied for, or were granted, permits for exploratory fishing, as required under the NEAFC bottom fishing regulations (NEAFC, 2021).

h. Strengths and weaknesses of the exploratory fishery protocols

Strengths:

- A "*preliminary assessment report*" is a very useful tool in order to describe and anticipate the potential impacts of the proposed exploratory bottom fishing and to design *ad hoc* mitigation measures. The content of this report, as is described in the Recommendation 10:2021 and in the PECMAS procedures and standards (NEAFC, 2015a), seems to be adequate for this purpose (e.g. The issue of the bycatch, a concern in DSF, is addressed in Rec. 10:2021 which requires that assessments of exploratory bottom fishing should include consideration of potential bycatch species).

- PECMAS and ICES (if required) provide scientific advice to the NEAFC Commission as to whether the proposed exploratory bottom fishing should be approved, or on the mitigation measures needed.

- Exploratory bottom fishing only can commence after having been assessed by PECMAS and approved by the Commission.

- Mandatory scientific observers on board allow monitoring of the exploratory bottom fishing. Information collected on board is key to assess the results of the exploration and to take management decisions (e.g. areas closed, authorization of new bottom fishing, etc.).

Weaknesses:

Regarding the methodology for the assessment (Recommendation 10:2021, Article 7), it is worth to note, that NEAFC only indicates that it *"shall be carried out in accordance with guidance developed by ICES, or, in the absence of such guidance, to the best of the ability of the CP concerned"*. Absence of clear instructions on the methodologies to be used can make the elaboration of the assessment difficult. Therefore, main stages involved within the methodology of the assessment should be clearly designed, as decisions regarding the feasibility of undertaking exploratory bottom fishing are made as a consequence of the assessments. It is crucial to employ assessment methods that make the best use of data and management procedures. Access to information, consultation, participation, transparency, and precautionary approaches are all required elements for best practice assessments.

As in other RFMOs, impact assessments are only required for proposed bottom fisheries, and are focused on VMEs.

i. Recommendations

Development of Guidelines for CPs about the methodology of the assessment can help CPs to prepare such assessments in a more standardized way. An example of CP approach is in Durán Muñoz (2015a, 2015b):

www.un.org/depts/los/reference_files/Bottom_Fishing_Workshop_2016_Presentations.pdf

Expand the impact assessments to all fishing activities and other elements of the marine ecosystems.

j. Other issues that could be useful for providing options for a framework for "*exploratory fisheries*"

As above (see section i).

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SOUTH EAST ATLANTIC FISHERIES ORGANISATION (SEAFO)

Partner short name: IEO

a. Legal framework and implications

Article 20 of the SEAFO Convention text states that contributions to new or exploratory fisheries should take into account the principles set out in article 6.6 of the 1995 UN Agreement: "*For new or exploratory fisheries, States shall adopt as soon as possible cautious conservation and management measures, including, inter alia, catch limits and effort limits. Such measures shall remain in force until there are sufficient data to allow assessment of the impact of the fisheries on the long-term sustainability of the stocks, whereupon conservation and management measures based on that assessment shall be implemented. The latter measures shall, if appropriate, allow for the gradual development of the fisheries*" (UNGA, 1995).

The CM 30/15 (SEAFO, 2015) has been set up following these principles as well as the guidance provided by FAO in the framework of the Code of Conduct for Responsible Fisheries.

This CM includes an identification of specific areas where bottom trawling and/or longlining can take place as well as areas which are closed to all fishing activities. There are also protocols for data reporting, for exploratory fishing and for encounters of VME biota.

This CM defines the fishing strategy in the SEAFO CA, namely:

- Article 4 where the existing bottom fishing areas are established using the period of 1987 to July 2011.
- In Annex 2A the Closed areas for the protection of VMEs and their coordinates are defined
- In Annex 2B the fisheries closed to All Fishing Gears Except for Pots and Longlines and
- Article 2 d that defines Exploratory fisheries.

The SEAFO SC in collaboration with FAO/ABNJ project has been working to develop a checklist, application and evaluation template for exploratory fishing applications, SEAFO (2017).

b. Definition/meaning of the concept "*exploratory fisheries*"

SEAFO defines "*Exploratory fisheries*" in article 2c) of the CM 30/15 as "*those fisheries in which all commercial bottom fishing activities outside area closures and existing bottom fishing areas, or fisheries within existing bottom fishing areas when a new fishing method and/or strategy are attempted to be used*".

Exploratory fisheries, however, are fishing experiments solely or primarily aimed to discover new resources or new fishing grounds and are as such from the outset motivated by commercial interest and are regulated by SEAFO by agreed protocols. SEAFO (2019b).

c. Description of the "*exploratory fisheries*" process and steps

The following procedures and standards were adopted by the SC as of 12 October 2016 (SEAFO, 2015):

- Prior to undertaking exploratory bottom fishing, Contracting Parties shall gather relevant data to facilitate assessments of exploratory bottom fishing by the Scientific Committee. Such data should preferably include data from sea-bed mapping programmes, i.e. data from echo-sounders, if practicable multi-beam sounders, and/or other data relevant to the preliminary assessment of the risk of significant adverse impacts on VMEs

- The relevant Contracting Party shall forward to the Executive Secretary a Notice of Intent to undertake exploratory bottom fishing at least 60 days prior to the proposed start of the fishery.

- Each Contracting Party proposing to undertake exploratory bottom fishing shall submit to the Executive Secretary, in addition to the Notice of Intent, a preliminary assessment of the known and anticipated impacts of the proposed bottom fishing activity

- The Notice of Intent will be evaluated by the Scientific Committee and the Commission during their respective annual meetings. If need be, this process can be done by correspondence allowing Scientific Committee 30 days for scientific evaluation and an additional 30 days for the Commission to approve, withhold or reject the proposal.

- The relevant Contracting Party shall provide promptly a report of the results of such activities to the Executive Secretary for circulation to all Contracting Parties. It shall ensure that the data, which derives from exploratory bottom fishing, will be made available to the Scientific Committee.

- The SC shall provide advice to the Commission as to whether the proposed exploratory bottom fishing should be approved, or would have significant adverse impacts on VMEs and, if so, on whether proposed mitigation measures would prevent such impacts

- The Commission shall review the assessments undertaken in accordance with Article 7 and the results of the fishing protocols implemented by the participating fleets. The Commission may decide to authorise new bottom fishing activities based upon the results of exploratory bottom fishing, taking due account of the rules and procedures set out in Annex 5. Areas where such new bottom fishing activities are authorised shall be defined as "*existing bottom fishing areas*" pursuant to Article 4.

d. Existence of a preliminary assessment, or bottom fishing impact assessment (BFIA): description of the content

The CPs preliminary assessment shall as a minimum demonstrate that every effort has been made to provide the information requested in Art. 7.1, Annex 3. The CP should address individual request point by point in order to facilitate SC evaluation:

a) type(s) of fishing conducted or contemplated, including vessels and gear types, fishing areas, target and potential by catch species, fishing effort levels and duration of fishing (harvesting plan);

b) best available scientific and technical information on the current state of fishery resources and baseline information on the ecosystems, habitats and communities in the fishing area, against which future changes are to be compared;

c) identification, description and mapping (geographical location and extent) of VMEs known or likely to occur in the fishing area;

d) identification, description and evaluation of the occurrence, character, scale and duration of likely impacts, including cumulative impacts of the proposed fishery on VMEs in the fishing area;

e) data and methods used to identify, describe and assess the impacts of the activity, the identification of gaps in knowledge, and an evaluation of uncertainties in the information presented in the assessment;

f) risk assessment of likely impacts by the fishing operations to determine which impacts on VMEs are likely to be significant adverse impacts; and

g) mitigation and management measures to be used to prevent significant adverse impacts on VMEs and the measures to be used to monitor effects of the fishing operations.

SC shall require that information provided is documented with references to published sources or other sources that SC can access/consult. If SC deems the contents of the submitted assessment, including the proposed mitigation measures (g), insufficiently rigorous and balanced to assess the risk of SAI, then the proposal shall not be approved.

e. Review of conservation and management measures to prevent significant adverse impacts

When evaluating the preliminary assessment, preference shall be given by the relevant Contracting Party to exploratory bottom fishing using fishing gear and methods with the least bottom contact, in well-mapped areas and at times when impacts are likely to have the least adverse impacts on organisms other than the target species.

f. Exploratory fisheries monitoring

The relevant Contracting Party shall ensure that vessels flying their flag conducting exploratory fishing have a scientific observer on board. Observers shall collect data in accordance with a VME Data Collection Protocol.

There are 5 mandatory elements:

a) harvesting plan, which outlines target species, proposed dates and areas and the type of bottom fishing gear to be used. Area and effort restrictions shall be considered to ensure that fishing occur on a gradual basis in a limited geographical area;

b) mitigation plan, including measures to prevent significant adverse impact to VMEs that may be encountered during the fishery;

c) catch monitoring plan, including recording/reporting of all species caught;

d) a sufficient system for recording/reporting of catch, detailed to conduct an assessment of activity, if required;

e) data collection plan to facilitate the identification of VMEs in the area fished (SEAFO,2016).

A review of the 2016 SC "*Procedures and Standards for SEAFO SC's Consideration of Proposals for Exploratory Fishing*" – in light of experiences gained during the 2017 SC meeting was discussed at the SC-2018 meeting (SEAFO,2018). The SC decided that the procedures are appropriate. However, it was emphasized that it might be necessary to improve evaluation criteria and documentation requirements concerning VME encounters in exploratory fisheries in the future but did not take action as no new experience had been gained.

According with the SEAFO System (SEAFO, 2019), the Article 13 established that each Contracting Party shall ensure that its vessels implement a satellite-based vessel monitoring system (VMS), but for all fishing operations including the Exploratory fisheries.

g. Experience with exploratory fishery protocols

There is only Japan's notice of intent for exploratory fishing in the SEAFO CA targeting Patagonian toothfish and they present them almost every year from 2012.

Japan presented results for the 2014 exploratory fishing conducted on the Discovery Tablemount seamount in Sub-Area D in the SC meeting in 2015 (SEAFO,2015b). The SC agreed that the experiments (2012-2014) fulfilled the requirements of the rules & procedures of CM 29/14 for opening new fishing areas therefore advises that the Commission consider converting a specific area into an existing fishing area, and amends CM 29/14 accordingly.

A concern was raised in the 2017 SC report about the inclusion of the two most southern 1x1 degree grids in the proposed Discovery area which seem to be deeper than 2000m because there is a regulation that states that no exploratory fishing may take place in depths deeper than the 2000m depth isobath. In 2018 at the SC meeting, the SC noted the decision to close two rectangles within the proposed exploratory fishing area from exploration.

A new Notice of Intent from Japan to conduct exploratory fishing in 2022 has been presented and assessed by SC's delegates intersessionally. It includes a Notice of Intent, Preliminary Impact assessment and Additional information on SAI.

With respect to Orange Roughy, there is no fishery data available since 2005, as a result SC cannot conduct stock assessment of the Orange Roughy stock within the Convention Area. Historically, most of the catch has occurred in Division B1. To provide an incentive to generate fishery data on which to base management decisions, the SC recommended a 50 tonnes TAC outside Division B1 subject to exploratory fishing protocols. So far, no use has been made of this TAC.

h. Strengths and weaknesses of the exploratory fishery protocols

There is a well-defined protocol for the SC to assess the exploratory fishery proposals, with detailed information about how to present the preliminary assessments and notices of intent to undertake exploratory fishing, with a defined deadline.

From the Performance review panel in 2016 (SEAFO, 2016b) where a recommendation to develop rules for exploratory fisheries further so that it becomes possible in practice to expand fisheries without putting the health of the ecosystem or stocks at risk were considered, some progress has been made.

A discussion about having biennial presential Commission meetings with the physical meetings coinciding with the same years in which the Commission sets TAC's happened in the Commission meeting in 2019. Every second year, the Commission meetings should then be conducted by correspondence. Email correspondence intersessionally was suggested between members when a proposal for exploratory fishing will be discussed.

i. Recommendations

Procedures and standards for proposals for exploratory fishing in the SEAFO CA are well defined. According to our information only Japan has presented Notices of intent for exploratory fishing although there is interest in SEAFO in the submission of exploratory plans to obtain fisheries data that could contribute to the assessments.

There does not seem to be much interest from countries in submitting exploratory fishing proposals. A recommendation to SEAFO SC would be to analyze the reasons why this is happening, whether it is due to scarce fish stocks, over-legislation, too many restrictions on commercial fishing, or others.

j. Other issues that could be useful for providing options for a framework for "*exploratory fisheries*"

In the 2018 SC meeting, it was agreed that an intersessional task team should be formed with the mandate to develop criteria for evaluation of an Exploratory and research fishing plan targeting Orange Roughy. The SC in 2021 agrees to revive this exercise and a Task Team consisting of four members from Namibia, EU, Angola and South Africa.

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GENERAL FISHERIES COMMISSION FOR THE MEDITERRANEAN (GFCM)

Partner short name: IEO

a. Legal framework and implications

There is no specific applicable legal framework, except the adoption of REC.CM-GFCM/29/2005/1 forbidding the use of towed dredges and trawl nets at depths beyond 1000 m (up to 58% of the area), acting on UNGA Res 64/72.

b. Definition/meaning of the concept "*exploratory fisheries*"

The GFCM WGVME (2017) agreed to define exploratory deep-sea bottom fishing activities as those activities conducted: i) on VME indicator features; ii) outside existing mapped bottom fishing areas, or iii) within existing bottom fishing areas when significant changes in the fishing patterns or in the technology used in the fishery occurred.

In the "*Management elements for the establishment of an exploratory deep-sea bottom fishing protocol in the GFCM area of application*" (WGVME, 2017 and reviewed by WGVME, 2018), the following definition was also included: "*Exploratory (or new) deep-sea bottom fishing*" occurs during the initial development phase of a DSF when the DSF operates in areas that have not been previously fished or in fished areas following significant changes in the gear or effort, as described in paragraphs 23, 55, 61 and 65 of the *FAO International Guidelines for the Management of Deep Sea Fisheries in the High Seas*.

c. Description of the "*exploratory fisheries*" process and steps

The "*Management elements for the establishment of an exploratory deep-sea bottom fishing protocol in the GFCM area of application*" (WGVME, 2017, 2018), which, however, has not resulted so far in any recommendation or legal framework to be implemented, included the following points:

- Geographical coverage: Mediterranean Sea (GSAs 01 to 28)

- Fisheries: All fishing vessels above 15 m (LOA) operating with bottom contact gears (bottom trawls, longlines, gillnets and pots and traps) are considered undertaking Exploratory (or new) deep-sea bottom fishing when operating: i) On VME Indicator Features (see Annex I a); ii) Outside of the existing bottom deep-sea fishing areas; iii) Inside of existing bottom fishing areas with bottom-contact fishing gears not previously used or when significant increases of effort are planned or when a new fishery is developing.

- Management measure. GFCM Contracting Party or Cooperating non-Contracting Party (CPCs) of flagged fishing vessels undertaking exploratory (or new) deep-sea bottom fishing shall be required to complete the Exploratory deep-sea bottom fishing protocol, including the following information: i) the start and end point of each tow or set; ii) the fishing characteristics of the vessel including the gear used; iii) the GSA area and the Statistical Grid where the exploratory deep-sea fishing occurred; iv) the catch, the bycatch, the discards, and fishing effort; v) VME Indicator Taxa (if any) through the VME Encounter Protocol.

- Reporting to GFCM Secretariat. Upon notification by the vessel captain, as described above, relevant CPCs shall forward, within 30 days, the exploratory deep-sea bottom protocol form reported by the vessel captain, to the GFCM Secretariat, including by electronic means.

- Review of the information gathered through the exploratory deep-sea bottom protocol. The GFCM Secretariat shall compile the data received with the exploratory deep-sea bottom protocol and shall regularly inform the SAC. The SAC shall review this information.

d. Existence of a preliminary assessment, or bottom fishing impact assessment (BFIA): description of the content

No preliminary assessment is required.

e. Review of conservation and management measures to prevent significant adverse impacts

No specific conservation and management measures apply to exploratory fishing activities.

f. Exploratory fisheries monitoring

Data should be collected according to the Exploratory deep-sea bottom fishing protocol summarized in section c. Additionally, the use of scientific observers to assist in data collection and reporting is highly desirable according to the Data Collection Reference Framework (GFCM, 2018).

g. Experience with exploratory fishery protocols

An exploratory deep-sea bottom fishing reporting protocol was agreed in WGVME 2017 and reviewed in 2018. No further meetings of this WG were carried out.

h. Strengths and weaknesses of the exploratory fishery protocols

There has not been a follow-up of the proposed protocol, neither a list of conservation and management measures to prevent significant adverse impacts of the exploratory fishing activities.

In the 2018 SAC (FAO, 2018), a phased approach was presented suggesting, in a first phase, the adoption of an encounter reporting protocol while concurrently working towards the determination of the footprint of deep-sea fisheries and the identification of potential thresholds of VME indicator abundance beyond which (semi-)automatic move-on rules could be triggered. A second phase would foresee the adoption of an exploratory fishing protocol and an encounter protocol including move-on rules. The Committee expressed support for the suggested two-phase approach and advised the Commission to adopt measures for the management of deep-sea fisheries and VMEs in line with the technical elements provided, but no further actions has been taken.

i. Recommendations

The available protocols should be updated (if needed) and become part of a recommendation in order to be applied. Further work should be done in this RFMO on this topic, which is still quite preliminary.

j. Other issues that could be useful for a framework for "*exploratory fisheries*"

NA

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FAO AREA 41: SOUTH WEST ATLANTIC OCEAN

Partner short name: IEO

a. Legal framework and implications

Since no RFMO is established in the high seas of FAO AREA 41, there is currently no specific legal framework for exploratory bottom fishing in this area, except the general provisions set out in the framework of the UNGA Resolutions (e.g. 61/105) and FAO DSF Guidelines.
In this regard, Council Regulation (EC) Nº 734/2008 on the protection of vulnerable marine ecosystems in the high seas from the adverse impacts of bottom fishing gears was adopted by the European Union. According to this regulation, EU Member States are obliged to carry out an assessment of the potential impacts of the fishing activities on vulnerable marine ecosystems in the areas of the high seas where no RFMO/Agreement has been established. The use of bottom fishing gears is prohibited where no scientific assessment has been carried out.

b. Definition/meaning of the concept "*exploratory fisheries*"

Since no RFMO is established in the high seas of FAO AREA 41, there is currently no specific definition of the "exploratory fisheries" concept for this area.

c. Description of the "*exploratory fisheries*" process and steps

In the areas not covered by RFMOs, fishing vessels from EU Member States carrying out fishing activities with bottom fishing gears in the high seas, are regulated by the measures contained in Council Regulation (EC) No 734/2008. Special fishing permits and impact assessments are key elements of this regulation:

Special fishing permit (Article 3):

1. In order to conduct the fishing activities with bottom gears in the high seas, Community fishing vessels shall have a special fishing permit.
2. The special fishing permit shall be issued in accordance with Regulation (EC) No 1627/94 and subject to the conditions established in this Regulation.

Conditions for issuance (Article 4):

1. Applications for a special fishing permit shall be accompanied by a detailed fishing plan specifying in particular: i) the intended location of the activities; ii) the targeted species; iii) the type of gears and the depth at which they will be deployed; iv) the configuration of the bathymetric profile of the seabed in the intended fishing grounds, where this information is not already available to the competent authorities of the Flag State concerned.
2. The competent authorities shall issue a special fishing permit after having carried out an assessment on the potential impacts of the vessel's intended fishing activities and concluded that such activities are not likely to have significant adverse impacts on vulnerable marine ecosystems.
3. For the purposes of the implementation of the assessment, the competent authorities shall rely on the best scientific and technical information available concerning the location of vulnerable marine ecosystems in the areas in which the fishing vessels concerned intend to operate. That information shall include, where available, scientific data on the basis of which the likelihood of occurrence of such ecosystems can be estimated. The assessment process shall include appropriate elements of independent scientific peer review.

4. The evaluation of the risk of significant adverse impacts on vulnerable marine ecosystems carried out under the assessment shall take into account, as appropriate, differing conditions prevailing in areas where fishing activities with bottom gears are well established and in areas where fishing such activities have not taken place or only occur occasionally.
5. The competent authorities shall apply precautionary criteria in the conduct of the assessment. In case of doubt as to whether the adverse impacts are significant or not, they shall consider that the likely adverse impacts resulting from the scientific advice provided are significant.

Where the assessment concludes that activities carried out in accordance with the submitted fishing plan might result in significant adverse impacts to vulnerable marine ecosystems, the competent authorities shall specify the assessed risks and allow applicants to amend the fishing plan to avoid them. In the absence of such amendments, the competent authorities shall refrain from issuing the requested special fishing permit.

d. Existence of a preliminary assessment, or bottom fishing impact assessment (BFIA): description of the content

Council Regulation (EC) No 734/2008 establishes the obligation to carry out an impact assessment for ensuring the protection of vulnerable marine ecosystems from the adverse impacts of bottom fishing gears (see details and description in "section c").

e. Review of conservation and management measures to prevent significant adverse impacts

Council Regulation (EC) No 734/2008 includes a set of conservation and management measures to prevent significant adverse impacts:

Unassessed areas (Article 6):

- In the areas where no proper scientific assessment has been carried out and made available, the use of bottom gears shall be prohibited.
- Bottom fishing activities shall be permitted under the conditions laid down in this Regulation where this scientific assessment shows that vulnerable marine ecosystems will not be at risk.

Unforeseen encounters with vulnerable marine ecosystems (Article 7):

- Where, in the course of fishing operations, a fishing vessel encounters a vulnerable marine ecosystem, it shall immediately cease fishing, or refrain from engaging in fishing in the site concerned. It shall resume operations only when it has reached an alternative site at a minimum distance of five nautical miles from the site of the encounter within the area foreseen in its fishing plan.
- If another vulnerable marine ecosystem is encountered in the alternative site referred to in paragraph 1, the vessel shall keep relocating in accordance with the rules set out in that paragraph until a site is reached where no vulnerable marine ecosystems are found.
- The fishing vessel shall report each encounter to the competent authorities without delay, providing precise information on the nature, location, time and any other relevant circumstances of the encounter.

Area closures (Article 8):

- On the basis of the best scientific information available on the occurrence or on the likelihood of occurrence of vulnerable marine ecosystems in the region where their fishing vessels operate, Member States shall identify areas that shall be closed to fishing with bottom gears. Member States shall implement these closures without delay in respect of their vessels and immediately notify the Commission of the closure. The Commission shall circulate the notification to all Member States without delay.
- Without prejudice to Article 7 of Regulation (EC) No 2371/2002, the Commission shall, where appropriate, submit proposals to the Council in accordance with Article 37 of the Treaty for the adoption of Community measures to implement area closures, whether on the basis of the information notified by Member States or on its own initiative.

f. Exploratory fisheries monitoring

Article 11 of Regulation (EC) No 734/2008 established requirements regarding observers on board vessels:

- Observers shall be on-board all vessels to which a special fishing permit provided for in Article 3 is issued. The observers shall observe the fishing activities of the vessel throughout the execution of its fishing plan provided for in Article 4.
- The observer shall: i) record independently, in the same format as that used in the vessel's logbook, the catch information prescribed in Article 6 of Council Regulation (EEC) Nº 2847/93 of 12 October 1993 establishing a control system applicable to the common fisheries policy; ii) record any instances of alteration of the fishing plan; iii) document any unforeseen encounters with vulnerable marine ecosystems, including the gathering of information that may be of use in relation to the protection of the site; iv) record depths at which gear is deployed; v) present a report to the competent authorities of the Member State concerned within 20 days following the termination of the observation period. A copy of this report shall be sent to the Commission, within 30 days following receipt of a written request.
- The observer shall not be any of the following: (a) a relative of the master of the vessel or other officer serving on the vessel to which the observer is assigned; (b) an employee of the master of the vessel to which he is assigned; (c) an employee of the master's representative; (d) an employee of a company controlled by the master or his representative; (e) a relative of the master's representative.

g. Experience with exploratory fishery protocols

Before the implementation of Council Regulation (EC) No 734/2008, several cooperative research activities were carried out in the Southwest Atlantic on board Spanish vessels, using the IEO exploratory fishing protocol that included monitoring (mandatory) through scientific observers on board, on a haul by haul basis. No exploratory bottom fishing has been conducted by Spain within this area since that regulation entered into force in August 2008:

- In the second half of 2001, an exploratory fishing was carried out by two Spanish bottom-longline commercial fishing vessels (F/V "Nueva Flecha" and F/V "Ronsel") within the Uruguayan Economic Exclusive Zone, targeting deep-water species (Portela *et al*., 2002). Trap fishing gears were also utilised as another alternative fishing method. The main objectives were to assess the possible economic profitability of a commercial fishery in the area; the determination of suitable characteristics of the fishing gears; and to know the potential yield of commercial fishing in those areas. Target species were sandperches (*Pinguipes* spp and *Pseudopercis* spp), kingclip (*Genypterus blacodes*) groupers and sea bass (*Epinephelus* spp and *Acanthistius* spp). Fishery and biological data were collected by the scientific observers on board the vessels (e.g. date, time, position, depth, sea surface and bottom temperatures, weather condition, catches, discards, length distributions, sex, maturity and stomach content). The development of this experimental fishing survey was supervised by the Instituto Español de Oceanografía (IEO, Spain) in coordination with the Instituto Nacional de Pesca (INAPE, Uruguay). The catches obtained in this experimental fishing do not seem to allow an economically viable exploitation of target species.

- In 2005 an exploratory fishing was conducted on board the Spanish commercial longlining vessel "Arnela", targeting Patagonian toothfish (*Dissostichus eleginoides*) with newly designed and selective traps (IEO, 2006), with the aim to improve the knowledge of the fishery resources in a new fishing area. Fishery and biological data were collected by a scientific observer on board. Fishing took place in the following divisions: (i) 42 (between 41ºS and 43ºS); (ii) 46 (between 43ºS and 47ºS); (iii) 49 (between 47ºS and Falkland waters) and; (iv) 54 (between 53ºS and 55ºS). Data were collected during 326 hauls, using 49.329 fishing traps. The catches obtained in this experimental fishing do not seem to allow an economically viable exploitation of Patagonian toothfish in this survey area using traps.

- Between 23th November 2007 and 7th April 2008, an experimental fishing was conducted on board the Spanish commercial longlining vessel "Arnela", which targeted mainly Patagonian toothfish (*Dissostichus eleginoides*) in international waters of the Southwest Atlantic. An "umbrella-and-stones" system to reduce interactions between bottom-set longlines and sperm whales (*Physeter macrocephalus*) and seabirds was used. The main goal of the study was to assess the extent of depredation and seabird bycatch and to test the potential of the so-called "umbrella" system, coupled with attached stones for faster sinking, for minimizing both. Fishing took place in two areas: (i) area extending east of the Argentine EEZ between 41ºS and 48ºS and up to 56ºW, and (ii) area bordering Falklands/ Malvinas waters to the west and extending between 53ºS and 55ºS and to 50ºW. Fishery and biological data were collected by a scientific observer on board. Data were collected during 297 hauls. Sperm whales were sighted during 35% of the hauls, always during gear retrieval, and their presence was positively related to fish damage. The overall depredation rate (0.44% of the total catch) was low, but is assumed to be underestimated because sperm whales were suspected of also taking fish without leaving visual evidence. The "umbrella-and-stones" system was highly effective in preventing bycatch and appeared to restrict depredation, but significantly reduced the catches. The results demonstrated that there was still some way to go to solve the problem of depredation (Goetz *et al*., 2011).

In the exploratory fisheries carried out in 2005 and 2007, special attention was paid to the interactions between the fishing gears and vulnerable marine ecosystems. In this regard, a photographic register with records of the benthic invertebrates captured by the fishing gears was taken.

h. Strengths and weaknesses of the exploratory fishery protocols

In the Southwest Atlantic, in line with the responsibilities of flag States as reflected in the UNCLOS and in line with the UNGA provisions, nations should adopt and implement individual regulatory measures and fishery protocols for their vessels. Regarding the Vulnerable Marine Ecosystems, only the EU and Spain, as the flag State, have adopted regulations, conducted an impact assessment, identified VMEs, or established measures to protect them in order to implement the UNGA Resolutions, pursuant to paragraph 86 of Resolution 61/105 for high seas areas where no RFMO exists (DSCC, 2020).

The absence of an RFMO in the Southwest Atlantic, with a competence over bottom fishing means absence of a multilateral forum for cooperation between States fishing in the area. The unilateral fishery protocols adopted by a particular flag State are not effective as they apply only to vessels of that particular flag.

In 2004, the UNGA first called upon States to act individually or through RFMOs to consider the prohibition of destructive fishing practices, pending the adoption of appropriate conservation and management measures. Paragraph 86 of Resolution 61/105 UNGA Resolution requested States to "identify VME and determine whether bottom fishing activities would cause significant adverse impacts to such ecosystems and the long-term sustainability of deep sea fish stocks, inter alia, by improving scientific research and data collection and sharing, and through new and exploratory fisheries".

i. Recommendations

The FAO DSF Guidelines established that deep-sea fisheries are to be ′rigorously managed′ during the experimental, exploratory and established stages of their development but the parameters of these stages were not expressly defined by the FAO. In the absence of RFMOs as occurs in the High Seas of SW Atlantic, all States fishing in the area should implement appropriate protocols for exploratory fisheries and impact assessments (including mandatory observer programmes and *ad hoc* mitigation and management measures), based on FAO DSF Guidelines and considering the progress in the RFMOs and their scientific bodies.

Precautionary conservation and management measures, including catch and effort control, were considered essential during the exploratory phase of the fishery in the study undertaken by Spain and should include measures to manage the impact on low-productivity species, non-target species and sensitive habitat.

Cooperation between States fishing in the area to exchange data on catch, bycatch and fishing effort is key to allow the assessment of fishing impacts.

The relevant conservation and management measures in the fishery protocols in the High Sea of the Southwest Atlantic should be adopted by the agreement of the participants in the fishery or any subsequent management body, in a manner similar to the regulations of exploratory fisheries by other RFMOs.

j. Other issues that could be useful for providing options for a framework for "*exploratory fisheries*"

The FAO DSF Guidelines considered an "*appropriate set of rules and regulations*" to be an element of a "*functioning regulatory framework*" for the opening of areas to exploratory fisheries, which should include rules to protect vulnerable populations, communities and habitats. This approach should be supported by regular review of stocks status and downwards revision of catch estimates if appropriate, alongside measures to prevent significant adverse impacts on VMEs and the monitoring of all fishing effort, catch statistics and interactions with VMEs.

Exploratory Fishery Protocol should be established as first step in exploratory fisheries. The Protocol requires the prior approval of separate plans for fishing, mitigation, catch monitoring and data collection.

References

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NORTH PACIFIC FISHERIES COMMISSION (NPFC)

Partner short name: MRAG EU

a. Legal framework and implications

NPFC has two Conservation Management Measures (CMMS), 2021-05 and 2019-06, to affect the conservation and management of all fisheries in the northwestern and northeastern Pacific Ocean, respectively. Both of these CMMs includes, in Annex 1, current protocols for exploratory fisheries (EF) in their respective Convention Areas.

The Annexes call for precautionary CMM including precautionary effort limits, precautionary spatial catch limits, regular review of appropriate indices of stock status, and measures to prevent adverse impacts on VMEs. If approved, all EF are to be permitted only where the assessment concludes that they would not cause significant adverse impacts (SAI) on marine species or any VMEs, and on the basis and recommendation of the Scientific Committee (SC).

b. Definition/meaning of the concept "*exploratory fisheries*"

Annex 1 of both CMMs describes exploratory fisheries as "*all bottom fishing activities in new fishing areas and areas where fishing is prohibited in a precautionary manner or with bottom gear not previously used in the existing fishing areas*".

c. Description of the "*exploratory fisheries*" process and steps

When a member of the Commission would like to conduct exploratory fisheries, it is to follow the following procedure:

(i) Prior to the commencement of fishing, the member of the Commission is to circulate the information and assessment in Appendix 1.1 to the members of the SC for review and to all members of the Commission for information, together with the impact assessment. Such information is to be provided to the other members at least 30 days in advance of the meeting at which the information shall be reviewed.

(ii) The assessment in (i) above is to be conducted in accordance with the procedure set forth in "*Science-based Standards and Criteria for Identification of VMEs and Assessment of Significant Adverse Impacts on VMEs and Marine Species (Annex 2)*", with the understanding that particular care shall be taken in the evaluation of risks of the significant adverse impact on vulnerable marine ecosystems (VMEs), in line with the precautionary approach.

(iii) The SC is to review the information and the assessment submitted in (i) above in accordance with "*SC Assessment Review Procedures for Bottom Fishing Activities (Annex 3)*."

(iv) The exploratory fisheries are to be permitted only where the assessment concludes that they would not have significant adverse impacts (SAIs) on marine species or any VMEs and on the basis of comments and recommendations of SC. Any determinations, by any Member of the Commission or the SC, that the exploratory fishing activities would not have SAIs on marine species or any VMEs, shall be made publicly available through the NPFC website.

Appendix 1.1 and 1.2 to Annex 1 (identical in both CCMs) provide information to be provided before the start of EF (including a harvesting, mitigation and catch monitoring plan), and information to be included in a report to the SC (e.g. list of VME species encountered).

Within 3 months of the end of the exploratory fishery, or within 12 months of the commencement of fishing, the member of the Commission will provide a report of the results of their activities to the members of the SC and all Members of the Commission. The SC will review the report and decide whether the EF activities had SAIs on marine species or any VME. The SC will then send its recommendations to the Commission on whether the exploratory fishery can continue and whether additional management measures shall be required. Members of the Commission shall only authorize continuation of EF activities or commencement of commercial fishing activities, under this protocol on the basis of comments and recommendations of the SC.

d. Existence of a preliminary assessment, or bottom fishing impact assessment (BFIA): description of the content

Members of NPFC are required to provide the following information listed in Annex 1.1 of each CMM before exploratory fishery commences:

1. A harvesting plan including:

   a. Name of vessel
   b. Flag member of vessel
   c. Description of area to be fished (location and depth)
   d. Fishing dates
   e. Anticipated effort
   f. Target species
   g. Bottom fishing gear-type used
   h. Area and effort restrictions to ensure that fisheries occur on a gradual basis in a limited geographical area

2. A mitigation plan including measures to prevent SAI to VMEs that may be encountered during the fishery

3. A catch monitoring plan including:

   a. Recording/ reporting of all species brought onboard to the lowest possible taxonomic level
   b. 100% satellite monitoring
   c. 100% observer coverage

4. A data collection plan:

   a. Data is to be collected in accordance with "*Type and Format of Scientific Observer Data to be Collected*" (Annex 5)

The above information is reviewed by the SC in accordance with guidelines and criteria to assess potential SAIs on VMEs and marine species (Annex 2). Each member of the Commission is required to conduct an impact assessment to establish if exploratory bottom fishing activities are likely to produce SAIs in a VME. Such an impact assessment needs to include, *inter alia:*

(a) Type of fishing conducted or contemplated, including vessel and gear types, fishing areas, target and potential bycatch species, fishing effort levels and duration of fishing;

(b) Best available scientific and technical information on the current state of fishery resources, and baseline information on the ecosystems, habitats and communities in the fishing area, against which future changes are to be compared;

(c) Identification, description and mapping of VMEs known or likely to occur in the fishing area;

(d) The data and methods used to identify, describe and assess the impacts of the activity, identification of gaps in knowledge, and an evaluation of uncertainties in the information presented in the assessment;

(e) Identification, description and evaluation of the occurrence, scale and duration of likely impacts, including cumulative impacts of activities covered by the assessment on VMEs and low-productivity fishery resources in the fishing area;

(f) Risk assessment of likely impacts by the fishing operations to determine which impacts are likely to be SAIs, particularly impacts on VMEs and low-productivity fishery resources (Risk assessments are to take into account, as appropriate, differing conditions prevailing in areas where fisheries are well established and in areas where fisheries have not taken place or only occur occasionally);

(g) The proposed mitigation and management measures to be used to prevent SAIs on VMEs and ensure long-term conservation and sustainable utilization of low productivity fishery resources, and the measures to be used to monitor effects of the fishing operations.

e. Review of conservation and management measures to prevent significant adverse impacts

Precautionary conservation and management measures, including catch and effort controls, are essential during the exploratory phase of deep sea fisheries. Implementation of a precautionary approach to sustainable exploitation of deep sea fisheries shall include the following measures:

(i) precautionary effort limits, particularly where reliable assessments of sustainable exploitation rates of target and main by-catch species are not available;

(ii) precautionary measures, including precautionary spatial catch limits where appropriate, to prevent serial depletion of low-productivity stocks;

(iii) regular review of appropriate indices of stock status and revision downwards of the limits listed above when significant declines are detected;

(iv) measures to prevent significant adverse impacts on vulnerable marine ecosystems; and

(v) comprehensive monitoring of all fishing effort, capture of all species and interactions with VMEs.

f. Exploratory fisheries monitoring

Members of the Commission must ensure that all vessels flying its flag conducting EF are equipped with a satellite monitoring device and have an observer onboard at all times.

As mentioned in section d, there must be 100% observer coverage and satellite monitoring during any exploratory fishing activity, and all species landed must be identified and recorded to the lowest taxonomic level.

Scientific observer data is collected under a data collection plan (d), which includes the collection of data for the detection of fishing in association with VMEs. Here, the SC is required to develop a guideline, species list and identification guide for benthic species (e.g. sponges, sea fans, corals) whose presence in a catch will indicate that fishing occurred in association with a VME. All observers on vessels are to be provided with copies of this guideline, species list and ID guide.

g. Experience with exploratory fishery protocols

The NPFC has never had an exploratory fishery since it was established in 2015. However, the SC received a request from Russia about its plan to resume its crab fishery in the Convention Area a few years ago. Even though this seemed not to fall under exploratory fishery protocol because it was not a new fishery, and the member changed its plans later and did not resume crab fishery (Alex Zavolokin, Science Manager of NPFC, *personal communication* May 2021).

h. Strengths and weaknesses of the exploratory fishery protocols

A strength is that the CMMs for the Convention sets out clear procedures in their exploratory fisheries protocols and the SC undertakes a thorough review of EF activities prior to it starting, within 3 months of the end of the exploratory fisheries, or within 12 months of the commencement of fishing. All members of the Commission are kept up to date throughout the process.

New and exploratory fishing are subject to the exploratory fishery protocol included as Annex 1 of CMM 2019-06 (Entered into force 29 November 2019) and CMM 2021-05 (Entered into force 10 July 2021). However, there are no specific exploratory fisheries protocols; in Appendix 1.1 of both CMMs, information to be provided for the preparation of exploratory fisheries is lacking.

The Interim Measures are voluntary, and exist to guide the participants into adopting their own national measures governing the behaviour of their fishing vessels. States are asked to report on their implementation of the voluntary measures, but there is no penalty for violations. For example, there are no technical guidelines for submitting a data collection/ catch monitoring plan or specific measures to mitigate SAIs on VMEs that may be encountered during exploratory fisheries. There are no specific reporting requirements during the course of and after the proposed exploratory fisheries. Moreover, there is a lack of detail in the procedures to evaluate impacts of exploratory fisheries operations on VME based on post-fishing reports.

Although the SC has drafted TORs for the development of technical guidelines that supplement exploratory fishery protocols (see Annex J; Scientific Committee, 2017), a weakness is that there has been no progress on this work since 2017.

i. Recommendations

It is recommended that NPFC provide an updated protocol that is explicit and details the requirements for individual member state. Moreover, detailed guidelines on how the exploratory fisheries will be enforced in practice should be provided in an updated protocol. Specifically the following updates and recommendations should be made (especially in the case of NPFC) (see Annex J; Scientific Committee, 2017):

- Develop technical guidelines for preparation and submission of notifications of exploratory fisheries that qualify the information required by Appendix 1.1;
- Develop templates for submitting preliminary assessments of the potential for proposed bottom fishing activities to have significant adverse impacts on VMEs (e.g. specify the pre-fishing assessment procedure and requisite information);
- Specify data collection plan and reporting requirement during the course of and after the completion of the proposed exploratory fisheries;
- Consider procedures to evaluate the impacts of exploratory fishing operations on VMEs (and fish stocks) based on the post-fishing reports (e.g. improve reporting requirements).

j. Other issues that could be useful for providing options for a framework for "*exploratory fisheries*"

As above.

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SOUTH PACIFIC REGIONAL FISHERIES MANAGEMENT ORGANISATION (SPRFMO)

Partner short name: IEO

a. Legal framework and implications

Conservation and Management Measure for the Management of New and Exploratory Fisheries in the SPRFMO Convention Area (CMM 13-2021) (Exploratory Fisheries), details the framework which governs the management of new and exploratory fisheries in the SPRFMO Convention Area (SPRFMO, 2021a). The objective this CMM is to: *"ensure that sufficient information is available to evaluate the long term potential of new and exploratory fisheries, to assist the formulation of management advice, to evaluate the possible impacts on target stocks and non-target and associated and dependent species, to ensure new and exploratory fishery resources are developed on a precautionary and gradual basis and to promote the sustainable management of new and exploratory fisheries."*

The main legal framework related to SPRFMO exploratory fisheries is as follows:

1. Articles 3(1)(a)(i) and (ii) of the SPRFMO Convention which call on the Commission, in giving effect to the objectives of the Convention, to adopt CMMs that take account of international best practices and protect the marine ecosystem, particularly ecosystems with long recovery times following disturbance.

2. Articles 3(1)(b) and (2) of the Convention which call on the Commission to apply the precautionary approach and ecosystem-based approach to fishery resources under the mandate of the Convention. Particularly, new and exploratory fisheries should not be permitted to expand faster than the acquisition of information necessary to ensure that the fishery can and will be developed in accordance with the principles set out in Article 2.

3. United Nations General Assembly (UNGA) Resolution 61/105 which calls upon Regional Fisheries Management Organisations (RFMOs) to assess, on the basis of the best available scientific information, whether individual bottom fishing activities would have significant adverse impacts on vulnerable marine ecosystems, and to ensure that if it is assessed that these activities would have significant adverse impacts, they are managed to prevent such impacts, or not authorised to proceed.

4. UNGA Resolution 64/72 which calls upon RFMOs to establish and implement appropriate protocols for the implementation of UNGA Resolution 61/105, including definitions of what constitutes evidence of an encounter with a VME, in particular threshold levels and indicator species; and to implement the FAO Guidelines for the Management of Deep-sea Fisheries in the High Seas (FAO, 2009) in order to sustainably manage fish stocks and protect VMEs.

5. UNGA Resolutions 71/123 and 72/72 call upon RFMOs to use the full set of criteria in the FAO International Guidelines (FAO, 2009) to identify where VMEs occur or are likely to occur as well as for assessing significant adverse impacts, to ensure that impact assessments, including for cumulative impacts of activities covered by the assessment, are conducted consistent with the FAO Guidelines, are reviewed periodically and are revised whenever a substantial change in the fishery has occurred or there is relevant new information, and that, where such impact assessments have not been undertaken, they are carried out as a priority before authorising bottom

fishing activities, and to ensure that CMMs are based on and updated on the basis of the best available scientific information, noting in particular the need to improve effective implementation of thresholds and move-on rules.

6. CMM 03-2021 on the Management of Bottom Fishing in the SPRFMO Convention Area (Bottom Fishing) (SPRFMO, 2021b) which place a number of obligations on Members and CNCPs who intend to authorise their flagged vessels to engage in any bottom fishing in the Convention Area.

b. Definition/meaning of the concept "*exploratory fisheries*"

In the CMM 13-2021 (Exploratory Fisheries) both "*new and exploratory fisheries*" are referred as "*exploratory fisheries*" (SPRFMO, 2021a).

For the purposes of this CMM, a fishery is defined as an "*exploratory fishery*": (i) if it has not been subject to fishing in the previous ten years; or (ii) for the purposes of fishing with a particular gear type or technique, if it has not been subject to fishing by that particular gear type or technique in the previous ten years; or (iii) if fishing in that fishery has been undertaken in the previous ten years pursuant to this CMM, and a decision has not yet been taken in accordance with paragraph 25[11] or 26[12] of this CMM to either close or manage the fishery as an established fishery; or (iv) if it is of a kind listed in paragraph 15 of CMM 03-2021 (Bottom Fishing) (SPRFMO, 2021b), that is, any proposals to undertake bottom fishing: (i) outside a SPRFMO Management Area[13]; or (ii) inside a Management Area using bottom fishing methods other than bottom trawl, midwater trawl or bottom line fishing; or (iii) in a mid-water trawl Management Area using bottom trawl gear or in a bottom line Management Area using bottom trawl or mid-water trawl gear; or (iv) inside a Management Area targeting species not previously targeted in the area proposed to be fished (unless the species has regularly been caught as part of an existing fishery). All these proposals shall be handled in accordance with CMM 13-2021.

c. Description of the "*exploratory fisheries*" process and steps

SPRFMO Exploratory fisheries process is indicated in the CMM-13-2021 (Exploratory Fisheries). This process is quite complex and it is connected with CMM 03-2021 (Bottom Fishing) and the SPRFMO Bottom Fishing Impact Assessment Standard (SPRFMO, 2019), as part of a suite of measures aimed at promoting sustainable and profitable fisheries that minimise harm to the marine ecosystem.

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[11] Paragraph 25. Once an exploratory fishery has been fished for 10 years pursuant to this CMM, any further fishing in that fishery shall be undertaken only in accordance with a CMM adopted by the Commission in accordance with paragraph 26 to manage that fishery as an established fishery.

[12] Paragraph 26. At any time if the Commission is satisfied that sufficient information is available: (a) to evaluate the distribution, abundance and demography of the target species to inform an estimate of the exploratory fishery's potential yield; and (b) to review the exploratory fishery's potential impacts on non-target and associated or dependent species and the marine ecosystem in which the fishery occurs; and (c) to allow the SC to formulate and provide advice to the Commission on appropriate management arrangements; the Commission may take a decision, on the application of any Member, to manage the fishery as an established fishery.

[13] SPRFMO Commission established an "Evaluated Area" and within this area, three associated "Management Areas" (bottom trawl, midwater trawl, and bottom lining Management Areas). Except in the case of exploratory fisheries, fishing in the SPRFMO Convention Area shall occur only in the three above mentioned Management Areas with the following gear restrictions: (i) Bottom trawling shall only occur in a bottom trawl Management Area, (ii) Midwater trawling shall only occur in a midwater trawl Management Area or a bottom trawl Management Area, (iii) Bottom lining (e.g. longlines, hand lines, drop lines, trot lines, etc.) shall only occur in a Management Area. All other situations shall be managed under CMM 13-2021 as exploratory fisheries (see section b).

The process involves several steps and considerations from the Commission and different Committees, including the review of the measure.

REQUIREMENTS FOR EXPLORATORY FISHERIES

Any Member or cooperating non-contracting party (CNCP) seeking to permit a vessel that flies its flag to fish in an exploratory fishery, or to fish in an exploratory fishery with a gear type that has not been used in that fishery for the previous ten years; shall submit:

1. A succinct description of their intended Fisheries Operation Plan for information purposes, using the templates developed by the Scientific Committee (SC), no less than 120 days prior to its next annual meeting. The Secretariat shall circulate this description to all Members and CNCPs, 115 days in advance of its next annual SC meeting.

2. A full Fisheries Operation Plan shall be submitted, taking into account paragraph 6 of CMM-13-2021 (jointly submissions of plans if several countries are seeking to participate) if relevant (not less than 60 days in advance of the next annual meeting of the SC), according to the following:

    2.a) submit an application to the Commission to permit a vessel or vessels that fly its flag to fish in that exploratory fishery, according paragraphs 2 and 3 of Annex 1 of CMM 05-2021 (Record of Vessels);

    2.b) prepare and submit a Fisheries Operation Plan to the SC, including the following information:

i) Description of the exploratory fishery: area, target species, proposed methods of fishing, proposed maximum catch limits and any apportionment of that catch limit among areas or species.

ii) Specification and full description of the types of fishing gear to be used, including any modifications made to gear intended to mitigate the effects on non-target and associated or dependent species or the marine ecosystem in which the fishery occurs.

iii) The time period the Fisheries Operation Plan covers (up to a maximum period of three years).

iv) Any biological information on the target species from comprehensive research and/or survey cruises (e.g. distribution, abundance, demographic data and information on stock identity).

v) Details of non-target and associated or dependent species and the marine ecosystem in which the fishery occurs, the extent to which these would be likely to be affected by the proposed fishing activity and any measures that will be taken to mitigate these effects.

vi) The anticipated cumulative impact of all fishing activity in the area of the exploratory fishery if applicable.

vii) Information from other fisheries in the region or similar fisheries elsewhere that may assist in the evaluation of the relevant exploratory fishery's potential yield, to the extent the Member or CNCP is able to provide this information;

viii) if the proposed fishing activity is bottom fishing, as defined in CMM 03-2021 (Bottom Fishing), the assessment[14] of the impact of their flagged vessels' bottom fishing activities, prepared pursuant to paragraph 21(a) of CMM 03-2021 (Bottom Fishing).

ix) where the target species is also managed by an adjacent RFMO or similar, a description of that neighbouring fishery sufficient to allow the SC to formulate its advice in accordance with paragraph 10 of CMM-13-2021.

2.c) provide a commitment in its proposal to implement the Data Collection Plan for the exploratory fishery developed in accordance with paragraph 11 of CMM-13-2021, should the Commission approve fishing in accordance with the Fisheries Operation Plan.

When several SPRFMO members/CNCPs are seeking to participate in an Exploratory Fishery for the same area/timeframe, all the participants of the proposed fishery shall made efforts to jointly submit the Fisheries Operation Plan.

SCIENTIFIC COMITTE CONSIDERATIONS

Regarding the Fisheries Operation Plans

At its annual meeting, the SC shall consider all Fisheries Operations Plans submitted pursuant to paragraph 5 of CMM-13-2021, and all relevant information provided (e.g. from Data Collection Plan).

The SC shall provide recommendations and advice to the Commission on each Fisheries Operation Plan on the following: (i) management strategies or plans for fishery resources; (ii) reference points, including precautionary reference points as described in Annex II of the 1995 Agreement; (iii) an appropriate precautionary catch limit; (iv) the cumulative impacts of all fishing activities in the area of the exploratory fishery; (v) the impact of the proposed fishing on the marine ecosystem; (vi) the sufficiency of information available to inform the level of precaution required and the degree of certainty with which the SC's advice is provided; (vii) the degree to which the approach outlined in the Fisheries Operation Plan is likely to ensure the exploratory fishery is developed consistently with its nature as an exploratory fishery, and consistently with the objectives of Article 2 of the Convention; (viii) in respect of a Fisheries Operation Plan that proposes any bottom fishing activity, advice and recommendations in accordance with paragraph 21 (b) of CMM 03-2021 (Bottom Fishing).

Regarding the Data Collection Plans

The SC shall develop a Data Collection Plan in respect of that exploratory fishery which should include research requirements. The Data Collection Plan shall identify and describe the data needed and any operational research actions necessary to obtain data to enable: (i) an assessment of the stock; (ii) the feasibility of establishing a fishery and (ii) the impact of fishing activity on non-target, associated or dependent species and the marine ecosystem in which the fishery occurs. The SC shall review and update the Data Collection Plan for each exploratory fishery annually as appropriate.

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[14] Each Member or CNCP proposing to participate in bottom fishing activities shall submit to the Scientific Committee a proposed assessment that meets the SPRFMO Bottom Fishery Impact Assessment Standard (BFIAS).

Data Collection Plan requirements: (i) a description of the catch, effort and related biological, ecological and environmental data required to undertake the evaluations described in paragraph 26 of CMM-13-2021; (ii) the dates by which the data must be provided to the Commission; (iii) a plan for directing fishing effort in an exploratory fishery to allow for the acquisition of relevant data to evaluate the fishery potential and the ecological relationships among harvested, non-target and associated and dependent populations and the likelihood of adverse impact; (iv) where appropriate, a plan for the acquisition of any other research data obtained by fishing vessels, including activities that may require the cooperative activities of scientific observers and the vessel, as may be required by the SC to evaluate the fishery potential and the ecological relationships among harvested, non-target, associated and dependent populations and the likelihood of adverse impacts; (v) an evaluation of the time scales involved in determining the responses of harvested, dependent and related populations to fishing activities.

COMPILANCE AND TECHNICAL COMMITTEE CONSIDERATIONS

The Compliance and Technical Committee (CTC) shall consider any Fisheries Operation Plan and any advice of the SC thereon and provide advice and recommendations to the Commission on appropriate management arrangements, including in light of the obligations in CMM 03-2021 (Bottom Fishing), if applicable.

COMMISSION CONSIDERATIONS

At its annual meeting, the Commission shall consider all Fisheries Operation Plans, any advice or recommendations provided by the SC and CTC**,** and any applicable obligations under CMM 03-2021 (Bottom Fishing) in respect of the proposed fishing activity. On the basis of this consideration, the Commission shall take a decision as to whether to approve fishing in the exploratory fishery in accordance with the Fisheries Operation Plan and for what period of time, up to a maximum period of three years.

If the Commission approves fishing in accordance with the Fisheries Operation Plan it shall adopt a CMM in respect of the exploratory fishery which shall include a precautionary catch limit and any other management measures the Commission considers appropriate.

The Commission may amend a Fisheries Operation Plan, as necessary, prior to approving fishing. Exploratory fisheries shall only be open to those vessels that are equipped and configured to comply with all relevant CMMs.

SPECIFICATIONS OF THE FISHING ACTIVITY

Commitments for Members and CNCPs

Members and CNCPs: (i) Shall not permit their flagged vessels to fish in an exploratory fishery without approval from the Commission; (ii) Shall ensure that any vessel that flies their flag only fishes in an exploratory fishery in accordance with the Fishery Operations Plan prepared and approved in respect of that vessel's proposed fishing activity; (iii) Shall ensure that where their flagged vessels fish in an

exploratory fishery, the data[15] required by the Data Collection Plan is provided to the

[15] Members and CNCPs whose vessels participate in exploratory fisheries shall be prohibited from fishing in the relevant exploratory fishery if the data specified in the Data Collection Plan has not been submitted to the Commission for the most recent season in which the fishing occurred, until the relevant data has been submitted to the Commission and the Scientific Committee has had the opportunity to review that data.

Commission, according to CMM 02-2021 (Data Standards); (iv) Shall ensure that each vessel participating in exploratory fisheries that flies its flag carries one or more independent observers sufficient to collect data in accordance with the Data Collection Plan.

None of the obligations in this measure exempt a Member or CNCP from complying with any other obligations in the Convention or any CMM adopted by the Commission. Any fishing activity undertaken pursuant to this CMM will not be considered to be a precedent for future allocation decisions.

Conditions for a replacement vessel

Members and CNCPs shall be entitled to authorise fishing in an exploratory fishery by a flagged vessel not identified in the Fisheries Operation Plan if a vessel specified in the Fisheries Operation Plan is prevented from fishing on account of legitimate operational or force majeure reasons and a replacement vessel is proposed. In such circumstances the Member or CNCP concerned shall immediately inform the Secretariat and provide: (i) full details of the intended replacement vessel; (ii) a comprehensive account of the reasons for the replacement and any relevant supporting evidence; (iii) specifications and a full description of the types of fishing gear to be used by the replacement vessel. The Secretariat shall circulate this information to all Members and CNCPs as soon as possible.

REVIEW OF THE MEASURE

Once a Fisheries Operation Plan expires, a Member or CNCP may prepare a new Fisheries Operation Plan in accordance with paragraph 5 of CMM-13-2021.

Once an exploratory fishery has been fished for 10 years pursuant to this CMM, any further fishing in that fishery shall be undertaken only in accordance with a CMM adopted by the Commission in accordance with paragraph 26 to manage that fishery as an established fishery.

At any time if the Commission is satisfied that sufficient information is available: (i) to evaluate the distribution, abundance and demography of the target species to inform an estimate of the exploratory fishery's potential yield; (ii) to review the exploratory fishery's potential impacts on non-target and associated or dependent species and the marine ecosystem in which the fishery occurs; (iii) to allow the SC to formulate and provide advice to the Commission on appropriate management arrangements; the Commission may take a decision, on the application of any Member, to manage the fishery as an established fishery.

This measure shall be reviewed at the annual meeting of the Commission in 2021. Such review shall take into account, inter alia, the most recent advice of the SC on exploratory fisheries.

d. Existence of a preliminary assessment, or bottom fishing impact assessment (BFIA): description of the content

In October 2019, the 7th meeting of the Scientific Committee (SC) approved an updated Bottom Fishery Impact Assessment Standard – BFIAS (SPRFMO, 2019). SC shall review the BFIAS every five years to ensure that it reflects best practice. Prior to this, at the 3rd Session of the Preparatory Conference in February 2012, SPRFMO had adopted the 2011 version of the BFIAS, taken into account relevant aspects of the FAO Guidelines (FAO, 2009).

The SPRFMO BFIAS applies to all bottom fishing across all fishable depths within the SPRFMO area. This includes the Evaluated Area and associated Management Areas specified in CMM 03-21(Bottom Fishing). The BFIAS also applies to all proposed new and exploratory bottom fishing activities in accordance with paragraph 5(b) viii of CMM 13-2021 (Exploratory Fisheries) (see section c, point 2b. viii).

It is worth highlighting that, the updated SPRFMO BFIAS goes beyond the issue of VMEs. Its purpose is to provide a standardized approach for assessing cumulative impacts of bottom fishing activities on VMEs, deep sea fish stocks and marine mammals, reptiles, seabirds and other species of concern, as well as a standardized approach for assessing bottom fishing impacts of new and exploratory fisheries.

This standard is intended to guide SPRFMO participants in preparing the required bottom fishery impact assessments, and to guide the SC when reviewing these assessments.

BIFIA PROCESS

The SPRFMO assessments shall follow the procedures outlined in CMM 03-2021:

1. Each Member or cooperating non-contracting party (CNCP) proposing to participate in bottom fishing activities shall submit to the SC a proposed assessment that meets the SPRFMO BFIAS (SPRFMO, 2019), with the best available data including consideration of cumulative impacts, not less than 60 days prior to the annual meeting of the SC. These submissions shall also include the mitigation measures proposed by the Member or CNCP to prevent such impacts.

2. The SC shall undertake a review of the proposed assessment and provide advice to the Commission on: (i) whether the proposed bottom fishing would contribute to having significant adverse impacts on deep sea fish stocks for which no stock assessment has been completed, by-catch species and/or VMEs and, if so; (ii) whether any proposed or additional mitigation measures would prevent such impacts.

3. In its review of the proposed assessment, the SC may use additional information available to it, including information from other fisheries in the region or similar fisheries elsewhere.

4. On the basis of the SC's review of the submitted assessment, taking into account any recommendations and advice of the SC and in line with the precautionary approach, the Commission shall: (i) consider whether, and if applicable the extent to which, bottom fishing in the Management Areas for which the proposed assessment was conducted should be authorized; (ii) which, if any, additional measures to those proposed are required to prevent significant adverse impacts on VMEs; (iii) which, if any, additional precautionary measures are required where it cannot adequately be determined whether VMEs are present or whether fishing could cause significant adverse impacts on VMEs, and (iv) in relation to an application to target a species for which no total catch limit exists, consider an exemption for such a Member or CNCP to paragraph 10 of CMM 03a-2021 (Deepwater Species), bearing in mind the need to be precautionary.

Members and CNCPs whose bottom fishing proposal has been authorized, shall ensure that a proposed assessment meeting the requirements contained in paragraph SPRFMO BFIAS (SPRFMO, 2019) is submitted to the SC and Commission at least every 3 years, and also when a substantial change in the fishery has occurred such that it is likely that the risk or impact of the fishery may have changed. According to the BFIAS, SPRFMO bottom fishery impact assessments and the SC's review of such assessments are to be made publicly available on the SPRFMO website. Participants are required to update bottom fishery impact assessments (including cumulative bottom fishery impact assessments) at least every five years, and whenever a substantial change in the fishery occurs or is proposed (e.g. changes in existing or intended fishing areas, fishing technique, management measures or the use of different types of vessels or gears), such that it is likely that the risk or impact of the fishery may change.

Many of these changes would also trigger the requirement for a new and exploratory fishing proposal (CMM 13). The onus for updating bottom fishing impact assessments (including cumulative assessments) will be on the Member or CNCPs.

CONTENT OF THE BFIA

The content of the BFIA (SPRFMO, 2019) is in line with FAO Guidelines (FAO 2009). Contracting Parties shall submit the following information, to be assessed by the SC:

1. Description of fishing activities: Detailed fishing plan, providing a quantified description of fishing activities (e.g. details of the vessels, description of fishing methods, seabed depth range, target and by-catch species, temporal aspects of fishing, effort indices, estimated total catch and discards, information required in CMM 13 in case of new or exploratory fisheries).

2. Mapping and description of fishing areas: Maps of the fishing areas in relation to available information on VMEs and seabed bathymetry (e.g. maps by method and target species, mapping of predictive habitat suitability models for VME indicator taxa or topographic features likely to support such VME indicator taxa, baseline data and description of the fishing areas, etc.).

3. Risk and impact assessment framework: SPRFMO BFIAS is structured around the following components: (i) Identification of objectives, assets, hazards and risks using a hierarchical risk assessment approach, (ii) Identification and assessment of impacts, (iii) Identification of mitigation, management and monitoring measures relevant to impacts and residual risks, and (iv) iterative and adaptive review (i.e. periodic reassessment and improvement). The Hobday *et al.* (2011) approach is an ecological risk assessment approach that, in this context, is nested within the SPRFMO BFIAS framework.

   The assessment should contain the following sections:

   a. *Scoping of objectives, assets and hazards*: identify objectives as well as all assets of value against all potential hazards the fisheries may pose: (i) target species; (ii) by-catch species; (iii) seabirds, marine mammals, reptiles and other species of concern, and (iv) benthic habitats, biodiversity and VMEs. For each hazard to be evaluated (e.g. fishing activity, taken into account each gear type used by all vessels, loss of bottom fishing gear, including the risk of ghost fishing and physical impact, non-gear impacts, for example bird strikes with vessels, offal discharge, use of lights at night etc.), a description of the impacts should be provided, in terms of what has been or may be affected and how. Any hazards that cannot be demonstrated to be low need to be assessed in more detail.

   b. *Information on status of the deepwater stocks to be fished*: information on the estimated status of the stocks of the intended target and by-catch species, for both established and exploratory fisheries (e.g. list of the intended target and by-catch species, historic catches and catch trends of these species in the intended fishing area, analyses of historic nominal and/or standardised CPUE trends, results of any surveys, results of the most recent stock assessments, any other relevant information on the status and sustainability of the mentioned species).

If a robust stock assessment is available with relevant reference points, this would constitute a high standard of risk assessment, where the outputs relative to reference points indicates the risk to the stocks, and where the impacts of fishing on the stocks can be managed and monitored (e.g. through a fishery harvest strategy). Where information is not available to provide fully quantitative assessments, specific methods[16] could be applied to provide estimates of risk and/or status based on species' biological characteristics in relation to the spatial extent/intensity of fishing.

c. *Interactions with marine mammals, reptiles, seabirds and other species of concern*: information on the estimated risk to, and/or status for both established and exploratory fisheries (e.g. list of the likely by-catch species and any conservation status, historic interactions with these species, including interaction types and life status, results or reference to any assessments or surveys conducted on these species, any other information relevant to understanding the status and sustainability of these species). This information should be used to describe impacts[17] on these species.

d. *Interactions with benthic habitats and VMEs*: address the impacts of the fishing gear on potential VMEs/VME indicator taxa: (i) What impacts on potential VMEs/VME indicator taxa are likely to result from the fishing gears to be used? All impacts should be identified, characterised and, if possible, quantified or ranked; (ii) What will be the probability, likely extent (% of habitat targeted) and intensity of the interaction between the proposed fishing gear/targeting practices on potential VMEs/ VME indicator taxa?; (iii) What are the characteristics of the habitats and benthic communities that may be impacted? Are the fished seabed features likely to support VMEs/VME indicator taxa? Do these areas include fragile or habitat-forming species? What proportion of the estimated distribution range of these potential VMEs/VME indicator taxa will the fishing activities impact? How widespread or localized are the potential VMEs/VME indicator taxa? How vulnerable are they to impact by the fishing gears?; (iv) How diverse is the ecosystem, and will the fishing activity reduce biodiversity? Do the fishing areas contain species that do not occur elsewhere? What are the levels of endemism? Could fishing lead to localised/global extinctions?; (v) What is the likely spatial scale and duration of the impacts? Will impacts be cumulative with previous impacts in the area? The overall consequences of impact will be the product of spatial scale, duration and cumulative impact on potential VMEs/VME indicator taxa and other marine resources. To the extent possible, rates of recovery, regeneration and re-colonisation should be quantified or estimated.

e. *Risk assessment for benthic habitats, biodiversity and VMEs*: Determining the level of risk to benthic habitats, biodiversity and VMEs for each hazard should be based on quantifiable criteria where possible. Where quantitative risk assessment approaches are used, evaluations of interactions will be directly provided by those assessments. Where qualitative criteria are used

[16] Productivity-Susceptibility Analysis (PSA, e.g. Stobutzki *et al.* 2002), Sustainability Assessment For Fishing Effects (SAFE, e.g. Zhou *et al.* 2008; Zhou *et al.* 2019) and Ecological Assessment of Sustainable Impacts of Fisheries (EASI-Fish, Griffiths *et al*. 2018).

[17] Some examples of approaches are mentioned: Ecological Risk Assessment (e.g. Hobday *et al.* 2011, Ford *et al.* 2015; Richard *et al*. 2017, Georgeson *et al*. 2019), a simple extrapolation of by-catch. Given the rareness of interactions with many of these species in established SPRFMO bottom fisheries and various uncertainties in some ERAs (e.g. PSA), a qualitative expert-based assessment (e.g. Scale-Intensity-Consequence Analysis (SICA) as applied by Ford *et al*. (2015)) may be preferable.

due to data gaps, qualitative judgments should be justified as far as possible by quantitative analyses. Criteria that should be considered are:

i. *Intensity* – The intensity or severity of the impact. This will be influenced by the unit of analysis chosen for the assessment (i.e. the scale at which impact is assessed) and should, where possible, be based on <u>quantitative measures</u> derived from impact assessment methods that have been applied successfully elsewhere (e.g. Sharp *et al*. 2009, Ellis *et al.* 2014; Pitcher *et al.* 2016a).

   Where quantitative approaches are not possible, intensity may be quantified by previous studies or an expert evaluation: (i) *None:* no detectable impact; (ii) *Low:* some physical damage to some taxa/colonies; (iii) *Medium:* substantial damage to a small proportion of colonies/taxa, or small damage to a large number of taxa at the site, likely to modify biological and ecological processes; (iv) *High:* significant damage to a significant proportion, where ecological functions and processes are significantly altered such that they temporarily or permanently cease.

ii. *Duration* – how long the effects of the impact may last.

iii. *Spatial extent* – The spatial impact relative to the extent of VME indicator taxa (e.g. will fishing impact 5%, 30% or 80% of the VME indicator taxa distribution) and whether there may be offsite impacts (e.g. will reproduction be impacted at a broader spatial scale).

iv. *Cumulative impact* – The frequency of the impact will influence the risk, with activities occurring repeatedly at a site likely to have a greater risk. This will depend on the amount of fishing effort and should be considered in relation to the recovery of the VMEs/taxa. Other potential cumulative impacts (e.g. non-fishing impacts) should also be considered.

v. *Overall risk* – The overall risk ranking of an activity is evaluated from the combination of the criteria used. The method for combining these criteria to assign low, medium or high risk to an activity — or preferably, to derive absolute estimates of status — should be detailed in the assessment report.

   If methods to derive absolute estimates of status are unable to be applied, the following risk categories apply: (i) *Low:* Where the impact will have a low or negligible influence on the environment and no active management or mitigation is required (impacts of low intensity and duration, and/or impacts of any intensity, if they occur at a local scale and are of temporary duration); (ii) *Medium:* Where the impact could have an influence on the environment, which will require active modification of the management approach and/or mitigation (short to medium-term impacts of moderate intensity, locally to regionally, with possibility of cumulative impact); (iii) *High:* Where the impact could have a significant negative impact on the environment, such that the activities causing the impact should not be permitted to proceed without active management and mitigation to reduce risks and impacts to acceptable levels (impacts of high intensity that are local, but last for longer, and/or impacts which extend regionally and beyond, with high likelihood of cumulative impact).

Where there are data limitations a robust categorical scoring-based or expert-based risk assessment should be used which considers the criteria above, as well as more precautionary monitoring, management and mitigation measures.

f. *Mitigation, management and monitoring measures*: Detailed description of the mitigation measures, management (to avoid or minimise the likelihood of SAI), and monitoring measures (to ensure the effectiveness of management and to detect any change in the impact) that are currently in place or planned to be implemented to limit the residual impacts to acceptable levels. The following monitoring measures should be implemented, according to the correspondant CMM: (i) VMS systems (CMM 06); (ii) catch and effort data collection and reporting systems, including retained and discarded by-catches and VME indicator taxa (CMM 02); (iii) scientific observer coverage (CMM 02), (iv) data that will be provided to the Secretariat, other information (e.g. seabed bathymetry or mapping, VME identification and characterization) and reporting of all benthic by-catch (CMM 02); (v) Where quantitative risk assessment approaches are used (e.g. Pitcher *et al.,* 2016a; 2016b), these approaches should also be used to evaluate the effectiveness of proposed mitigation measures, by quantitatively evaluating the reduction in risk resulting from those mitigation measures.

g. *High level assessment across all assets/objectives*: summary statement of risks and impacts across all assets/objectives.

h. *Uncertainties, next steps and research requirements*: details of the uncertainties inherent in the various assessments made. It should detail a plan for how these uncertainties will be addressed, including outlining any additional research and/or data collection requirements.

EXCEPTIONS IN THE CONTENT OF BFIA

BFIA for exploratory fisheries shall be undertaken in accordance with SPRFMO BFIAS and the requirements of CMM 13 (Exploratory Fisheries). It shall consider all the elements of the SPRFMO BFIAS (see previous section "*CONTENT OF THE BFIA*"), except where the following differences have been identified, as is indicated in the Appendix D of the BFIAS (SPRFMO, 2019):

1. *Description of the proposed fishing activities*: Estimates of catch and discard quantities may not be available given the nature of the fisheries and so estimates of factors such as fishing duration, number of tows and potential catch rates should be provided. Once information is available from the new or exploratory fishery the impact assessment would be updated using this data,

2. *Mapping and description of fishing areas:* Maps of the proposed fishing areas should be provided. These maps should display seabed type, depth, bathymetry and, if available, any information on the location of known VMEs or the likelihood of VMEs or VME indicator taxa in the areas to be fished. Appendix A provides additional information on mapping,

3. *Impact assessment:* Where little information is available, predictive approaches should be used to evaluate the likelihood of interaction with, and potential impact on, VMEs or VME indicator taxa. All assumptions used in the impact assessment should be clearly stated and evaluated.

This section should describe the conditions for when a new assessment should be undertaken,

4. *Information on status of the deepwater stocks to be fished and on marine mammals, reptiles, seabirds and other species of concern:* Approaches such as ecological risk assessment could be used to inform the assessment of impact on deepwater stocks to be fished and on marine mammals, reptiles, seabirds and other species of concern with which the fishery will interact. Additionally, literature review and information from other fisheries should also be used to assist in evaluating potential impacts

5. *Monitoring, management and mitigation measures:* Monitoring, management and mitigation measures are critical in situations where new or exploratory fisheries are being undertaken. As outlined in the FAO Deep-sea Fisheries Guidelines (FAO, 2009). Therefore, assessments for new or exploratory fisheries must include a description of the monitoring, mitigation and precautionary management measures that will be in place, as outlined above. Details regarding the reporting of evidence of a VME to the SPRFMO Secretariat should be included.

e. Review of conservation and management measures to prevent significant adverse impacts

SPRFMO requires prior assessments for all bottom fishing (CMM-03-2021), including exploratory fisheries (CMM-13-2021), and has prohibited the use of large-scale pelagic driftnets and all deepwater gillnets (CMM-08-2019).

The time period of a Fisheries Operation Plan covers a maximum period of three years.

Members and CNCPs shall require vessels flying their flag and undertaking bottom fishing to implement seabird mitigation measures in accordance with CMM 09-2017 (Seabirds).

An encounter protocol and move on rule for VME indicator taxa in bottom fisheries are specified in CMM-03-2021. The adopted thresholds levels, the list of VME indicators, the procedures for scientific assessment of the encounters (including the use of VME habitat suitability models) and the provision of advice are matters of concern for some authors (e.g. see Fuller *et al.,* 2020).

Specific management measures are indicated in the correspondant CMM adopted for the different exploratory fisheries approved by the SPRFMO Commission (e.g. CMMs 14a-2019; 14b-2021; 14d-2020; 14e-2021). Besides the obligation to conduct the fishing in accordance to the details and specifications of the approved proposal (e.g. authorized vessels, fishing area and dates, total allowable catch if any, etc.), this includes particular measures such as: (i) gear specifications; (ii) minimum fish tagging rates; (iii) measures to mitigate deepwater sharks, skates and macrourid catches; (iv) data collection including target species, bycatch and VME indicators; (v) bycatch mitigation methods for marine mammals, seabirds and other species of concern.

f. Exploratory fisheries monitoring

According to CMM-13-2021 (Exploratory Fisheries) the Data Collection Plan is crucial in the SPRFMO Exploratory Fisheries. It is mandatory: members and CNCPs shall ensure the data required by the Data Collection Plan is provided to the Commission.

Moreover, members and CNCPs whose vessels participate in exploratory fisheries shall ensure that each vessel carries one or more independent observers to collect data required in the Data Collection Plan (100% observer coverage level). It is important to note that Members and CNCPs whose vessels participate in exploratory fisheries shall be prohibited from fishing if the data specified in the Data Collection Plan has not been submitted to the Commission.

Specific data collection requirements (e.g. capacity to collect the data, observers, video recording, time stamp and geo-location, VMS, etc.) are indicated in the correspondant CMM adopted for the different exploratory fisheries approved by the SPRFMO Commission (e.g. CMMs 14a-2019; 14b-2021; 14d-2020; 14e-2021).

Other measures related with monitoring of bottom fisheries, including the exploratory ones, are indicated in two specific measures: (i) CMM-02-2021 (Data Standards) regarding collection of data on fishing activities and the impacts of fishing; (ii) CMM 06-2020 (Commissions VMS) about the establishment of the Vessel Monitoring System in the SPRFMO Convention Area, and (iii) CMM-03-2021 (Bottom fishing) that includes general considerations of monitoring.

g. Experience with exploratory fishery protocols

There is some experience with exploratory fishery protocols in the SPRFMO Area, since New Zealand presented in 2015 a proposal to conduct exploratory bottom longlining for toothfish in the in mid-Pacific (SPRFMO, 2015). According to CMM-13-2021, when the Commission approves fishing in accordance with the proposed Fisheries Operation Plan (considering any advice from SC and CTC), it then adopts a CMM in respect of the particular exploratory fishery (e.g. recent CMMs 14a-2019; 14b-2021; 14d-2020; 14e-2021).

It is worth to note that in year 2018, the SC developed a summary table or "*checklist*" (SPRFMO, 2018) to better assess exploratory fishing applications. This table is considered very useful to the assessments and the provision of recommendations on the Fisheries Operation Plans and Data Collection Plans proposed by the applicants.

SC CHECKLIST FOR ASSESSMENT OF EXPLORATORY FISHERIES PROPOSALS

1. Fisheries Operation Plans

The SC shall provide recommendations and advice to the Commission on each Fisheries Operation Plan on the following matters, as appropriate:

a) management strategies or plans for fishery resources; [Noted that SC Interpreted this as to mean as having a clear objective for the fishery]

b) reference points, including precautionary reference points as described in Annex II of the 1995 Agreement;

c) an appropriate precautionary catch limit;

d) the cumulative impacts of all fishing activity in the area of the exploratory fishery;

e) the impact of the proposed fishing on the marine ecosystem;

f) the sufficiency of information available to inform the level of precaution required and the degree of certainty with which the Scientific Committee's advice is provided;

g) the degree to which the approach outlined in the Fisheries Operation Plan is likely to ensure the exploratory fishery is developed consistently with its nature as an exploratory fishery, and consistently with the objectives of Article 2 of the Convention; and

h) in respect of a Fisheries Operation Plan that proposes any bottom fishing activity, advice and recommendations in accordance with paragraph 12 of CMM 03-2018 (Bottom Fishing).

2. Data Collection Plans

When considering a Fisheries Operation Plan, the Scientific Committee shall develop a Data Collection Plan in respect of that exploratory fishery which should include research requirements, as appropriate. The Data Collection Plan shall identify and describe the data needed and any operational research actions necessary to obtain data from the exploratory fishery to enable an assessment of the stock, the feasibility of establishing a fishery and the impact of fishing activity on non-target, associated or dependent species and the marine ecosystem in which the fishery occurs. The SC shall review and update the Data Collection Plan for each exploratory fishery annually as appropriate.

The Data Collection Plan shall require, as appropriate:

a) a description of the catch, effort and related biological, ecological and environmental data required to undertake the evaluations described in paragraph 24;

b) the dates by which the data must be provided to the Commission;

c) a plan for directing fishing effort in an exploratory fishery to allow for the acquisition of relevant data to evaluate the fishery potential and the ecological relationships among harvested, non-target and associated and dependent populations and the likelihood of adverse impact;

d) where appropriate, a plan for the acquisition of any other research data obtained by fishing vessels, including activities that may require the cooperative activities of scientific observers and the vessel, as may be required by the Scientific Committee to evaluate the fishery potential and the ecological relationships among harvested, non-target, associated and dependent populations and the likelihood of adverse impacts; and

e) an evaluation of the time scales involved in determining the responses of harvested, dependent and related populations to fishing activities [Note that SC interpreted this to mean "*when will data be analysed and available*"].

3. Regarding Exploratory Fisheries for Cook Islands (CMM 14b)

a) a detailed and specific proposal and Fisheries Operation Plan that includes formal sampling designs and data collection plans for all phases of the proposed exploratory fishery that conform with CMM13 2019 (Exploratory fisheries);

b) a description of how the proposed fishing meets the requirements of the Convention and relevant CMMs, including a bottom fishing impact assessment;

c) propose measures to ensure the long-term viability of the target species, including reproduction;

d) a description of any fishing conducted to date, including effort, catch, and information on measures taken to protect VMEs.

CURRENT EXPLORATORY FISHERIES ASSESSED AND APPROVED IN THE SPRFMO AREA:

1. Exploratory Fishing for toothfish by New Zealand-flagged Vessels in the SPRFMO Convention Area (CMM 14a-2019. It expires following the regular meeting of the Commission in 2022):

Objective of this fishery: to provide for exploratory bottom longline fishing for toothfish in the Convention Area for the purpose of obtaining scientific data to support the following objectives: (i) Continue to map the bathymetry of the fishable area (shallower than about 2500 m) in mid-Pacific to the north of the SPRFMO-CCAMLR boundary; (ii) Document the spatial distribution, catch rates, and relative abundance of toothfish; (iii) Characterise the biology, life history and spawning of toothfish; (iv) Tag toothfish; (v) Collect information on bycatch; (vi) Collect toothfish eggs using plankton net tows if practical; (vii) Conduct Continuous Plankton Recorder (CPR) tows, and (viii) Collect acoustic data.

Dates, number and type of Vessels: 2019-2021; two longliners.

2. Exploratory Potting Fishery in the SPRFMO Convention Area, by Cook Islands (CMM 14b-2021. It expires on September 30th 2023):

Objective of this fishery: to provide for exploratory bottom pot fishing for lobster and crab in the Convention Area for the purpose of obtaining scientific data: (i) to allow the evaluation of the long term fishery potential for a lobster and crab fishery; (ii) to evaluate the possible impacts on the target stocks, associated or dependent species, and marine ecosystems; (iii) to evaluate the effectiveness of mitigation measures, and (iv) to ensure that the bottom pot exploratory fishery is developed on a precautionary and gradual basis according to the best available science.

Dates, number and type of Vessels: 1st July 2021- 30th 2023. One Pot trapping vessel.

3. Exploratory Fishing for toothfish by Chilean-Flagged Vessels in the SPRFMO Convention Area (CMM 14d-2020. It expires following the regular meeting of the Commission in 2023):

Objective of this fishery: To provide for exploratory bottom longline fishing for toothfish in the Convention Area for the purpose of obtaining scientific data to support the following objectives: (i) Map the bathymetry of the fishable area (shallower than about 2500 m) in the FAO Area 87.3 (Pacific South East excluding the coastal States EEZ), document the spatial distribution, catch rates, and relative abundance of toothfish; (ii) Characterise the biology, life history and spawning dynamics of toothfish; (iii) Tag toothfish; (iv) Take samples for further genetic studies; (v) Collect information on bycatch; (f) Provide occurrence information on marine mammals, seabirds, turtles, sharks and other species of concern.

Dates, number and type of Vessels: 2020-2022; one longliner.

4. Exploratory Fishing for Toothfish by the European Union in the SPRFMO Convention Area (CMM 14e-2021. It expires following the regular meeting of the Commission in 2024):

Objective of this fishery: to allow for exploratory bottom longline according to the best available science to meet the following objectives: fishing for toothfish (*Dissostichus* spp.), in the Convention Area on a precautionary and gradual basis according to the best available science to meet the following objectives: (i) to further explore the presence and distribution of toothfish; (ii) to collect and provide information and data contributing towards the sustainable management of potential toothfish stocks in specific, data-poor zones; (iii) to assess the potential for a future sustainable toothfish fishery; (iv) to provide occurrence information on marine mammals, seabirds, sharks, skates and rays and other species of concern; (v) to better understand patterns of seabirds and marine mammals and their potential for interactions with fishing vessels; (vi) to evaluate the potential impacts of longlines on non-target associated or dependent species, and VMEs; (vii) to undertake tagging activities on toothfish.

Dates, number and type of Vessels: three trips of 60 days, between 1st May and 31st October, one each in the years 2021, 2022 and 2023; one longliner.

h. Strengths and weaknesses of the exploratory fishery protocols

According to the 2018 performance review panel (Ridings *et al.,* 2018) SPRFMO has adopted a comprehensive measure for new and exploratory fisheries. The Panel commended the adoption of CMM 13-2018 and believed that it provides an excellent framework for the development of proposals for new and exploratory fisheries in line with the precautionary approach. The panel also noted that there is room for improvement. In considering the effectiveness of SPRFMO's measures on exploratory fisheries, most respondents supported efforts by SPRFMO to address new and exploratory fisheries.

Strengths:

The SC "*checklist for assessment of exploratory fisheries proposals*" (see section g), is a useful tool to guarantee an efficient scientific assessment and advice. CTC considers and provides advice and recommendations on management arrangements.

Gjerde *et al.,* 2021 highlights several strengths of the exploratory fishing process in the SPRFMO:

- The SPRFMO provisions on exploratory fishing, explicitly require: "*details of non-target and associated or dependent species and the marine ecosystem in which the fishery occurs, the extent to which these would be likely to be affected by the proposed fishing activity and any measures that will be taken to mitigate these effects*".

- While public consultation is not specifically sought, all proposals for new exploratory fisheries are available publicly on the website at least twice (60 days prior to the SC meeting and again 45 days prior to the Commission meeting) and remain publicly available in perpetuity.

- Precautionary and ecosystem approaches in Convention's core objective and a new/exploratory fishery can only commence if cautious preliminary conservation and management measures have been adopted. Decisions shall be based on the best scientific and technical information available and the advice of all relevant sub subsidiary bodies.

- Fishing Operation Plans requires information on "*the anticipated cumulative impact of all fishing activity in the area of the exploratory fishery if applicable*". The time period of the Plan covers up to a maximum period of three years.

Weaknesses:

SPRFMO does not specify that a proposal for exploratory fishery should be rejected if there is a shortage of information. Moreover, as in other RFMOs, impact assessments (CMM 03-2021) are only required for proposed bottom fisheries. (Gjerde *et al.,* 2021) [18].

The encounter protocol and move on rule for VME indicator taxa, are specified in CMM-03-2021. Some authors (e.g. see Fuller *et al.,* 2020), consider that the adopted thresholds levels, the incomplete list of VME indicators, the procedures for scientific assessment of the encounters (including the use of VME habitat suitability models) and the provision of advice on encounters, are matters of concern.

i. Recommendations

Improve the list of VME indicators and the thresholds levels. Expand the impact assessments to all fishing activities.

Despite the fact that SPRFMO has adopted a VME indicator list based on the criteria in the FAO International Guidelines, this list of indicator taxa is not a full list of taxa which may be encountered. Updating this list must help to prevent significant damage to all VMEs impacted by bottom fishing and will ensure that the encounter protocol designed to be established when a VME is like to be encountered is including all VME taxa. This list of VME taxa should be reviewed periodically and updated as necessary when better information on the taxa become available, so that taxa can be assessed against more VME criteria.

j. Other issues that could be useful for providing options for a framework for "*exploratory fisheries*"

As above (see section i).

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SOUTHERN INDIAN OCEAN FISHERIES AGREEMENT (SIOFA)

Partner short name: IEO

a. Legal framework and implications

Article 6b of the SIOFA agreement establishes that in determining criteria for participation in fishing, including allocation of total allowable catch or total level of fishing effort, the Contracting Parties shall allocate catch quantities for <u>exploration</u> and scientific research.

To our knowledge the first time in addressing the term "*Exploratory fisheries*" in SIOFA has been in 2018 when it was agreed at the Meeting of the Parties (MoP5) to progress intersessionally the work towards the definition of new/exploratory/research fisheries and the elaboration of a framework governing their development in the SIOFA area.

Due to time constraints, the SC in 2019 agreed to progress the work to develop a draft CMM on fishing research and exploratory fisheries intersessionally. The objective of this CMM is to govern the undertaking and management of new and exploratory fisheries in the SIOFA Area and to set out a clear legal framework for new and exploratory fisheries based on the precautionary approach. France-OT was the designated member to lead this intersessional work.

A draft CMM was submitted to the 6th meeting of the Parties (EU-2019).

Japan at the 2021 meeting of the SC requested to consider that the framework to establish the Spatial Extent of Historic Catch Data and Bottom Fishing Footprint was defined as two areas (existing (up to 2015) and new fishing area), so that scientific research activities (fishing surveys, exploratory fishing, BFIA and other associated activities) could be implemented differently and meaningfully under this framework and to establish the criteria to categorise new fishing grounds as established fishing grounds.

b. Definition/meaning of the concept "*exploratory fisheries*"

In drafting the CMM (UE, 2019) the term "*new fishery*" encompasses both "*new*" and "*exploratory*" fisheries. A fishery shall be considered as a "*new fishery*" for a species using a particular fishing method when one or more of the following conditions is/are met: i) information on fishing activity (catch, effort, distribution) using a given fishing method in the proposed activity area has not previously been submitted to SIOFA; or ii) catch and effort data from the two most recent years in which fishing activities occurred have not been submitted to SIOFA; or iii) the proposed combination of fishing area and gear falls outside the defined fishing footprints for the corresponding gear ("*benthic/demersal trawl*" and "*gears other than benthic/demersal trawl*"). The reference year will be 2018.

The Protected Areas and Ecosystems Working Group (PAEWG) in 2021 discussed that footprints should be used to define areas that represent "*new and exploratory*" fishing that may be subject to additional management controls and trigger the need for new research and data collection. Also noted that new and exploratory fisheries are to be defined by the SC.

c. Description of the "*exploratory fisheries*" process and steps

For the time being there are no measures regulating exploratory/new fisheries, only a draft presented in the MoP6 in 2019 as a proposal to establish a Framework for New and Exploratory Fisheries in the SIOFA Area.

Regarding the authorization for fishing, the CMM 2020/01 states that any Contracting Party, cooperating non-Contracting Party, participating fishing entity or cooperating non-participating fishing entity (collectively CCPs) that is seeking to authorise any vessel flying its flag to bottom fish in the Agreement Area shall, at least 30 days prior to the commencement of the ordinary meeting of the Scientific Committee in 2018, submit to the Secretariat a Bottom Fishing Impact Assessment (BFIA) for its individual bottom fishing activities in the Agreement Area and at least 30 days prior to the commencement of any subsequent ordinary meeting of the Scientific Committee where it has not been presented in 2018.

Any CCP that has not submitted a BFIA pursuant the above paragraph may, at least 30 days prior to the commencement of any subsequent ordinary meeting of the Scientific Committee and before the Meeting of the Parties has authorised the SIOFA bottom fishing footprint and the SIOFA BFIA developed by the Scientific Committee in accordance with paragraph 7, submit to the Secretariat a BFIA.

The draft CM presented at MoP-P6 (EU, 2019) establishing that any CCPs seeking to authorise any vessel flying its flag to fish in a new fishery shall, at least [30] days prior to the commencement of the ordinary meeting of the Scientific Committee, prepare and submit a Fishery Operations Plan (FOP) for the fishing season concerned for review by the Scientific Committee.

d. Existence of a preliminary assessment, or bottom fishing impact assessment (BFIA): description of the content

CMM 2020/01 states that CCPs that have fished more than 40 days in a single year, in the Agreement Area:

i. limits on its bottom fishing effort and/or catch, over a 12 month period to its average annual level in active years over a representative period for which reliable data exists;

ii. constraints on the spatial distribution of its bottom fishing effort, excluding line and trap methods, to recently fished areas to prevent any expansion of such fishing activities;

iii. provisions to ensure its bottom fishing will not have significant adverse impacts on VMEs and, where applicable, shall take into account its BFIA prepared and submitted, and any areas identified where VMEs are known to occur, or are likely to occur; and

iv. provisions ensuring that any vessel flying its flag is not authorised to fish in any areas that the Meeting of the Parties has decided to close to fishing.

The Scientific Committee considers all BFIAs received and provides advice about the likely cumulative impacts of bottom fishing impact activity from vessels flying the flag of a CCP in the Agreement Area; and whether each BFIA meets an appropriate standard in light of international standards and the SIOFA BFIAS, where applicable.

All BFIAs, including the SIOFA BFIA, shall:

a. be prepared, to the extent possible, in accordance with the FAO International guidelines for the management of deep-sea fisheries resources in the high seas;

b. meet the standards of the SIOFA BFIAS (if the BFIA is prepared after the Meeting of the Parties has adopted the BFIAS);

c. take into account areas identified where VMEs are known or are likely to occur in the area to be fished;

d. take into account all relevant information provided pursuant to paragraphs 20 and 18, and in addition, for the SIOFA BFIA, paragraph 21 and 22;

e. be updated when a substantial change in the fishery has occurred, such that it is likely that the risk or impacts of the fishery may have changed;

f. assess, to the extent possible, the historical and anticipated cumulative impact of all bottom fishing activity in the Agreement Area, if applicable;

g. address whether the proposed activities achieve the objectives described in paragraph 1 of this CMM and Article 2 of the Agreement; and

h. be made publicly available on the SIOFA website, once developed.

e. Review of conservation and management measures to prevent significant adverse impacts

CMM 2020/01 designs an Interim Protected Area Designation with 5 areas provisionally designated as protected areas. In these areas, CCPs shall prohibit all vessels flying their flag from engaging in bottom fishing, excluding line and trap methods; and for all other gears, CCPs shall ensure each vessel flying their flag has a scientific observer onboard at all times while fishing inside those areas. This measure does not differentiate between different types of fishing (exploratory/new/research versus commercial).

This CM also establishes the threshold levels for encounters with VMEs by gear type and the extension of the fishing ban when they have been exceeded.

f. Exploratory fisheries monitoring

CMM 2020/01 regulates the scientific observer coverage. Each CCP shall ensure that any vessel flying its flag and undertaking bottom fishing in the Agreement Area and when using trawl gear has 100 percent scientific observer coverage for the duration of the trip or 20% when using any other bottom fishing gear type.

There is a proposed way to replace human observers by electronic observation system when the MoP has adopted a guidelines for evaluating and approving electronic observer programs.

The CMM 2020/15 that manages the demersal stocks in the Agreement Area obliges to have 100% observer coverage when fishing for toothfish in the DelCano and Williams ridge areas. Observer shall have a target of observing 25% of hooks hauled per line over the duration of the fishing deployment.

g. Experience with exploratory fishery protocols

SIOFA is working into the definition of the protocols for new/exploratory fishing. Not yet implemented.

h. Strengths and weaknesses of the exploratory fishery protocols

We understand that SIOFA is working towards a definition and to create protocols with respect to exploratory/new and research fishing that is not already completed. The draft CM proposed by the EU is a good way forward but there is a need for discussion between members.

There is a lack of definition between "*Exploratory*", "*New*" and "*Research*" fishing that should be addressed in the future, for example the CMM 2020/15 sets a catch limit for *Dissostichus* spp. on Del Cano Rise but a "*research catch limit*" for *Dissostichus* spp. on William's Ridge, but there's not an explanation about why there are two different status when referring to catch between these two areas.

Similarly, in draft CM (EU, 2019) in which the term "*new fishery*" encompasses both "*new*" and "*exploratory*" fisheries.

There is not a template for the BFIA presentations by CCPs neither an established protocol to assess them.

i. Recommendations

There is already an EU proposal to establish a Framework for New and Exploratory Fisheries in the SIOFA Area (MoP-Prop08), but more work is needed on that to get approved for the MoP.

j. Other issues that could be useful for providing options for a framework for "*exploratory fisheries*"

SIOFA virtual meeting agendas in 2020 and 2021 have been reduced to address the agreed priorities, but the draft CM (EU, 2019) shall be addressed and discussed to avoid ambiguity as soon as possible.

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COMMISSION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES (CCAMLR)

Partner short name: MRAG EU

a. Legal framework and implications

The current legal framework for the regulation of "*new or exploratory fisheries*" is adopted under Article 6(6) of the 1995 UN Fish Stocks Agreement (UNFSA) which states,

> *"For new or exploratory fisheries, States shall adopt as soon as possible cautious conservation and management measures, including, inter alia, catch limits and effort limits. Such measures shall remain in force until there are sufficient data to allow assessment of the impact of the fisheries on the long-term sustainability of the stocks, whereupon conservation and management measures based on that assessment shall be implemented. The latter measures shall, if appropriate, allow for the gradual development of the fisheries*".

With "*new or exploratory fisheries*" expanding most notably in the Southern Ocean, CCLAMR have accordingly enshrined the necessary conservation and management measures within their regulatory purviews which are binding to their members. Within these measures, the official procedure for a Member State to participate in an exploratory fishery is outlined and must be adhered to.

b. Definition/meaning of the concept "*exploratory fisheries*"

Under CM 21-02, an exploratory fishery is defined as a fishery that was previously classified as a "*new fishery*" (defined in CM 21-01 as a fishery targeting a species where no information or catch and effort data has been submitted to the Commission) as there still remains insufficient information on the distribution, abundance and demography of the target species. Until this is known, an estimate of the fishery's potential yield cannot be calculated and therefore the potential impacts of the fishery on dependent and related species cannot be established. Once this information is gathered, the Scientific Committee will be able to formulate and provide advice to the Commission on appropriate harvest catch levels, as well as effort levels and fishing gear, where appropriate.

During the period when a fishery is classified as exploratory, the Commission will establish an annual precautionary catch limit in order to provide information to the Scientific Committee, as required in the Data Collection Plan. This will enable the Scientific Committee to conduct an assessment of the stock and undertake evaluations of the fishery which will be annually reported to the Commission.

c. Description of the "*exploratory fisheries*" process and steps

Within the Commission's Area, there are two key stages of evaluation for exploratory fisheries: prior notification and assessments.

<u>Notification Phase:</u>

Under CM 21-02, if a Member would like to participate in an exploratory fishery, they must submit a notification to the Secretariat of the Commission by 1 June, accompanied by the notification fee submitted by 1 July, prior to the fishing season. The notification must include details of the proposed fishing vessel and license details, prescribed in CM 10-02, paragraph 3 and 4; prepare and submit a Fishery Operations Plan for the fishing season; and, if in relation to bottom fishing in the Convention

Area, a preliminary assessment of the impact of planned activities on vulnerable marine ecosystems.

The Fishery Operations Plans should include as much of the following information to assist Scientific Committee in its preparation of the Data Collection Plan:

(a) the nature of the exploratory fishery, including target species, methods of fishing, proposed region and maximum catch levels proposed for the forthcoming season;

(b) specification 6 and full description7,8 of the types of fishing gear to be used;

(c) biological information on the target species from comprehensive research/survey cruises, such as distribution, abundance, demographic data and information on stock identity;

(d) details of dependent and related species and the likelihood of their being affected by the proposed fishery;

(e) information from other fisheries in the region or similar fisheries elsewhere that may assist in the evaluation of potential yield;

(f) if the proposed fishery will be undertaken using bottom trawl gear, information on the known and anticipated impacts of this gear on vulnerable marine ecosystems, including benthos and benthic communities.

These documents will be reviewed by the Working Groups on Statistics, Assessments and Modelling (WG-SAM), Ecosystem Monitoring and Management (WG-EMM), Fish Stock Assessment (WG-FSA), the Scientific Committee and the Commission.

Additionally, for notifications for participation in exploratory fisheries for *Dissostichus* spp. in Statistical Subarea 48.6 and Statistical Divisions 58.4.1, 58.4.2 and 58.4.3a, Members must prepare and submit to the Secretariat a Research Plan for review by WG-SAM, WG-FSA, the Scientific Committee and Commission.

Finally, Members must provide a commitment, in its proposal, to implement any Data Collection Plan that may be established for that fishery by the Scientific Committee; such fishing opportunities may then only be conducted by fishing vessels which are suitably equipped and comply with all relevant conservation measures for the fishery.

Assessment Stage:

The information submitted within the notification shall be considered and evaluated by the Scientific Committee and the Standing Committee on Implementation and Compliance (SCIC) to advise the Commission on the adoption of relevant conservation measures for each exploratory fishery.

Management**:**

Once approved, the vessel(s) flagged to the Contracting Party will have access to fish within the total allowable catch (TAC) limits set for a particular area. Small Scale Research Units (SSRU) manage the allowable catch for an area and once the catch limit is reached, the CCAMLR Secretariat will close the fishery.

d. Existence of a preliminary assessment, or bottom fishing impact assessment (BFIA): description of the content

A preliminary assessment is required under CM 22-06, paragraph 7, if a Contracting Party wishes to participate in bottom fishing activities in the Commission's Area. Based on the pro forma in Annex 22-06/A, the assessment must include information on the proposed fishing activity (gear and scale of operation) and best available data of the known and anticipated impacts of bottom fishing activities on VMEs, as well the mitigation measures to prevent such impacts. The assessment must be submitted to the Scientific Committee and the Commission by 1 June prior to the season in which it intends to fish.

As mentioned in section c, a research plan must be submitted within a Member's notification for participation in exploratory fisheries for *Dissostichus* spp. in Statistical Subarea 48.6 and Statistical Divisions 58.4.1, 58.4.2 and 58.4.3a. Research plans must be reported in accordance of CM 24-01, Annex 24-01/A, format 2, to the Secretariat by 1 June. The plan must detail the main objective of the research proposal; the fishery operations; survey design, data collection and analysis; proposed catch limits; research capability; reporting for evaluation and review; and conservation measure exemptions.

e. Review of conservation and management measures to prevent significant adverse impacts

To prevent significant adverse impacts of bottom fishing on VMEs, the Commission will adopt conservation measures, taking into account the advice and recommendations provided by the Scientific Committee, that are appropriate such as:

a. allow, prohibit or restrict bottom fishing activities within particular areas;

b. require specific mitigation measures for bottom fishing activities;

c. allow, prohibit or restrict bottom fishing with certain gear types; and/or

d. contain any other relevant requirements or restrictions to prevent significant adverse impacts to VMEs.

f. Exploratory fisheries monitoring

To fulfill monitoring requirements of exploratory fisheries, participating Members should, as outlined under CM 21-02, paragraph 13, ensure each vessel carries a CCAMLR-designated scientific observer to collect data in accordance with the Data Collection Plan, and to assist in collecting biological and other relevant data; annually submit to CCAMLR the data specified by the Data Collection Plan.

When conducting bottom fishing activities, under CM 22-06, paragraph 13, Members should also submit data on where VMEs are likely to occur to provide the Scientific Committee with all the relevant information and all the Secretariat to maintain an inventory of digital maps showing all the known VMEs in the Convention Area.

For exploratory longline fisheries, each Contracting Party shall forward VMS reports to the CCAMLR Secretariat no later than one hour after receipt under CM 10-04, paragraph 11.

In accordance with CM 21-02 for exploratory fisheries, fishing vessels shall report catch and effort data according to CM 23-04 (trawl fisheries form C1, longline fisheries form C2, or pot fisheries form C5) and biological data as required in CM 23-05. Members should transmit those data in the specified format to the Executive Secretary no later than the end of the following month.

g. Experience with exploratory fishery protocols

There are 7 exploratory fisheries targeting toothfish in Areas 48, 58 and 88[19], below are two examples of the protocols from these fisheries.

<u>Case Study 1: (CCAMLR Fishery Report 2020 in Division 58.4.3b)</u>

The exploratory longline fishery for Patagonian toothfish (*Dissostichus eleginoides*) and Antarctic toothfish (*Dissostichus mawsoni*) in Division 58.4.3b began as a new fishery in 1997 and was reclassified as exploratory in 2000 (CCAMLR Report, 2021). The same year, the Commission approved four exploratory fisheries for *Dissostichus* spp. in this region outside Australia's national jurisdiction: exploratory trawl fisheries on BANZARE Bank and Elan Bank; and exploratory longline fisheries on BANZARE Bank and Elan Bank.

<u>Spatial management</u>: In 2001, Division 58.4.3 was divided to form two new divisions: Division 58.4.3a (Elan Bank) and Division 58.4.3b (BANZARE Bank). Since 2004, licensed longline vessels have fished in Division 58.4.3b for *Dissostichus* spp. targeting primarily Antarctic toothfish (*D. mawsoni)* with smaller catches of Patagonian toothfish (D. eleginoides). Furthermore, in 2007, Division 58.4.3b was subdivided into Small-Scale Research Units A (north of 60◦S) and B (south of 60◦S). In 2008, SSRU A was further subdivided into SSRUs A, C, D and E.

<u>Catch limits:</u> Between 2004 and 2007, the commercial catch limit for *Dissostichus* spp. was set at 300 tonnes which later decreased to 200 tonnes in 2008 and 120 tonnes in 2009. Since 2010, fishing in this division has been limited to research only with the catch limit set at 0 tonnes. There has now been no targeted fishing in this area since 2012.

Following this, in 2012 and 2013, CCAMLR put in place a more structured approach to setting catch limits after the results of an analysis of fine-scale catch and effort data indicated that "*intensive legal fishing in small areas, combined with high levels of IUU fishing, have resulted in the localised depletion of Dissostichus spp. in Division 58.4.3b and a severe decline in catch-per-unit-effort (CPUE)*."

<u>Case Study 2: (CCAMLR Fishery Report 2020 in Subarea 88.1 and Small-Scale Research units 882A and 882B)</u>

The fishery began in 1997 and covers an area between 150°E to 150°W in longitude and from the Antarctic Continent to 60°S in latitude. Fishing is limited to bottom longlines and occurs around seamounts and ridges, on the continental shelf and continental slope areas. The creation of the Ross Sea region Marine Protected Area (RSrMPA) in 1997 closed off most of the Continental shelf to commercial fishing. A number of nations (for example New Zealand, Italy, Republic of Korea, UK) undertake scientific research in this area to assess whether the RSrMPA is meeting its objectives. The fishery remains an exploratory fishery, vessels wishing to fish must notify CCAMLR and submit a research plan (CM 21-02), including, where necessary and evaluation of the impacts of their gear on VMEs (CM 22-06, CM 22-07). In 2020, 19 vessels participated in the fishery (Fishery Report 2020).

[19] https://www.ccamlr.org/en/fisheries/toothfish-fisheries

<u>*Spatial management:*</u> Prior to the creation of the RSrMPA in 2017, the fishery was managed through a series of Small-Scale Research Units (SSRUs), with separate quotas set for each one. Closing off various SSRUs would allow the Commission to direct fishing to various areas, as was the case in in 2006 where several were closed to concentrate fishing in the central Ross Sea region (SC-CAMLR-XXIV) and 2009 when an SSRU was closed to protect a likely toothfish migration corridor in the Western Ross Sea (SC-CAMLR-XXVII). In 2017 CCAMLR established RSrMPA, the largest of its kind at the time. The MPA has a lifespan of 35 years and has multiple objectives including preserving a representative portion of the Ross Sea environment, including benthic and pelagic marine resources. It is divided into three zones, each with different management objectives, the General Protection Zone (GPZ), the Special Research Zone (SRZ) and the Krill Research Zone (KRZ). The GPZs are designed to provide representative protection of different habitats and bioregions by eliminating potential threats from fishing. The SRZ is designed to be a scientific reference area to examine the effects of things such as climate change, limited fishing following a defined plan is allowed. Finally, the KRZ allows the investigation into the life history, biological parameters, ecological relationships and variations in biomass and production of Antarctic krill (CM 91-05).

Catch Limits: The season runs from 31 December through to 31 August each year, although in reality it closes earlier due to quotas being reached or areas becoming inaccessible due to sea ice. Catch limits are defined under CM 41-09 and divided between areas north and south of 70°S (outside of the RSrMPA) and the SRZ. Current limits are set at 664 tonnes to the north, 2,307 tonnes to the south and 459 tonnes in the SRZ.

h. Strengths and weaknesses of the exploratory fishery protocols

Strengths:

- The implementation of scientific observers on-board all exploratory fisheries to undertake data collection plans. Since 2003, it is now mandatory for at least two scientific observers to be present for exploratory fisheries for *Dissostichus* spp. in Subareas 48.6, 88.1 and 88.2, and Divisions 58.4.2, 58.4.3a and 58.4.3b.

- The establishment of data collection, research and fishery operational plans for each exploratory fishery (CCAMLR, 2000, paragraphs 10.2 to 10.8; see also Conservation Measure 41-01 (2004) in CCAMLR, 2004b).

- Establishment of a Scientific Committee to review and advise the Commission on appropriate fishery management and approval of Member applications to participate in exploratory fisheries.

- Introduction of small-scale research units (SSRU) to manage the allowable catch limits for an area.

Weaknesses:

The CCAMLR second performance review (CCAMLR-XXXVI/01) identified that there could be better target fish stock research in exploratory fisheries at stock distribution and productivity. It highlighted that research could be coordinated across multiple management areas rather than fragmented within each management area and that mechanisms should be put in place to ensure that the data that are collected and analysed are suitable to provide advice to the Commission to enable it to meet the objectives of the Convention Although not specific to exploratory fisheries it went on to recommend establishing research plans in conservation measures for the mandatory collection of fishery independent data and cooperation, including data sharing with other international bodies with an interest in the Southern Ocean such as the Scientific Committee on Antarctic Research (SCAR) and the Southern Ocean Observing System (SOOS).

i. Recommendations

None to suggest, the current protocol covers all requirements.

j. Other issues that could be useful for providing options for a framework for "*exploratory fisheries*"

The procedure follows a logical path in that for fisheries where little data is available they require a greater level of data collection, the methodology for how a fishery proceeds from new to assessed is clearly laid out.

References

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CM 21-02. Exploratory fisheries.

CM 22-06. Bottom Fishing in the Convention Area.

CM 22-07. Interim measure for bottom fishing activities subject to Conservation Measure 22-06 encountering potential vulnerable marine ecosystems in the Convention Area

CM 91-05. Ross Sea region marine protected area.

SC-CAMLR-XXIV. Report of the Twenty-fourth Meeting of the Scientific Committee. Hobart, Australia. 24-28 October 2005.

SC-CAMLR-XXVII. Report of the Twenty-seventh Meeting of the Scientific Committee. Hobart, Australia. 27-31 October 2008.

SUB-TASK 4.3 – FRAMEWORK FOR RESEARCH ACTIVITIES NOT RELATED TO FISHERIES

1. EXISTING PROCEDURES FOR RESEARCH ACTIVITIES IN THE RFMOs

Scientific research activities play an essential role in the assessment of deep-sea fish stocks and the advice on the identification and protection of VMEs. Particularly, different types of scientific research surveys can be successfully used for underpinning these purposes (e.g. fisheries surveys, benthic surveys, multibeam surveys, visual surveys, etc.). They provided high-quality, robust and timely data to the scientific community, society, stakeholders and policymakers, and their results can be routinely integrated into the RFMO advisory processes, being essential to underpin management policies (Durán Muñoz *et al.*, 2012, 2020).

A review of the existing general procedures for research activities in the RFMOs was conducted. Table 1 summarizes the existing approaches, emphasizing their main elements. This information will be used as a base to bring options for establishing a framework for *"research activities"* in relevant RFMOs, in accordance with international law as reflected in the UN Convention on the law of the Sea (UNCLOS)[1].

Role of the scientific advisory bodies

In general, scientific advisory bodies, such as Scientific Councils or Committees (SC), play the role of promoting and encouraging cooperation in marine research (e.g. NAFO, SEAFO, SPRFMO, SIOFA, CCAMLR). SC´s role is not specifically mentioned in the case of NPFC, although the NPFC Commission has the function to establish the terms and conditions for any scientific activities. In the case of NEAFC, the RFMO does not undertake research of its own, as ICES acts as its advisory body. ICES is in charge of these functions, supported by the PECMAS[2] of NEAFC

Research work plans

RFMOs have adopted annual (e.g. SEAFO, SPRFMO in the past) or multi-annual (e.g. NAFO; NPFC, SPRFMO, CCAMLR) work plans, programs or roadmaps for their SC. In the case of NEAFC, ICES is thus enabled to develop appropriate research programs, supported by the PECMAS. In general SC work plans are focused on the provision of specific scientific advice to assist the Commission´s work, more than to develop general science (it should be primarily developed through mechanisms other than the work programs, e.g. CCAMLR). In the case of NAFO, SC work plan also includes research on the impacts of activities other than fishing (e.g. oil and gas, marine litter). Most of RFMOs have developed their own technical guidelines to have a unique framework for a certain type of surveys (e.g. demersal trawl, pelagic acoustic surveys, etc.) with the main aim of standardizing data collection in fisheries research.

[1] Article 206 - Assessment of potential effects of activities: When States have reasonable grounds for believing that planned activities under their jurisdiction or control may cause substantial pollution of or significant and harmful changes to the marine environment, they shall, as far as practicable, assess the potential effects of such activities on the marine environment and shall communicate reports of the results of such assessments in the manner provided in article 205.

[2] Permanent Committee on Management and Science of NEAFC

Guidelines for scientific research

Most RFMOs have not developed guidelines or codes of conduct for scientific research, although technical protocols for fisheries surveys have been implemented with the aim of standardize data collection (e.g. NAFO, GFCM and CCAMLR). Only SEAFO has developed specific *"guidelines for fisheries research and basic marine science activity"*. In the case of the Northeast Atlantic Ocean, the OSPAR area overlaps with the NEAFC area. In 2008 OSPAR adopted a non-legally binding *"code of conduct for scientific research in the deep seas and high seas of the OSPAR maritime area"* in order to mitigate seabed disturbance and associated impacts. Moreover, according to the NEAFC regulations, States intending to conduct scientific investigations should consider the provisions from Article 206 of UNCLOS (i.e. assessment of potential adverse effects of activities on the marine environment). Additionally, if the need to set measures to control scientific research should arise, these can be established thanks to Article 10 of the NEAFC Convention.

Measures in force regarding scientific research

Notification of research plans is mandatory in some RFMOs (NAFO, NEAFC in the case of closed/restricted areas, SEAFO, NPFC, CCAMLR), but few specific conservation and management measures for scientific research have been adopted (e.g. SEAFO, NPFC and CCAMLR) and most of them are focus on fisheries research. In the case of SEAFO, any party intending to conduct fisheries research as well as other marine science is requested to adhere to the SEAFO *"guidelines for fisheries research and basic marine science activity"*. RFMOs such as NPFC and CCAMLR have implemented some conservation and management measures related to scientific research. Additionally, NPFC CMM 2021-05 indicates the need for data other than fisheries data (e.g. physical, chemical, biological, oceanographic, meteorological, ecosystem, seabed mapping and images).

Impact of research vessel surveys on VMEs

The issue of the impact of research vessel surveys on VMEs is considered, in different ways, in some RFMOs (conservation and management measures of NEAFC, SEAFO, SIOFA and CCAMLR). Other RFMOs have not specific measures for research, but they started the process to develop them (e.g. SPRFMO and SIOFA). In 2021, NAFO started a discussion about the need of scientific review (and confirmation of scientific validity) by the SC, of the intended *Survey Research Plans*. Moreover, there are studies in progress on the effects on fish stock assessments of excluding groundfish surveys trawls from the VME closed areas. NAFO has outlined the alternative non-invasive sampling methods available to study VME, but has not yet made any decisions on their use[3].

Recent new initiatives to regulate and encourage scientific research

The regulation of scientific research is currently a matter of concern in NAFO, SPRFMO and SIOFA. As previously mentioned, several initiatives are being carried out in this regard. In the case of SPRFMO, the discussion and review of a proposal on the management of scientific research are currently ongoing. In SIOFA, a proposal on a framework for scientific research and fisheries-based research is also being discussed, but the processes appear less advanced. Moreover, NAFO just started the process to amend Article 4 of NAFO CEM, in order to include a scientific review of proposed major research surveys.

[3] Report of the 10th Meeting of the NAFO Scientific Council Working Group on Ecosystem Science and Assessment (WGESA). Northwest Atlantic Fisheries Organization. 8-16 November 2017, Dartmouth, Canada. Serial No N6774, NAFO Scientific Council, 2017. Summary Document 17/21

Table 1. Existing procedures for research activities in the RFMOs, emphasizing their main elements.

	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
	NAFO	**NEAFC**	**SEAFO**	**GFCM**	**NPFC**	**SPRFMO**	**SIOFA**	**CCAMLR**
Main role of the scientific advisory bodies regarding scientific research	The NAFO SC-STACREC coordinates international cooperative research, encourages and promotes cooperation in scientific research.	ICES is the scientific advisory body of NEAFC (2019 ICES-NEAFC MoU). ICES promotes and encourages marine research. PECMAS of NEAFC supports ICES in its work by identifying and highlighting research needs to the Commission, stimulating national and co-operative research. Moreover, the 2008 NEAFC - OSPAR MoU encourages the funding and conduct of marine science.	The SEAFO SC encourages and promotes cooperation in scientific research in order to improve knowledge of the living marine resources.	The GFCM Commission encourages, recommends, coordinates, and undertakes research and development activities, including cooperative projects in the areas of fisheries and the protection of living marine resources.	In the NPFC Convention, the functions of encouraging, promoting, coordinating scientific research, are not specifically mentioned as primary functions of the SC.	The SPRFMO SC encourages and promotes cooperation in scientific research in order to improve knowledge of the state of fishery resources and the marine ecosystems.	The SIOFA SC encourages and promotes cooperation in scientific research in order to improve knowledge of the state of the fishery resources.	The CCAMLR SC encourages and promote co-operation in the field of scientific research in order to extend knowledge of the marine living resources of the Antarctic marine ecosystem. SC also shall formulate proposals for the conduct of international and national programs of research into Antarctic marine living resources.
Research work plans	A Five-Year Work Plan of the NAFO SC has been developed. Work on the plan commenced in 2019. It includes survey planning, protocols and data collection (including fishing and activities other than fishing such as oil and gas).	In carrying out its objectives, NEAFC does not undertake any scientific work but rather relies on ICES for scientific advice. ICES is thus enabled to develop appropriate research programs to meet longer-term issues raised by NEAFC, and take these issues into account in presenting its advice to NEAFC. PECMAS of NEAFC supports ICES in its work (see above).	Work Plan for SEAFO SC (including the preparation of survey plans and survey design protocols) are reviewed by the SC in an annual basis.	Since 2018, GFCM research programmes have been included, through specific recommendations, in the GFCM work plan. They are being launched to address data and management issues.	A Five-Year Research Plan and Work Plan of the NPFC SC (2021-2025) have been developed for consideration by the SC. Moreover, the *NPFC-PICES Framework for Enhanced Scientific Collaboration in the North Pacific*, identified areas of joint interest to both organizations (e.g. knowledge gaps and research needs, as well as coordination of science plans).	In 2013, the SPRFMO Commission adopted a "roadmap for the SC" that outlined work priorities and identified advice needs. The same format was used in 2014 and 2015. Between 2016 and 2018, annual "work plans for SC" were adopted, while since 2019 are designed as "multi-annual work plans". In 2013 the SC published its own Research Programme, which highlights SPRFMO's medium and long term research priorities.	The SIOFA MoP endorsed in 2016 the work plan for the SC to provide the necessary information to advise on the fishery management.	The annual work program of the SC and its subsidiary bodies is focused on the requirements of Article XV.2 (provision of specific scientific advice to assist the Commission), whereas a strategy for meeting the requirements of Article XV.1 (general science on Antarctic marine living resources) should be primarily developed through mechanisms other than the annual work program.
Specific guidelines and/ or codes of conduct for scientific research	There are no specific guidelines or code of conduct for research. Nevertheless, technical protocols for trawl sampling have been produced.	Code of Conduct for scientific research in the deep seas and high seas of the OSPAR maritime area (OSPAR, 2008). Non-legally binding	Guidelines for fisheries research and basic marine science activity in the SEAFO CA (SEAFO, 2014).	Research has not directly been reflected in GFCM's specific measures on procedures or protocols for the conduct of research. Nevertheless, technical guidelines were produced to have a unique framework for regional demersal trawl and pelagic acoustic surveys (Carpentieri *et al.*, 2020).	Research within the NPFC area is conducted on an ad-hoc basis, although specific research on SAIs on VMEs should be conducted according to Annex 2 of CMMs 2019-06 and 2021-05 for bottom fishing. Annex 2 outlines the science based standards and criteria for the identification of VMEs and assessment of	Fishing research activities in the SPRFMO CA are undertaken on an ad hoc basis and there is no mechanism for notifying non-fishing research and for approval of fishing research (*Ridings et al.*, 2018).	There are no specific guidelines or code of conduct for research. The SIOFA Agreement defines the harvesting of fishery resources for scientific research as a fishing activity, indicating that the CP may allocate catches for this purpose.	Technical protocols for trawl sampling, recording of biological data and hydrography (Knutsen *et al.*, 2018), as well as technical guidelines for fisheries-directed research (Parker and Dunn, 2018) have been produced.

	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
	NAFO	NEAFC	SEAFO	GFCM	NPFC	SPRFMO	SIOFA	CCAMLR
					SAIs on VMEs and other marine species.			
Specific conservation and management measures in force regarding scientific research	NAFO CEM - Article 4: Flag State shall notify their intended research and provide a *Research Plan*. Review of the *Research Plans* and confirmation of scientific validity by the SC is not required.	NEAFC Recommendation 10:2021 (Articles 5.4 and 5.5): that CP intending to conduct scientific investigations (excluding exploratory fishing) within closed areas and/or restricted bottom fishing areas shall notify the Secretary of their intended *Research Programmes*, taking account of Article 206 of the 1982 United Nations Convention on the Law of the Sea[4]. Such notifications shall forward to all CP and to the PECMAS. CP shall also ensure that any such proposed investigations shall be assessed to see whether they would have significant adverse impacts on VMEs.	Chapter VIII - Article 9 of the SEAFO System of Observation, Inspection, Compliance and Enforcement (SEAFO, 2019), is dedicated to the measures and obligations related with vessels conducting fishing research (e.g. notification of *Research Plans*, etc.). Notwithstanding obligations of such Chapter VIII, the SEAFO guidelines for research indicates that any party intending to conduct fisheries research as well as other marine science activity in the SEAFO Convention Area is requested to adhere to the SEAFO guidelines for research during the different phases of the activity (letter of intent, *detailed plan*, etc.).	--	CMM for bottom fisheries and protection of Vulnerable Marine Ecosystems in both the Northwestern (CMM 2021-05) and Northeastern (CMM 2019-06) Pacific Ocean, contain several specific statements on scientific research. CMM 2021-05 indicates the need of data other than fisheries data (e.g. physical, chemical, biological, oceanographic, meteorological, ecosystem, seabed mapping and images). CMM 2019-06 states that scientific research activities for stock assessment purposes are to be conducted in accordance with a research plan that has been provided to the SC prior to the commencement of such activities.	--	--	CM 24-01: Fishery-related research activities require prior notification to the Commission, including the provision of a *Research Plan*. Based on this, the SC provides advice to the Commission. Until the review process is complete, the planned fishing for research purposes shall not proceed. All fishery-dependent research surveys must be undertaken in accordance with all applicable CM in force. CM 24-02: Describes the technical specifications for longline weighting for seabird conservation. CM 24-04 allows designating "Special Areas for Scientific Study" following ice shelf retreat or collapse. CM 24-05: the list of Research activities authorised by the Commission pursuant to CM 24-01, is published in season basis. CM 22-09: All bottom fishing activities shall be prohibited within the "Registred VME Areas", with the exception of scientific research activities agreed by the Commission on advice from the SC and in

[4] This Article requires that States *"having reasonable grounds for believing that planned activities may cause harmful changes to the marine environment, shall assess the potential effects of such activities on the marine environment and shall communicate reports of the results of such assessments to all members of the competent international organization"*

	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
	NAFO	NEAFC	SEAFO	GFCM	NPFC	SPRFMO	SIOFA	CCAMLR
								accordance with CM 22-06 and 24-01.
Impact of research vessel surveys on VMEs	There are studies in progress (2021) on the effects on fish stock assessments of excluding groundfish surveys trawls from the VME closed areas.	NEAFC Recommendation 10:2021 (Articles 5.4 and 5.5): See above.	Guidelines for fisheries research and basic marine science activity in the SEAFO CA (SEAFO, 2014): See above.	--	--	--	--	CM 22-09: See above
Recent new initiatives to regulate and encourage scientific research	In September 2021 SC recommended that the NAFO Commission amend Article 4 in NAFO CEM to include a scientific review of proposed major research surveys.	--	--	--	--	A proposal was submitted to the 2018 SC for a CMM on management of scientific research, to address research issues and to provide more systematic approach to research activities.	A first draft proposal for a CMM on a framework for fisheries research was presented at MoP in 2017, with the aim to provide an approach to research activities, taking into account Article 6f of SIOFA Agreement. The discussion and review of the proposal (considering scientific research and fisheries-based research), including the identification of gaps and options for addressing them, is currently ongoing.	--

ACRONYMS

CA: Convention Area
CCAMLR: Convention for the Conservation of Antarctic Marine Living Resources
CEM: Conservation and Enforcement Measures
CM: Conservation Measure
CMM: Conservation and Management Measure
CP: Contracting Parties
GFCM: General Fisheries Commission for the Mediterranean
SC: Scientific Council/Scientific Committee
MoP: Meeting of the Parties
MoU: Memorandum of Understanding
NAFO: Northwest Atlantic Fisheries Organization
NEAFC: Northeast Atlantic Fisheries Commission
NPFC: North Pacific Fisheries Commission
PECMAS: Permanent Committee on Management and Science
SEAFO: South East Atlantic Fisheries Organisation
SIOFA: Southern Indian Ocean Fisheries Agreement
SPRFMO: South Pacific Regional Fisheries Management Organisation
STACREC: Standing Committee on Research Coordination

2. KEY FINDINGS

Diversity of approaches for the management of research activities in the RFMOs

At present, there is a diversity of approaches across the RFMOs regarding the management of research activities:

- NAFO Contracting Parties (CPs) only have the obligation to notify their intended research activity and to provide a *Research Plan*, but there are no provisions about impacts on VMEs and/or closed areas, and the review of the plans by the SC is not required.
- NEAFC regulations only indicate that CPs intending to conduct scientific investigations within closed areas and/or restricted bottom fishing areas, shall notify their intended research, taking account of Article 206 of UNCLOS (i.e. assessment of potential adverse effects on the marine environment). In addition, the OSPAR Commission adopted the non-legally binding "Code of Conduct for scientific research in the deep seas and high seas of the OSPAR maritime area" which overlaps with the NEAFC Area.
- SEAFO have implemented specific measures for research: The "SEAFO System of Observation, Inspection, Compliance and Enforcement", contains specific provisions for fishing research. Moreover, any CP intending to conduct fisheries research, as well as other marine science activities, is requested to adhere to the "SEAFO guidelines for fisheries research and basic marine science activity".
- Research has not directly been reflected in GFCM's specific measures on procedures or protocols for the conduct of research.
- Research within the NPFC Area is conducted on an ad-hoc basis, although specific research on SAIs on VMEs should be conducted according to Annex 2 of CMMs 2019-06 and 2021-05 for bottom fishing.
- Fishing research activities in the SPRFMO CA are undertaken on an ad hoc basis and there is no mechanism for notifying non-fishing research and for approval of fishing research.
- The SIOFA Agreement defines the harvesting of fishery resources for scientific research as fishing activity, but at present, there are no specific guidelines or specific mechanisms for regulating and encouraging research in the SIOFA Area.
- Five main "CM" govern the application of conservation measures to scientific research and experiments within the CCAMLR Convention Area.

Regional Seas Conventions: Interaction with RFMOs

The 18 Regional Seas programmes[5] across the world are an important part of the implementation of Part XII of the UNCLOS, which establishes obligations in relation to the protection and preservation of the marine environment, including from pollution.

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[5] Five Regional Seas Conventions currently include Areas Beyond National Jurisdiction (ABNJ): the Convention for the Protection of the Marine Environment of the North-East Atlantic (**OSPAR Convention**); the Convention on the Conservation of Antarctic Marine Living Resources (**CAMLR Convention**); the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (*Barcelona Convention*); the Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (**Noumea Convention**); and the Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific (**Lima Convention**).

The OSPAR[6] Convention is the mechanism by which 15 Governments and the European Union cooperate to protect the marine environment of the North-East Atlantic. As was mentioned previously, the spatial overlap between OSPAR, NEAFC and ICES areas is conducive to integrated, cross-sectoral ecosystem-based ocean management. The existing and newly established cooperative arrangements, including a Memorandum of Understanding (MoU), between NEAFC, OSPAR and ICES are aimed at enhancing this conduciveness (Molenaar and Elferink, 2009).

The Comisión Permanente del Pacífico Sur (CPPS)[7] is the Executive Secretary of the 1981 Lima Convention and of the Action Plan for the protection of the marine environment and the coastal areas of the Southeast Pacific. Its main activities include scientific studies related to the "Niño" in order to timely forecast and alert the climatic risks associated with this event. This activity is developed through research cruises, coordinated by the CPPS, constituting a joint action, unique at the international level. In 2019, SPRFMO signed a MoU with the CPPS, with the objective to establish a consultation and cooperation framework on matters of mutual interest (e.g. scientific data, monitoring, VMEs, etc.). The Secretariat of the CPPS collaborates with the STRONG[8] High Seas project, a five-year project that aims to strengthen regional ocean governance for the conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction (BBNJ). In February 2020, the SPRFMO's ongoing work related to the conservation and sustainable use of BBNJ was presented at the III Dialogue Workshop held in Lima, Perú. This initiative for the Southeast Pacific region was organized under the STRONG High Seas project, in collaboration with CPPS.

The regional seas convention related to the Southern and Antarctic Ocean is the Conservation of Antarctic Marine Living Resources (CCAMLR). As part of the Scientific Committee, there are various Working Groups established to conduct scientific programmes in the Convention's Area. However, there are currently no relevant programmes dedicated to DSFs management and/or VME conservation apart from the programme to set up a series of MPAs. Much of the data on benthic organisms, including VMEs, is managed through SCAR (Scientific Committee on Antarctic Research) and data on it can be accessed at www.marinespecies.org/rams, although a login is required for some areas.

Research activities

Research projects

There are a variety of recent research projects which study areas overlap the regulatory areas of the RFMOs (Table 2). The results of some of these initiatives are of interest to the RFMOs work. Some projects are funded by the countries under specific financial instruments (e.g. EU H2020: ATLAS, SPONGES, FARFISH, iATLANTIC; EU FP7: CORALFISH). In other projects, RFMOs participate as partners (e.g. ABJN Deep Seas Project: SPRFMO, SEAFO, SIOFA) or coordinate the research funded by particular Contracting Parties (e.g. NEREIDA: NAFO research coordination under EU funding). In the case of the Southern and Antarctic Oceans, currently, there are no scientific research projects supported or coordinated by CCAMLR which are specifically focused on DSFs management or VME conservation, but individual members propose and conduct research in the area, either themselves or in collaboration.

[6] https://www.ospar.org
[7] http://cpps-int.org/
[8] https://www.prog-ocean.org/our-work/strong-high-seas/

Table 2. Recent research projects and research activities which study areas overlap the regulatory areas of the RFMOs.

Project / research activity name	NAFO	NEAFC	SEAFO	GFCM	NPFC	SPRFMO	SIOFA
ATLAS (EU H2020)	X	X					
BLACK SEA4FISH -GFCM				X			
Common oceans programme[1]-ABJN Deep Seas Project (FAO-GEF)			X			X	X
CORALFISH (EU FP7)		X					
EAF NANSEN (FAO)			X				
ECOVUL-ARPA (Spain)		X					
Emperor Smts.(Japan)					X		
EU Grant for support stock assessment							X
FARFISH (H2020)			X				
HERMES (EU FP6)		X		X			
HERMIONE (EU FP7)		X		X			
iATLANTIC (EU H2020)	X	X	X				
IUCN Smts.							X
MARECO (CoML)		X	X				
MARISMA (BCC)			X				
Multidisciplinary mapping (Spain, Namibia)			X				
NEREIDA (EU DG MARE, lead by Spain)	X						
NW Hawaiian ridge/Emperor Smts. (USA)					X		
South Pacific VME (New Zealand)						X	
SPONGES (EU H2020)	X	X					

[1] A second phase of the Common Oceans Program (2022-2027) is under planning.

Surveys at the sea

There have been several scientific cruises and ad dedicated surveys carried out by RFMOs member countries in the different RFMOs areas, some of which provide information for assessing deep-water resources and VMEs in such areas. SC work plans highlight RFMO's medium and long term research priorities. Science considered important to the scientific advice, unless written as mandatory requirements by the RFMO, is undertaken voluntarily by members. In some cases, research cruises are organized in the context of international or national research projects (Table 2) not coordinated through the annual SC work programs.

In general, the lack of a public database on research cruises makes it difficult to summarize a global inventory of such activities in the different RFMOs. This is an issue of concern. This is the case of SPRFMO: in 2019, the SPRFMO habitat monitoring working group (HMWG) agreed to develop an inventory of research programmes currently being developed by industry and scientific institutions.

In some RFMOs, the research activities conducted by member countries are summarized in the correspondent *National Research Reports*. Such reports are submitted to the SC on an annual basis in order to keep the SC informed, in a concise format of their fishing, research and management activities over the previous year (e.g. NAFO, SIOFA, SPRFMO). In some RFMOs, such reports are publically available as standalone documents on the websites (e.g. NAFO, SPRFMO).

Experience with data sharing and data integration

There are many examples of data sharing and data integration in the advisory cycle of both well-established (e.g. NAFO, NEAFC) and young (e.g. SEAFO, SIOFA, SPRFMO) RFMOs, considering data from research projects and surveys at the sea.

In the NAFO context, results and survey data from both research projects coordinated (e.g. NEREIDA) and not coordinated (e.g. ATLAS) by the RFMO, have been shared and integrated into the NAFO advisory cycle, contributing to address a wide range of requests from the *NAFO Commission*, including protection of VMEs (e.g. NEREIDA, see Barrio-Froján *et al*., 2016) and seabed litter distribution (e.g. ATLAS, see García-Alegre *et al.*, 2020). In the case of NEAFC, data sharing is regulated under the MoUs signed with ICES and OSPAR. Results from research projects are submitted by ICES members to the appropriate ICES working groups. If these results are considered sound and relevant, they can be integrated into the ICES work in order to provide advice to NEAFC (e.g. VME closed areas, see Durán Muñoz *et al*., 2009). Scientific research is necessary to underpin different management and conservation actions. For example, results from HERMIONE project were used in the joint OSPAR/NEAFC/CBD Scientific Workshop on the identification of Ecologically or Biologically Significant Marine Areas in September 2011.

In the case of the younth organizations (e.g. SEAFO, SIOFA, SPRFMO), the ABJN Deep Sea Project, a five-year international initiative supported by the Global Environment Facility (GEF), and implemented jointly by FAO and the United Nations Environment Programme (UNEP), has contributed significantly to improving the knowledge on the biology and assessment of deep-sea fisheries, the protection of VMEs and biodiversity, as well as the capacity building activities.

Need for a framework for scientific research activities

Unregulated marine scientific research may potentially harm the marine environment (Hubert, 2011). Some adverse effects are not specific to marine research and are common to other ocean uses (e.g. operating research vessels can have the same impacts as shipping: noise, waste, pollution, etc.). Other environmental impacts are science-specific, related to the means and methods used to study the oceans. These impacts can be classified as (i) physical from sampling methodologies (dredges, bottom trawls, seabed drilling, etc.); (ii) acoustical from seismic instruments and acoustic methods; (iii) chemical from chemical tracers or disposable devices; and (iv) accidental from marine research operations.

There is an ethical dilemma (Durán Muñoz *et al.*, 2020) between the need for data for the assessments and the "Precautionary Principle" (ASTEC, 1998): surveys can potentially harm ecosystems, but can significantly contribute, in the long term, to the sustainability of deep-sea fisheries, thanks to the management measures underpinned on survey data series (e.g. total admissible catches of fish stocks, identification of VME protected areas, etc.). On the other hand, there is a need for scientific review (e.g. by the appropriate advisory body) and confirmation of the scientific validity of the different research initiatives conducted in the RFMOs Regulatory Areas, to ensure its usefulness as a data source for scientific advice.

For these reasons, it is recommended to have clear definitions of the main types of research that can take place within the RFMOs areas (e.g. "general scientific research", "fisheries-based research", "fishing for scientific purposes", etc.), and establish processes and requirements for each type[9] of research activity (including impact mitigation measures), considering the role of the Scientific Councils / Committees. In addition, the terms "fisheries resources, "scientific research" and "research survey" also need to be clearly defined.

Strengths and weaknesses

The strengths and weaknesses of the current approaches used by the RFMOs were summarized:

One of the most notable strengths of NAFO is the existence of a long series of scientific surveys and associated databases (e.g. groundfish surveys funded by the EU, NEREIDA surveys led by EU-Spain), which underpin management decisions on fish stocks and VMEs. NAFO is one of the few RFMOs that assesses VMEs through scientific surveys; however, these are done as part of groundfish surveys and are themselves invasive, which can also be seen as a weakness. To solve this issue, NAFO is currently evaluating the effects on fish stock assessments of excluding survey trawls from the VME closed areas, and if this exclusion compromises the quality of index data used in the assessments. Additionally, a reflection on the potential use of non-invasive sampling techniques to monitor VMEs has been initiated. The introduction of such methods would potentially strengthen NAFO scientific research programmes and could inform research on VMEs in other regions.

With regard to the research managed by NAFO, there are currently no specific provisions for scientific approval of survey plans. To overcome this weakness, in 2021 the SC recommended that the NAFO Commission amend the current protocols to include a scientific review of proposed major research surveys going forward, in order to ensure that best practices are followed.

Scientific international research projects such as ATLAS (www.eu-atlas.org) and SPONGES (http://www.deepseasponges.org) funded by the EU, provided important results, based on groundfish survey data, supporting the advice on VMEs and contributing to implement the *Galway Statement on Atlantic Ocean Cooperation*[10].

Research related to activities other than fishing (e.g. oil and gas) is not regulated by NAFO, but is relevant in NAFO Regulatory Area, including within VME closed areas. It could provide useful VME data (e.g. visual surveys) or produce adverse impacts (e.g. seismic surveys, drilling surveys) on the ecosystems that support NAFO fisheries. The lack of coordination between the different management authorities (e.g. NAFO and CNLOPB[11]) can be considered a weakness in terms of ocean governance, as this prevents research optimization and impacts mitigation.

NEAFC has signed Memorandums of Understanding (MoUs) with ICES and OSPAR. Such MoUs strengthen the collaboration between these organizations.

ICES is the scientific advisory body of NEAFC, as NEAFC does not undertake research of its own. ICES, supported by the Permanent Committee on Management and Science (PECMAS) of NEAFC, develop appropriate research programs to meet longer-term issues raised by NEAFC. The involvement of ICES strengthens the advisory process: (i) ICES advice is independent and free from political influence, (ii) it is subject to the best international quality procedures for research, and (ii) it includes ecosystem considerations (e.g. fisheries impacts on marine mammals, sea birds and sensitive hábitats, etc.)

[9] It is necessary to know if the RFMO has the authority to manage all types of scientific research or if there is any limitation.
[10] In 2013, the EU, the US and Canada signed the *Galway Statement on Atlantic Ocean Cooperation*, which aims to join forces on the Atlantic Ocean research, in order to better understand this Ocean and promote the sustainable management of its resources.
[11] Canada-Newfounland & Labrador offshore petroleum board

NEAFC has not adopted any specific actions to minimise the impacts of research as there has been no suggestion of relevant adverse impacts associated with scientific investigations. NEAFC recommendations contain only general provisions on this issue and this could be considered a weakness. However, NEAFC Convention guarantees the legal competence to take action in this regard.

There is a good cooperation between NEAFC and OSPAR over the adoption and delineation of high seas MPAs and bottom fisheries closures (as well as other closures), based on data from scientific research. Both are often held up as examples of cross-organizational cooperation and coordination, it should also be noted that the conditions that enable and facilitate NEAFC and OSPAR's cooperation do not exist in most other areas of the world; while lessons can be learned from their approach, its model could not be successfully replicated across the globe. It is worth noting that the OSPAR Area overlaps with the NEAFC Area and that OSPAR has adopted the non-legally binding "Code of Conduct for Deep Sea and High Seas Scientific Research of the Maritime OSPAR Area" with the aim of mitigating the impacts of research.

The FAO ABNJ Deep Seas Project is providing useful assistance to SEAFO on the VME database, best practices for VMEs, work on sponges, ecosystem approaches, and the potential for facilitating fisheries sector representation in international fora among other issues. Its collaboration with SEAFO is of utmost importance.

Further research on orange roughy is desirable and the possibility of extending the Namibian orange roughy surveys to the SEAFO Convention Area (CA), has been discussed within SEAFO. However, given Namibian´s current financial situation, a survey is not likely in the immediate future.

The spatial distribution of VME indicators such as corals and sponges is however not well known in SEAFO, hence a need for further information from scientific investigations at sea has been recognized. Additionally, there are 11 fishing closures within the SEAFO CA, and a new area on the Valdivia was closed to other gears than pots and longlines. These closures were likely to represent VME locations. Research aimed to validate these potential VMEs locations is highly recommended. Scientific research (e.g. Spanish-Namibian surveys and Nansen surveys) has contributed to this although more research efforts are needed.

Although different activities are being carried out at GFCM, there are not scientific research projects of scientific surveys carried out under their coordination. In European waters, several projects are carried out whose results can be used for these activities, as well as the Data Collection of commercial and survey data funded by the EU, which includes both demersal bottom trawl surveys and acoustic surveys. They are carried out under internationally agreed protocols which are also followed by non-EU countries such as Morocco and Algeria.

In NPFC, there has been an active collaboration among Japan, the Republic of Korea and the USA on the development of a standard field guide for coral identification. A standard field guide has also been drafted in all three languages for use by observers and scientists at sea.

A large focus on VME research in NPFC has focused on coral species rather than vulnerable fish and invertebrate species.

Both CMM 2019-06 and 2021-05 have identified the need to collect follow up data collection and research to determine whether fished seamounts contain VME taxa. This includes the use of ROV or drop cameras and biological samples collected during research activities or through observer programmes. While this has been recommended, it is unclear whether this is being done on a systematic basis. In addition, there are no detailed mitigation measures that are specific to research activities not related to bottom fisheries outlined in the above-mentioned measures.

SPRFMO is a young RFMO that is taking advantage of the opportunities to engage in collaborative research or data sharing with other organisations, and this contributes to strengthening its science-based management. In this regard, SPRFMO is involved in international research programmes (e.g. the ABNJ Deep Seas project). Additionally, SPRFMO has signed different Memoranda of Understanding (MoU) or Agreements with adjacent RFMOs and other organisations. All these initiatives provide opportunities to promote and facilitate cooperation, including collaborative research and capacity building, as well as sharing experiences and data on matters of mutual interest. Since 2013, the SPRFMO research programme considers the incorporation of different components of the exploited resources and their associated ecosystems, and encompasses both the Precautionary Approach and the Ecosystems Approach to Fisheries Management. Moreover, research priorities are set out in the SPRFMO SC work plan (SPRFMO, 2018), and this provides a level of coordination for research that strengthens support for SPRFMO goals.

Nevertheless, some weaknesses have been noted by the SPRFMO Performance Review Panel (Ridings *et al.,* 2018): (i) Research and associated activities to support the scientific work of SPRFMO are primarily funded and conducted by Members and consequently, SPRFMO is dependent on those Members to report on these activities to SPRFMO. The Review Panel noted that a dedicated science programme funded and owned by SPRFMO would facilitate a more integrated and consistent approach; (ii) Fishing research activities in the SPRFMO Convention Area are undertaken on an ad hoc basis and, at present, there is no mechanism for notifying non-fishing research and for approval of fishing research; (iii) SPRFMO does not have a standardised database for Members to submit catch, effort and associated biological data from research cruises, or other scientific research activities (sharing of research data is therefore undertaken on an ad hoc basis and through SC's Working Groups). Moreover, the SPRFMO SC noted the current lack of a mechanism to provide for research activities in the SPRFMO CA. This represents a weakness in terms of sustainability, risks and opportunities for the fishery resources and impacts on resources and ecosystems. For this reason, the SC recommended that the Commission adopt conservation and management measures to address this issue.

SIOFA, as SPRFMO, is also a young RFMO and although much progress has been made in their scientific management, some issues remain to be addressed. For instance, the FAO ABNJ Deep Seas Project assisted on: (i) the VME database, (ii) best practices for VMEs, (ii) work on sponges, (iii) ecosystem approaches, (iv) the potential for facilitating fisheries sector representation in international fora, and (v) a prospective work on the electronic monitoring system with the Cook Islands.

Most of the SIOFA scientific activity is carried out by external consultants that are financed by the SIOFA budget, with support from members/operators or through projects such as the ABNJ Deep Seas Project from FAO. To promote greater involvement of the scientists from the parties to provide more robust and transparent advice to the Meeting of the Parties would be recommended, rather than delegating scientific work to external consultants. Projects or grants could finance thematic workshops, training courses etc.

There is a limited amount of information available on indicator species in the SIOFA Area. The objectives of most research surveys in the SIOFA CA have been focused either on the study of oceanographic variables and the pelagic ecosystem or within the coastal ZEEs that are not part of SIOFA CA. There is a need to collect more data from the benthic ecosystem, including via the use of photographic/video surveys. Multidisciplinary research surveys designed to develop SIOFA definition of VME indicator species and to assess the impact of fishing gears on the seafloor would be of great interest and could serve to analyse different encounter thresholds for VMEs and taxonomic studies within the SIOFA CA. Results from these surveys could help to develop a VME habitat mapping and to progress with the benthic bioregionalization.

Acoustic surveys devoted to the abundance population estimates for orange roughy/alfonsino would be of great interest. There is information available from commercial surveys but independent surveys would enhance this research.

The lack of detailed data in most of the fisheries makes difficult to have an integrated stock assessment for most of the commercial species. Although the progress in the last years has been significant, work remains. To fund these research activities and to promote data acquisition would be advisable.

Marine mammal depredation on fish catch had been identified as a major concern. Research and commercial surveys could be used as platforms to collect data on sightings and potential catch depredation.

A major strength of the CCAMLR programmes is that collaborative research is encouraged and many of the research proposals submitted are joint proposals from a number of Members. The recent synoptic survey on krill, for example, required extensive cooperation between members and scientists to coordinate a survey between several vessels over a large area, including collecting, standardising and analysing the data at the end.

However, the main weakness that has been identified is due to the large number of different research programmes being undertaken by the different Member States. These take place in a variety of areas within CCAMLR and there has been some concern over the standardisation of gear and vessels and how this may affect any conclusions that can be drawn from research data (WG-FSA-2018 report).

3. MANAGEMENT OF SCIENTIFIC RESEARCH IN THE RFMOs: CURRENT SITUATION

Northwest Atlantic Fisheries Organization (NAFO)

The NAFO Scientific Council (SC) compiles and maintains statistics and records, and publishes information about the fisheries including environmental and ecological factors. It also provides advice for the Commission and the Coastal States on stocks and the conservation and management of fishery resources. The SC has four standing committees[12]. One of these committees, the Standing Committee on Research Coordination (STACREC), is responsible for matters related to scientific research. STACREC (i) leads on issues relating to the collection, compilation and dissemination of statistical information on fisheries in the Convention Area, (ii) coordinates the planning and execution of international cooperative research, (iii) encourages and promotes cooperation in scientific research and (iv) reviews and evaluates data and information on advances in knowledge of biology.

A Five-Year Work Plan for the NAFO SC has been developed[13]. Work on the plan commenced in 2019 in response to a Commission Request and continued during SC meetings in 2020 and 2021. This plan includes survey planning, protocols and data collection (including fishing and activities other than fishing such as oil and gas). In order to collect data on scientific research, NAFO requests to the contracting parties on an annual basis: (i) the national research reports (including the fisheries status and the research studies conducted), (ii) the list of biological sampling data, (iii) the list of research vessel surveys on a stock by stock basis, (iv) the inventories of biological surveys and (v) the list of tag releases. National scientists are normally the ones that prepare and submit this information (NAFO, 2019).

Regarding research vessel surveys, Article 4 of the NAFO Conservation and Enforcement Measures (NAFO, 2021) only indicates that no less than seven days prior to the commencement of a fishery research period, the flag State Contracting Party shall: (i) notify the Executive Secretary of all research vessels entitled to fly its flag it has authorized to conduct research activities in the NAFO Regulatory Area (NRA), and (ii) provide a *Research Plan*, including the survey purpose, location and dates. A review of the research plans and confirmation of scientific validity by the SC is not required.

In this regard, it is worth noting that in 2021, STACREC expressed serious concerns[14] on a certain type of surveys (Steingrund, 2021) recently conducted in the NRA and discussed the necessity of reviewing the designs of scientific surveys ahead of the actual surveys being carried out. STACREC recommended that in future, any scientific surveys to take place in the NRA should be provided to SC to be given the opportunity for discussion. STACREC also recommended to Commission that the role of SC in future scientific surveys in the NRA should be clarified (e.g. review and discussion of the *Research Plans* of new proposed surveys). In line with this, in September 2021, SC recommended that the NAFO Commission amend the protocols from Article 4 in NAFO CEMs to include a scientific review of proposed major research surveys going forward, to ensure best practices are followed.

On the other hand, the impact of research vessel groundfish surveys on VMEs is being monitored by NAFO. To move forward in solving this concern, there are studies in progress focused on the effects on fish stock assessments of excluding groundfish

[12] See: https://www.nafo.int/About-us/Science
[13] https://www.nafo.int/Portals/0/PDFs/sc/2021/scs21-15.xlsx
[14] A longline survey of cod in NAFO Div 3M was carried out by Denmark/Faroe Islands in 2021. Without proper planning and design, the usefulness of such survey was questioned. There were also questions that this survey might be an exploratory fishery more than a scientific research survey.

surveys trawls from the VME closed areas, and if this exclusion compromises the quality of index data used in the assessments[15] (Durán Muñoz *et al*., 2020). This is a key issue from the NAFO fisheries management perspective, due groundfish surveys are essential for the assessments. Additionally, NAFO has made the effort to summarize the list of alternative non-invasive sampling methods[16] available to study VMEs, but has not yet made any decisions on their use within the NAFO Regulatory Area.

Northeast Atlantic Fisheries Commission (NEAFC)

NEAFC does not undertake research of its own. ICES is the scientific advisory body of NEAFC. It provides NEAFC with scientific information and advice, which is independent and free from political influence and subject to the best international quality procedures for research. ICES promotes and encourages marine research, in particular in relation to living resources, draws up the necessary programmes and organises such research. Members of ICES undertake surveys in the North-East Atlantic, some of which provide information for assessing deep-water resources and VMEs[17] in the NEAFC Regulatory Area. These investigations supplement existing published scientific information and databases available for assessments conducted by ICES expert groups such as WGDEC and WGDEEP (FAO, 2016). According to the Memorandum of Understanding (MoU) signed between ICES and NEAFC in 2019, both organizations will continue to consult on ways to improve cooperation (e.g. bilateral meetings, joint activities, seminars, symposia). ICES could use this information to guide research programs and take these issues into account in presenting its advice to NEAFC. ICES is thus enabled to develop appropriate research programs to meet longer-term issues raised by NEAFC, and take these issues into account in presenting its advice to NEAFC. Moreover, the Permanent Committee on Management and Science (PECMAS) of NEAFC has the function, *inter alia*, to support ICES in its work by identifying and highlighting research needs to the Commission and thereby stimulating national and co-operative scientific activity to underpin science-based management actions.

Regarding management measures, Articles 5.4 and 5.5 of the NEAFC Recommendation 10:2021 (NEAFC, 2021) indicates that Contracting Parties intending to conduct scientific investigations (which excludes exploratory fishing) within closed areas (i.e. areas closed to bottom fishing) and/or restricted bottom fishing areas (i.e. areas outside closed areas and existing bottom fishing areas), shall notify the Secretary of their intended research programmes, taking account of Article 206[18] of the 1982 United Nations Convention on the Law of the Sea. The Secretary shall forward such notifications to all Contracting Parties as well as to the PECMAS. Contracting Parties shall also ensure that any such proposed investigations shall be assessed to see whether they would have significant adverse impacts on VMEs.

NEAFC has not adopted any specific actions to minimise the impacts of research as there has been no suggestion of relevant adverse impacts associated with scientific investigations. However, should the need arise to establish control measures for scientific research, Article 10 of the NEAFC Convention guarantees the legal competence of NEAFC to do so (NEAFC, 2014).

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[15] NAFO 2021 SC Report in press

[16] Report of the 10th Meeting of the NAFO Scientific Council Working Group on Ecosystem Science and Assessment (WGESA). Northwest Atlantic Fisheries Organization. 8-16 November 2017, Dartmouth, Canada. Serial No N6774, NAFO Scientific Council, 2017. Summary Document 17/21

[17] See section A1.5.5 from SC08 Final Report

[18] This Article requires that States *"having reasonable grounds for believing that planned activities may cause harmful changes to the marine environment, shall assess the potential effects of such activities on the marine environment and shall communicate reports of the results of such assessments to all members of the competent international organization"* (FAO, 2016).

The OSPAR[19] Convention is the mechanism by which 15 Governments and the European Union cooperate to protect the marine environment of the North-East Atlantic. The OSPAR Area encompasses sizeable high seas areas. The spatial overlap between OSPAR, NEAFC and ICES areas is conducive to integrated, cross-sectoral ecosystem-based ocean management. The existing and newly established cooperative arrangements between NEAFC, OSPAR[20] and ICES are aimed at enhancing this conduciveness (Molenaar and Elferink, 2009).

OSPAR assesses and manages a wide range of human activities[21], including the extraction of non-living resources, in particular through its Offshore Industry Committee (OIC) and Environmental Impacts of Human Activities Committee (EIHA). Particularly, as part of its Joint Assessment and Monitoring Programme (JAMP)[22], OSPAR assesses the environmental impact of both established activities (e.g. tourism, coastal defence, cables and pipelines, carbon capture and storage and artificial reefs) and emerging activities (e.g. deep sea mining[23]).

The Annex V[24] of the OSPAR Convention[25] allows the OSPAR Commission to adopt programmes and measures to protect and conserve marine ecosystems and biodiversity from the impacts of most human activities (Annex V, Article 3 and Appendix 3), with the explicit exception (Annex V, Article 4) of fisheries management (NEAFC responsibility) and certain limitations regarding shipping (IMO responsibility). This allows the OSPAR Commission to act as an "authority by default" in the absence of a competent international organization at the global level and for new and emerging activities (Molenaar and Elferink, 2009). This has led, *inter alia*, to the adoption of the non-legally binding "Code of Conduct for scientific research in the deep seas and high seas of the OSPAR maritime area" (OSPAR, 2008), in order to mitigate seabed disturbance and associated impacts. It is recognized that certain research activities, including exploration of marine genetic resources and minerals, are currently ongoing in the North-East Atlantic that may potentially impact VMEs. In 2015 OSPAR discussed the need for new measures related to the search for and exploitation of marine genetic resources (FAO, 2016).

South East Atlantic Fisheries Organisation (SEAFO)

The Commission is the main decision-making body of SEAFO and has a wide range of functions identified by article 10 of the Convention. It is responsible, among other things, for promoting proper scientific research. The Scientific Committee (SC) was

[19] Convention for the Protection of the Marine Environment in the North-East Atlantic (OSPAR Convention) (https://www.ospar.org) OSPAR is the Regional Seas Convention responsible for protecting and conserving the North-East Atlantic and its resources. It manages human activities impacting the marine environment and provides regular assessments of the state of the North-East Atlantic.

[20] According to the 2008 MoU, NEAFC and OSPAR will encourage the funding and conduct of marine science in the North-East Atlantic, including in areas beyond national jurisdiction that will contribute towards the enhancement of knowledge on: (i) the distribution, abundance and condition of vulnerable deep water habitats; (ii) the status of populations of marine species; (iii) the effectiveness of measures aimed at the conservation of marine biological diversity, including in areas beyond national jurisdiction, (iv) the costs of non-action.

[21] OSPAR Annual report 2020-21 https://www.ospar.org/documents?v=46765

[22] https://www.ospar.org/work-areas/eiha/other-activities

[23] In 2019 the OSPAR Commission agreed to establish a task group on deep sea mining in order, *inter alia*, to exchange information and positions related to deep seabed mining and help Contracting Parties ensure that obligations under the OSPAR Convention are upheld.

[24] OSPAR Convention, ANNEX V: "On the protection and conservation of the ecosystems and biological diversity of the maritime area".

[25] https://www.ospar.org/convention/text

established in 2005, to provide the Commission with scientific advice and recommendations for the formulation of conservation and management measures for fishery resources, and to encourage and promote cooperation in scientific research in order to improve knowledge of the living marine resources of the Convention Area (CA). Work Plan for SEAFO SC, including the preparation of survey plans and protocols (e.g. survey design protocols) are reviewed by the SC on an annual basis[26].

In 2013, the Commission requested the SC to establish a protocol and guidelines for fisheries research in the SEAFO CA (SEAFO, 2013). In 2014, the SC discussed this issue and prepared "provisional guidelines". The SC proposed to the Commission the adoption of such "provisional guidelines". It also pointed out that the Commission may consider if there is a need for specific guidelines for fisheries research and other marine science activity in the closed areas, including what research activity is required to consider re-opening of closures (SEAFO 2014a). That year the Commission (SEAFO, 2014b) agreed on "Guidelines for fisheries research and basic marine science activity in the SEAFO CA" (SEAFO, 2014c). These guidelines serve to augment existing legally-binding measures contained in the SEAFO System of Observation, Inspection, Compliance and Enforcement (SEAFO, 2019)[27]. The SEAFO System is a comprehensive management utility used to promote compliance in the CA and came into effect in February 2013. Moreover, in its application, is essential for conservation purposes and for the international efforts to combat Illegal, Unregulated and Unreported fishing (IUU).

The primary purpose of the SEAFO guidelines for research is to facilitate that high-quality science may be conducted freely and to the benefit of all while also ensuring that the activity is conducted in a manner that does not cause significant adverse impacts (SAI) on the marine ecosystems and organisms, including fisheries resources. The guidelines define (i) *Fisheries Research*: investigations aimed to create a firm basis for fisheries management advice, (ii) *other marine science:* primarily curiosity-driven marine science which, independent of the utility of the results in relation to management and commercial interests, aims to study the environment, organisms, and ecosystems in order to explain patterns and processes in the sea[28] and (iii) *Exploratory Fisheries:* fishing experiments solely or primarily aimed to discover new resources or new fishing grounds, motivated by commercial interest.

Chapter VIII - Article 9 of the SEAFO System of Observation, Inspection, Compliance and Enforcement (SEAFO, 2019), is dedicated to the measures and obligations related to vessels conducting fishing research (e.g. notification of *Research Plans*, research vessels are not permitted to conduct commercial fishing, but must keep a stowage plan on board). Notwithstanding obligations of such Chapter VIII, the SEAFO guidelines for research indicate that any party intending to conduct fisheries research as well as other marine science activity in the SEAFO Convention Area (CA) is requested to adhere to the SEAFO guidelines for research during the different phases of the activity:

- <u>Planning phases</u>: (i) Prior to the activity, Contracting Party (CP) must submit to the Executive Secretary a letter of intent explaining the planned activity. The Executive Secretary will provide guidance on management measures, forms and routines for submitting reports and/or data. (ii) Upon receiving the response from SEAFO, CP is requested to submit, in advance of the trip, a more detailed research plan, also providing information on measures

[26] e.g. SEAFO Scientific Committee Report for 2020: http://www.seafo.org/media/a1812c93-c85f-417b-82cc-a88889374b3a/SEAFOweb/pdf/Meeting%20Files/2020/SC/SC%20Report%202020_pdf
[27] http://www.seafo.org/media/189e4c4b-e5ce-404a-9d66-e31bf1f2b1da/SEAFOweb/pdf/Press%20Releases/Press%20Release%202014_pdf
[28] In terms of scientific rigour, however, there is basically not a major difference between these two categories i and ii.

proposed to mitigate negative impacts on fisheries resources, biodiversity and VMEs. (iii) Upon receipt the letter of intent and detailed plan should be forwarded to all SEAFO CPs and the SEAFO SC.

- Field phases: (i) effort should be made to avoid activity compromising the SEAFO measures implemented to conserve fisheries resources and biodiversity, especially VMEs (particularly important in closed areas to protect VMEs). (ii) Sampling levels should satisfy scientific standards, but an excessive sampling of fisheries resources and VME associated organisms should be avoided. The use of invasive sampling methods, especially in VMEs areas, should preferably be avoided. If such methods cannot be fully excluded, should be carefully planned and monitored in order to minimize sampling, preventing excessive redundancy. (iii) Sampling of regulated species is encouraged to the extent that such sampling facilitates the provision of much needed data to the SEAFO SC. Care should be taken to avoid incentives to sample excessively and the need for discarding superfluous samples, (iv) Considerations should be given to how to facilitate timely post-cruise reporting of data and results of relevance to SEAFO. (v) Vessels conducting research are requested to convey positional data (VMS or equivalent) to SEAFO.

- Publication and data provision phase: (i) Cruise reports should be provided to SEAFO as soon as possible after the completion of the cruise. The SEAFO Executive Secretary will forward such reports to the CPs. (ii) Any publication deemed relevant to SEAFO resulting from the research activity should be submitted to SEAFO and made available to the SC. (iii) CPs are requested to submit data of relevance to the SC assessments and evaluations. Such data will be stored in a Secure SEAFO database (iv) If raw data cannot be submitted to SEAFO, then aggregate data at an agreed level of aggregation may be made available (particularly VME data, indicator species, etc.).

General Fisheries Commission for the Mediterranean (GFCM)

In accordance with its objectives and general principles (GFCM, 2014, Article 8g), the GFCM Commission shall exercise several research related functions, such as encouraging, recommending, coordinating, and undertaking research and development activities, including cooperative projects in the areas of fisheries and the protection of living marine resources.

Research has not directly been reflected in GFCM's specific measures on procedures or protocols for the conduct of research in the Mediterranean and Black Seas (FAO, 2016), but it is clearly a necessary initial step in the submission of proposals for new Fisheries Restricted Areas (FRAs) (GFCM, 2016a, b).

Since 2018, GFCM research programmes have been included, through specific recommendations[29], in the GFCM work plan (FAO, 2020). They are being launched to address data and management issues. These programmes not only allow for the collection of scientific data in support of new and/or enhanced fisheries management measures, but also provide a platform of cooperation and networking towards

[29] Recommendation GFCM/43/2019/4 on a management plan for the sustainable exploitation of red coral in the Mediterranean Sea. https://gfcm.sharepoint.com/:b:/g/CoC/EW3w-GWBZoVLtxUVE_cOIsQBeuC112a4GvUWvIKHPLHeeA
Recommendation GFCM/42/2018/9 on a regional research programme for rapa whelk fisheries in the Black Sea (geographical subarea 29).
https://gfcm.sharepoint.com/:b:/g/CoC/EfLgmDbgvkVGu71LnPExVRYBsIP2d5PkuD1XqHmkNY5gug
Recommendation GFCM/42/2018/1 on a multiannual management plan for European eel in the Mediterranean Sea. https://gfcm.sharepoint.com/:b:/g/CoC/EeUqwjAJ9WhFgbrHi8Asjp8B2igsW-4n9k2S3EjiS49p3g
Recommendation GFCM/42/2018/7 on a regional research programme on blue crab in the Mediterranean Sea. https://gfcm.sharepoint.com/:b:/g/CoC/EcDWGZ6rTIJBuQQ94K-XOq4Bmw5bDl7wbt4XewR9Q0wvxw

capacity building and the effective cooperative management of shared resources. They also facilitate the transfer of knowledge where needed, paving the way for effective cooperative management. Such programmes are implemented in those cases where an improvement in the sustainability and management of a specific fishery is expected to benefit from dedicated actions towards improving the quality and quantity of information on the resource, while addressing previously identified knowledge gaps and shortcomings in the relevant scientific/technical advice. In all cases, the core principle is to take full advantage of ongoing research at the country level by providing a platform for coordination and filling the gaps with new activities (e.g. the red coral programme includes remotely operated vehicle (ROV) surveys) and/or capacity-building support, generally aimed at providing the scientific basis for the determination of the most appropriate management measures.

The GFCM has identified, among the main priorities of its mid-term strategy (2017–2020) towards the sustainability of Mediterranean and Black Sea fisheries (mid-term strategy), the need to develop a unique framework for the planning and implementation of regional demersal (bottom and beam) trawl and pelagic acoustic surveys based on existing protocols – namely the Mediterranean International Bottom Trawl Survey (MEDITS), the Solea Monitoring Survey (SoleMon) and the Mediterranean International Acoustic Survey (MEDIAS) that are being implemented in the European Union. Technical guidelines were produced with the aim to support this endeavour (Carpentieri *et al.*, 2020). Their use can serve different purposes: (i) implementation of new surveys (applicable to areas where demersal trawl and/or pelagic acoustic surveys are not regularly carried out), (ii) increasing comparability between existing surveys by standardizing methods, sampling of catches, and recording and analysis of data; and (iii) definition of minimum requirements towards sustainability and management objectives (e.g. assessing the status of resources, establishment of management plans) at a regional and subregional scale.

North Pacific Fisheries Commission (NPFC)

Article 7, Section 1(a) of the Convention on the Conservation and Management of High Seas Fisheries Resources in the North Pacific Ocean states that the NPFC Commission shall, in accordance with the Convention principles, and based on the best scientific information and advice of the Scientific Committee (SC), adopt conservation and management measures (CMM) to ensure the long-term sustainability of fisheries resources within the Convention Area. CMM for bottom fisheries and protection of Vulnerable Marine Ecosystems in both the Northwestern and Northeastern Pacific Ocean, compiled in the *NPFC Conservation and Sustainable Use Handbook*, contain several provisions for scientific research:

- CMM 2021-05[30] indicates that, as appropriate, information collected by research vessels operating in the western part of the Convention Area should include (i) physical, chemical, biological, oceanographic, meteorological, etc., (ii) ecosystem surveys, (iii) seabed mapping (e.g. multibeam or other echosounders), (iv) seafloor images by drop camera, remotely operated underwater vehicle (ROV) and/or autonomous underwater vehicle (AUV). Moreover, it states that a variety of data would be required to assess whether a specific seamount that has been fished is a VME, including (i) pictures of seamounts taken by an ROV camera or drop camera, (ii) biological samples collected through research activities and observer programs, and (iii) detailed bathymetry map. Ongoing scientific research is also considered relevant to

[30] CMM 2021-05 *(Entered into force 10 July 2021)* Conservation and Management Measure for bottom fisheries and protection of Vulnerable Marine Ecosystems in the Northwestern Pacific Ocean. The North Pacific Fisheries Commission (NPFC). https://www.npfc.int/cmm-2021-05-bottom-fisheries-and-protection-vmes-nw-pacific-ocean

reduce the uncertainty in the assessments of (i) VMEs presence and (ii) significant adverse impacts (SAIs) on VMEs from bottom fishing activities.

- CMM 2019-06[31] states that scientific research activities for stock assessment purposes are to be conducted in accordance with a research plan that has been provided to the SC prior to the commencement of such activities.

Science-based standards and criteria for identification of VMEs and assessment of SAIs on VMEs and marine species are described in Annex 2 of both measures. Such standards are consistent with the FAO international guidelines for the management of deep-sea fisheries on the high seas.

According to Article 7, Section 3b of the NPFC Convention, the Commission shall adopt a plan of work for the SC. In this regard, Article 10, Section 4a states that the SC will "recommend to the Commission a research plan including specific issues and items to be addressed by the scientific experts or by other organizations or individuals, as appropriate, and identify data needs and coordinate activities that meet those needs". A Five-Year Research Plan and Work Plan of the NPFC SC (2021-2025) have been developed for consideration by the SC. This plan[32] is intended to guide the work of the SC by identifying key research priorities and associated areas of work. The plan should also serve to: ensure efficient utilization of scarce resources within the Commission, inform Parties' domestic research planning as a means to complementing the Commission's science activities and help the omission identify potential sources of external funding. The proposed priority research areas are: (i) stock assessments for target fisheries and bycatch species, (ii) ecosystem approach to fisheries management and (iii) data collection, management and security.

NPFC developed guidelines (https://www.npfc.int/guidelines-projects-1) outlining the process for submission, review, approval and implementation of projects to be supported by the NPFC budget. Additionally, a Special Projects Fund (https://www.npfc.int/special-projects-fund-0), was established as a financial mechanism to accommodate the specific purpose of addressing special science and compliance initiatives.

Morever, the "NPFC-PICES Framework for Enhanced Scientific Collaboration in the North Pacific"[33] identified three broad areas of joint interest to both organizations: (i) stock assessment for priority species, (ii) VMEs and (iii) ecosystem approach to fisheries. Workshops to identify knowledge gaps and research needs, as well as coordination of science plans, were identified as potential mechanisms for improving collaboration.

South Pacific Regional Fisheries Management Organisation (SPRFMO)

Article 10 of the SPRFMO Convention established the Scientific Committee (SC). Besides planning, conducting and reviewing scientific assessments and providing advice and recommendations to the SPRFMO Commission, the SC has the important function to encourage and promote cooperation in scientific research in order to improve knowledge of the state of fishery resources and the marine ecosystems in the Convention Area, including knowledge in relation to fishery resources straddling the Convention Area and areas under national jurisdiction. In this line, at its first

[31] CMM 2019-06 (Entered into force 29 November 2019) Conservation and Management Measure for bottom fisheries and protection of VULNERABLE MARINE ECOSYSTEMS in the Northeastern Pacific Ocean. The North Pacific Fisheries Commission (NPFC). https://www.npfc.int/cmm-2019-06-bottom-fisheries-and-protection-vmes-ne-pacific-ocean

[32] Five-Year Research Plan and Work Plan of the Scientific Committee. North Pacific Fisheries Commission Scientific Committee 2021-2025 Research Plan. The North Pacific Fisheries Commission (NPFC).https://www.npfc.int/2017-2021-research-plan

[33] NPFC-PICES Framework for Enhanced Scientific Collaboration in the North Pacific" https://www.npfc.int/npfc-pices-framework-enhanced-scientific-collaboration-north-pacific-0

meeting in 2013, the SPRFMO Commission adopted a "roadmap for the SC"[34] that outlined work priorities and identified advice needs. The same format was used in 2014 and 2015. Between 2016 and 2018, annual "work plans for SC" were adopted, while since 2019 are designed as "multi-annual work plans".

In 2013 the SC published its own Research Programme[35], which highlights SPRFMO's medium and long term research priorities. According to this programme, research should incorporate, as much as possible, the different components of the exploited resources and their associated ecosystems, and encompass both the Precautionary Approach and the Ecosystems Approach to Fisheries Management. Five main components with a number of associated topics were proposed:

1. *Environmental variability at different temporal and spatial scales*: (i) determination of different environmental scenarios, (ii) identify patterns of seasonal, inter-annual variation in environmental conditions and (iii) investigate their effects on fisheries resources.

2. *Chilean Jack mackerel*: (i) Biology and Ecology, (ii) stock structure, (iii) stock assessment and (iv) conservation, rebuilding plan and management procedures. Acoustic and egg surveys should be routinely undertaken to provide data for the stock assessment.

3. *The Deepwater Research Programme*: (i) Biology and (ii) assessment of target species, as well as (iii) identification and mapping of VMEs. Minimum biomass estimates might be derived from acoustic surveys. Moreover, multibeam acoustics and acoustic optical systems (AOS) should be considered.

4. *The Squid Research Programme*. There are three squid species of interest: jumbo flying squid (*Dosidicus gigas*), purple-back flying squid (*Sthenoteuthis oualaniensis*) and neon flying squid (*Ommastrephes bartrami*), for which several key areas of research have been identified: (i) biology (growth, mortality, migrations, stock structure and population dynamics) and (ii) collection of fisheries independent data (stock assessment surveys, both swept area bottom trawl and acoustic).

5. *Ecosystems Approach to Fisheries Management.* The interaction between fishing activity and the marine ecosystem should be considered (Garcia *et al*., 2003). Fisheries should not be managed in isolation and so, research should be focused on the assessments of the impact of fishing on non-target, associated or dependent species (e.g. seabirds, marine reptiles and marine mammals). In this context, observer programmes are essential.

Fishing research activities in the SPRFMO Convention Area are undertaken on an ad hoc basis and there is no mechanism for notifying non-fishing research and for approval of fishing research (Ridings *et al.,* 2018). A proposal was submitted to the 2018 SC for a Conservation and Management Measure on research to address these issues and to provide a more systematic approach to research activities (SPRFMO, 2018). SC agreed to recommend to the Commission that it adopt a CMM to provide for research activities in the Convention Area taking into account that research should be enabled within sustainable limits and that different types of research should be recognised. SPRFMO does not have a standardised database for Members to submit catch, effort and associated biological data from research cruises, or other scientific

[34] Roadmap for the Scientific Committee" (https://www.sprfmo.int/assets/Meetings/Meetings-2013-plus/Commission-Meetings/1st-Commission-Meeting-2013-Auckland-New-Zealand/Annex-L-Roadmap-for-the-Scientific-Committee.pdf

[35] See SC Research Programme in the 2013 Scientific Committee meeting, Annex 6: https://www.sprfmo.int/assets/Meetings/Meetings-2013-plus/SC-Meetings/1st-SC-Meeting-2013/Report/SC-01-2013-Report-amended-16-Dec-13-a.pdf

research activities. Sharing of research data is therefore undertaken on an ad hoc basis and through SC's Working Groups. There is no specific guidance given to the Secretariat on the sharing of datasets. This inhibits the sharing of data not only with SC, but also with external researchers and other organisations.

In 2019, the habitat monitoring working group (HMWG) agreed to develop an inventory of research programmes currently being developed by industry and scientific institutions regarding to data collection and monitoring of marine habitats (SPRFMO, 2019).

Southern Indian Ocean Fisheries Agreement (SIOFA)

The SIOFA Agreement[36] states that the Meeting of the Parties (MoP) shall promote and coordinate research activities on fishery resources and shared stocks, including discards and impacts of fishing on the marine environment (Article 6a). Moreover, MoP shall develop rules for the collection of scientific data (Article 6f). The Agreement defines the harvesting of fishery resources for scientific research as fishing activity, indicating that the Contracting Parties (CPs) may allocate catches for this purpose. The SIOFA Scientific Council (SC), established by the MoP to provide assessments, advice and recommendations (e.g. on fisheries resources, the impact of fishing, management measures, etc.), has also the function to encourage and promote cooperation in scientific research in order to improve knowledge of the state of the fishery resources. The MoP endorsed in 2016 the work plan for the SC to provide the necessary information to advise on the fishery management[37].

At present, there is no specific mechanism for regulating and encouraging research in the SIOFA Area. A first draft proposal for a Conservation and Management Measure (CMM) on a framework for fisheries research was presented at MoP in 2017[38], with the aim to provide an approach to research activities, taking into account Article 6f of SIOFA Agreement. The discussion and review of the proposal (considering scientific research and fisheries-based research), including the identification of gaps and options for addressing them[39], is currently ongoing[40]. MoP requested that SC provides advice and recommendations on further development of this CMM[41]. In the context of this future framework, according to the SC advice, there is a need to:

- Stated a clear purpose and intend for the CMM,
- Define the main key concepts (e.g. surveys, scientific research, fisheries-related research, etc.),
- Consider the need for research plans and define its specifications,
- Consider the range of types and approaches to conduct research, trying to avoid unnecessary barriers, allowing flexibility to conduct the research at the sea and the subsequent analysis,
- Consider the issue of catches in fisheries research (allocation of catches, exemptions, etc.),

[36] https://www.apsoi.org/sites/default/files/documents/SIOFA%20AGREEMENT_EN.pdf
[37] http://apsoi.org/sites/default/files/documents/meetings/MoP%20Report%20III%202016%20La%20Reunion.pdf
[38] http://apsoi.org/sites/default/files/documents/meetings/MoP4%20Report%20FINAL.pdf
[39] http://apsoi.org/sites/default/files/documents/meetings/SC-04-INFO-12%20Straw%20man%20on%20Scientific%20Research%20and%20New%20or%20Exploratory%20Fisheries_EU.pdf
[40] http://apsoi.org/sites/default/files/documents/meetings/MoP6-Report_FINAL.pdf
[41] http://apsoi.org/sites/default/files/documents/meetings/SIOFA_SC5_Report_with_annexes_and_budget.pdf

- Provide a template for research activities, based on the experience of other RFMOs (e.g. CCAMLR),
- Define the role of the SC in the proposed processes (e.g. review of research plans).

Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)

CCAMLR is not an RFMO *sensu estricto*. It is an international commission, part of the Antarctic Treaty System[42], responsible for the conservation of marine living resources and fisheries management in the Convention Area. According to the *Convention on the Conservation of Antarctic Marine Living Resources*[43], the Commission is the decision body of CCAMLR, responsible (Article IX) for the adoption of conservation measures (CM). Regarding scientific research, the Commission has the function to facilitate research into and comprehensive studies of Antarctic marine living resources and ecosystem. The Scientific Committee (SC) is the consultative body of the Commission (Article XIV). SC established a number of working groups to assist in formulating advice. SC shall encourage and promote co-operation in the field of scientific research in order to extend knowledge of the marine living resources of the Antarctic marine ecosystem (Article XV.1). SC also shall formulate proposals for the conduct of international and national programs of research into Antarctic marine living resources (Article XV.2f).

Five main CM govern the application of conservation measures to scientific research and experiments within the CCAMLR Convention Area:

- CM 24-01: Fishery-related research activities require prior notification to the Commission, including the provision of a Research Plan. The plan shall be submitted to the Secretariat, for review by the relevant working groups of the SC. Based on this, the SC provides advice to the Commission. Until the review process is complete, the planned fishing for research purposes shall not proceed. In some cases, prior approval by the SC is required (FAO, 2016). Vessels undertaking such research are required to report their research catch, effort, and biological data. Observation and inspection shall be carried out on board vessels engaged in scientific research or harvesting of marine living resources. Research catches are included in the annual catch limits in areas where such limits apply, and summary and full reports of the research activities must be provided to the SC. Research expeditions may present evidence of VMEs to the working group on Ecosystem Monitoring and Management (WG-EMM). All fishery-dependent research surveys must be undertaken in accordance with all applicable CM in force, including those that pertain to minimizing adverse impacts on VMEs (CM 22-06 and CM 22-07).
- CM 24-02: This measure describes the technical specifications for longline weighting for seabird conservation (e.g. minimum sink rate, sink rate tests, use of time-depth recorders, regular sink rate monitoring, etc.).
- CM 24-04: One of the most evident signs of regional climate change in Antarctica has been a glacial retreat and ice-shelf collapse in the Antarctic Peninsula (Statistical Subareas 48.1, 48.5 and 88.3). Due to the scientific value of potential habitats exposed, there is a need to facilitate research in such areas. CM 24-04 allows designating "Special Areas for Scientific Study" following ice-shelf retreat or collapse. Scientific research activities "related to

[42] https://www.ats.aq/index_e.html#
[43] https://www.ccamlr.org/en/system/files/e-pt1_3.pdf

fisheries and the harvesting of marine living resources" in such areas shall be carried out in accordance with the provisions of CM 24-01, subject to certain specific conditions. Moreover, members planning to initiate, or undertake any "non-fisheries-related" scientific research or monitoring of marine living resources are encouraged to inform the SC of their intended research plans, and to report any results relevant to the work of the Commission and the SC.

- CM 24-05: In order to increase both transparency and documentation in relation to fishing for research purposes that have been authorised by the Commission, the list of Research activities pursuant to CM 24-01 is published in a season basis (e.g. CM 24-05 for 2020/21 season).

- Additionally, according to CM 22-09, all bottom fishing activities shall be prohibited within the "Registred VME Areas" listed in this CM, with the exception of scientific research activities agreed by the Commission on advice from the SC and in accordance with CM 22-06 and 24-01.

The second performance review panel[44] observed that at present, only fieldwork that relates to research undertaken by commercial fishing vessels is specified in conservation measures. Ecosystem measurements, including remote sensing, fishery-independent surveys and monitoring, most laboratory work, and all other scientific work, are not included in the mandatory requirements of conservation measures. Moreover, science considered important to the development and maintenance of CM, unless written as mandatory requirements, is undertaken voluntarily by Members. In some cases, essential science for the Commission is vulnerable to not being undertaken should a Member or funding body withdraw from, or not be available to do, the non-mandatory work. Additionally, only a few areas of the CCAMLR Convention Area have regular surveys, with many activities undertaken by only one or a few Members at a time. A working mechanism is needed to better coordinate the research activities among Members in terms of both the focus of research and the temporal–spatial scales to maximise the delivery of such collaborative efforts to support the work of the Commission.

The panel also observed that the annual work program of the SC and its subsidiary bodies focus on delivering the requirements of Article XV.2 (provision of specific scientific advice to assist the Commission), whereas a strategy for meeting the requirements of Article XV.1 (general science on Antarctic marine living resources) should be primarily developed through mechanisms other than the annual work program (e.g. triennial development of key scientific questions that would support the long term development of advice to the Commission, engagement with the Scientific Committee on Antarctic Research, SCAR, and other relevant bodies to encourage them to address those questions in a manner consistent with the SC requirements).

[44] Second Performance Review of CCAMLR. Final Report of the Panel. CCAMLR-XXXVI/01. August 2017. https://www.ccamlr.org/en/system/files/e-cc-xxxvi-01-w-cp.pdf

4. LESSONS LEARNED FROM THE RFMOs: RECOMMENDATIONS ON THE POTENTIAL ELEMENTS NEEDED FOR DEVELOPING A FRAMEWORK FOR SCIENTIFIC RESEARCH

In light of the diversity of approaches in the RFMOs regarding the management of research activities, taking into account weaknesses and strengths, a number of potential elements needed for developing a framework for scientific research were identified:

- *Objectives and purposes of the framework*: It is important to clarify the objectives of the framework and if the RFMO has full authority to manage all types of scientific research or if there is any limitation[45]. As most RFMOs have among their functions *"to encourage and promote scientific research and cooperation"* care must be taken not to create unnecessary barriers to conducting research. An example of a clear purpose statement is in the SEAFO guidelines: *"The primary purpose of these guidelines is to facilitate that high-quality science may be conducted freely and to the benefit of all while also ensuring that the activity is conducted in a manner which does not cause significant adverse impacts (SAI) on the marine ecosystems and organisms, including fisheries resources"*.

- *Definitions:* It is recommended to have clear definitions of the main types of research that can occur within the RFMOs areas. In addition, the terms "fisheries resources", "scientific research" and "research survey" also need to be clearly defined (see examples of definitions in: SEAFO guidelines for research, SPRFMO and SIOFA proposals for a framework for research). Exploratory fishing should have its own specific framework different from the framework for scientific research.

- *Processes and requirements*: The framework should establish clear processes and requirements for each type of scientific activity managed by the RFMO (including impact mitigation measures), taking into account the risks and opportunities for the fisheries resources and ecosystems. Examples of protocols and requirements (e.g. notice of intent, submission of detailed *Research Plan*, measures to avoid impacts on VMES, etc.) are in SEAFO guidelines, CCAMLR conservation measures and SPRFMO and SIOFA proposals for a framework.

- *Coordination and collaboration*: The framework should encourage and promote coordination and collaboration between members in order to maximize the effectiveness of the research. Multi-year work plans for research can facilitate the coordination of the activities.

- *Role of the scientific advisory bodies*: The role of the Scientific Councils / Committees in the process should be clearly defined (e.g. review, discussion and approval of the *Research Plans* of proposed research activities).

- *Research Plans*: Standardized templates in order to submit the *Research Plans* should be developed.

- *National scientific research reports*: Standardized templates in order to submit, on an annual basis, the *national scientific research reports*, should be

[45] Generally, research related to activities other than fishing is not regulated by the RFMOs (e.g. oil and gas), but could provide useful data for the study of VMEs (e.g. visual surveys) or produce adverse impacts on the ecosystems that support the fisheries (e.g. seismic surveys, drilling surveys). In this case, cooperation between RFMOs and other management authorities is recommended in order to optimize the research efforts and minimize the impacts.

developed. These reports should include a list of the scientific research activities (including different types of surveys) in the region.

- *Inventory of research activities*: A database of research activities (including different types of surveys) can be useful to maintain an inventory of the activities planned and conducted in the RFMO area, to inform the scientific advisory bodies.

- *Database of research data and data sharing*: A standardized database for members to submit data from research cruises or other scientific research activities and a data-sharing protocol can be helpful in maintaining and sharing the data necessary for the work of scientific advisory bodies (e.g. ICES VME Database and data protocols).

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Baseline information on research activities in the RFMOs

For each RFMO, information on the following points was compiled by the partners:

a. Relevant research projects

b. Relevant research programmes

c. Surveys at the sea

d. Identify strengths and weaknesses of the scientific research projects/relevant programmes

e. Experience with data sharing and potential integration of new data in the RFMO advisory cycle, and remarkable consequences, if any

f. Potential adverse impacts of scientific research activities and mitigation measures. Alternative methods.

g. Other issues/recommendations that could be useful for providing options for the development of a framework for scientific research activities (not related to fisheries)

- References

CONTENTS

NORTHWEST ATLANTIC FISHERIES ORGANIZATION (NAFO)

Partner short name: MRAG EU

a. Relevant scientific research projects

Scientists from many different countries, and areas of expertise, cooperate within NAFO to coordinate research in the NAFO Regulatory Area.

NEREIDA project (https://www.nafo.int/About-us/International-Cooperation)

The NEREIDA Expedition carried out research in the NAFO Regulatory Area in 2009 and 2010. This project was multidisciplinary research of the sensitive habitats and fishing activities as well as analysis of the fishing resources for the study and protection of the vulnerable ecosystems.

NAFO developed a methodology for the determination of significant concentrations of coral and sponge taxa from research vessel survey bycatch. This methodology was established over a series of meetings by NAFO scientific working groups commencing in March 2008 and ending in May 2009. The NAFO Fisheries Commission at their 2009 meeting in Bergen, Norway closed 11 areas covering 2500 km^2 to bottom fishing activities to protect sponge grounds, sea pen fields and large gorgonian corals as well as black coral habitat within the fishing footprint of the NRA. These closures were in addition to previous closures to protect seamounts, and coral habitat in Division 3O. The objectives of the Hudson/NEREIDA missions were to collect in situ data on corals and sponges from the NRA both in existing fishing areas and in potential exploratory fishing areas outside of the current fished area. Three different sampling tools were used to conduct video and photographic surveys of the benthos. ROPOS and the 4KCam worked the deeper waters to 3000 m, while CAMPOD operated at shallower depths to 700 m. These data will be used to relate bycatch data to actual abundance on the bottom and to provide more detailed information on the benthic habitat in areas currently protected but scheduled for review in 2010 and 2011. New data from the deep waters of Flemish Cap (to 3000 m) provide a first description of the benthos outside of the fished area in the NRA.

NAFO has identified sponge grounds as vulnerable marine ecosystems. A number of areas in the NAFO Regulatory Area (NRA) have been closed to protect the dense aggregations of sponges that are known to occur. One of the largest of these is on Sackville Spur, where research vessel catches have filled the nets in a single 15 minute trawl. Sponges are very vulnerable to disturbance by bottom-tending gear and one of the questions scientists have is whether the present-day distribution of the sponges has been modified by fishing activity. The NEREIDA push core samples may provide an insight into this question. Sponges use various materials to reinforce their tissue and this forms the main basis for their identification. These sponge "bones" are called spicules and they are made of calcium carbonate or silica. They come in a wide variety of shapes and sizes which are unique for each species. These spicules can form very dense mats on the sea floor as the sponges die. Spicule mats become a specialized habitat of their own. If left undisturbed, these spicules will eventually become covered with sediment. Some Push Cores showed evidence of sponge spicules both at the surface and at depth along the core. The project will be analyzing these spicules to determine: 1) the sponge species that deposited the spicules 2) whether historically sponges occupied different areas of Flemish Cap (100s of year time scale) – from spicules deep in the cores 3) whether there is evidence of a recent change in sponge distribution – from spicules near the top of the cores.

Ashford *et al.*, (2018) analyzed 312 sediment samples, forming the largest macrofaunal sample set yet collected from the deep ocean. Samples were collected with a box corer (area 0.25 m^2) from the continental slopes of the Northwest Atlantic

Ocean (depth range: 582–2294 m) between May-August 2009 and June–August 2010, and form part of the international 'NEREIDA' programme. The study found temperature and bottom trawling intensity to be among the environmental factors significantly related to assemblage diversity. Results hint that deep-ocean communities are highly sensitive to their physical environment and vulnerable to environmental perturbation, including by direct disturbance through fishing, and indirectly through the changes brought about by climate change.

Research in support of the re-assessment of NAFO Bottom Fisheries in 2021 under the EU NEREIDA project was presented in WGESA 2020 (NAFO, 2020). An update on the description and classification of the different fisheries and distribution of fishing effort in the NRA for a four-year period (2016 to 2019) was conducted. This characterization of the different demersal fisheries was done on the basis of two data sources: Haul by haul logbook information and Vessel Monitoring System (VMS) data. Two analyses were presented on the quality and coverage of VMS and logbooks data. Additionally, an overlay analysis to estimate the area of VME polygons that was overlapped by the 2016 to 2019 cumulative fishing effort and fisheries-specific effort layers was conducted. This work was conducted as part of the NEREIDA project funded by the European Commission under Grant Agreements SI2.770786; SI2.793318 and SI2.827558.

ATLAS project (http://www.eu-atlas.org/)

To achieve the trans-Atlantic scale and incorporate the diversity of sensitive Atlantic deep-water ecosystems, ATLAS has assembled 12 Case Studies that follow the major Atlantic current patterns. These were selected on basis of proximity to Blue Growth activities, presence of focal ecosystems, availability of existing data/samples and opportunities for offshore cruises during the ATLAS project. Case studies include the Davis Strait and Flemish Cap (Canada) and the Mid-Atlantic Canyons (North America). Case Studies cross-cut the project and give the biogeographic, regulatory and jurisdictional range needed to meet ATLAS's objectives (see https://atlanticstrategy.eu/fr/best-practices-database/atlas-project).

The EU-Atlas project (Flemish Cap) is a four-year H2020 project that started in May 2016 and aims to gather diverse new information on sensitive Atlantic ecosystems (including Vulnerable Marine Ecosystems and Ecologically or Biologically Sensitive Areas) to produce a step-change in our understanding of their connectivity, functioning and responses to future changes in human use and ocean climate. The Instituto Español de Oceanografía (Centro Oceanográfico de Vigo) is the coordinator of the ATLAS Case Study No 11, which includes Flemish Cap and Flemish Pass area (3LM NAFO Divisions). The main partners involved in this Case Study are the Instituto Español de Oceanografía (IEO), Centro Oceanográfico de Vigo, and Fisheries and Oceans Canada (DFO), Bedford Institute of Oceanography. Both have extensive experience (e.g. NEREIDA project) and have plans to develop future research in the area (NAFO, 2019).

During the 12th NAFO WGESA meeting, EU ATLAS project (in collaboration with iSEAS project) was presented giving updated information regarding Species Distribution Models (SDMs) for the *Pennatula aculeata* and *Acanella arbuscula* deep-water corals for Flemish Cap Case Study (Flemish Cap and Flemish Pass areas).

Regarding SDMs, different modelling algorithms were presented to classify the probability of habitat suitability for *Pennatula aculeata* and *Acanella arbuscula* as a function of a set of environmental variables. Species data were collected during two bottom-trawl groundfish surveys carried out by the Instituto Español de Oceanografía (IEO) jointly with the European Union (EU): i) the EU Flemish Cap survey sampled all the Flemish Cap (NAFO Division 3M) and ii) the Spanish 3L survey sampled the

“Nose” of the Grand Banks of Newfoundland and the Flemish Pass (NAFO Division 3L). See NAFO report (2019) for more information.

b. Relevant research programmes

Scientific surveys have played a critical role in the identification of VMEs on the east coast of Canada and in NAFO. The surveys have been used to identify VME indicators present, map their distributions and determine where significant concentrations occur. Targeted surveys have been conducted to validate models and to collect new information on VMEs. This has occurred both within Canada, and within NAFO where Spain and Canada led a multinational/multidisciplinary survey effort to collect new information on VMEs.

NAFO is unique amongst RFMOs in that it has identified significant concentrations of VME indicators based on a combination of high biomass and discreteness of the area occupied, assessed using geospatial tools. These significant concentrations of large gorgonian corals, small gorgonian corals, sea pens, and sponges are considered to be the VMEs (NAFO 2013). Canada has also used this approach to identify significant benthic areas (SBAs) for coral and sponges under their equivalent domestic policy (DFO 2017). Biomass data for the analyses were from depth stratified random trawl surveys conducted by Canada and the EU. These surveys have been recording coral and sponge catch for over a decade and use VME species identification guides that were developed to improve the quality of the data.

Kernel density estimation (KDE) was the primary approach used to identify the general location of the significant concentrations of VME indicators (Kenchington *et al*., 2014, Kenchington *et al*., 2016). Area-catch weight curves were used to identify the weight thresholds defining the significant concentrations. Species distribution modelling was then used to interpolate between survey trawl locations within the VME polygons to further refine the delineation of the VMEs. For many of the areas, *in situ* observations were then made to validate the VME presence.

Identification of VMEs then allowed for an assessment of overlap with fisheries, as the closed areas do not protect all of the VME. This has been done both in Canada (logbooks and VMS) and in NAFO (VMS). NAFO is further exploring the impact of fishing on VME outside closed areas through a modelling approach. At the same time, two EU Horizon 2020 projects are undertaking research to learn more about the ecosystem function of coral and sponge VME. This information will be used to examine potential impacts on the ecosystem in the future.

c. Surveys at the sea (NAFO, 2020)

Since 1995, Spain carries out annually a Spring-Summer survey in the NAFO Regulatory Area of Div. 3NO. From 1995 to 2000, the survey was conducted on board the C/V Playa de Menduíña with a net trawl type Pedreira. In 2001 this vessel was replaced by the R/V Vizconde de Eza, using a trawl net type Campelen 1800. In 2003, it was decided to extend the Spanish 3NO survey toward Div. 3L (Flemish Pass). In 2020, for the first time, the 3NO and 3L surveys could not be carried out due to the exceptional pandemic situation caused by COVID 19.

New data on deep-water corals and sponges were presented from the 2020 EU-Spain and Portugal bottom trawl groundfish survey. The data was made available to the NAFO WGESA to improve the mapping of VME species in the NAFO Regulatory Area (Divs. 3LMNO). Distribution maps of presence and catches above threshold for RV data of sponges (100 kg/tow), large gorgonians (0.6 kg/tow), small gorgonians (0.15 kg/tow) and sea pens (1.3 kg/tow) were presented.

Sponges: Sponges were recorded in 47 of the 184 tows (25.5% of the total tows analyzed), with depths ranging between 141 - 1166 m. No Significant catches of sponge (≥ 100 kg/tow) were found.

Large Gorgonians: Large gorgonians were recorded in 2 of the 184 tows (1% of total tows analyzed), with depths ranging between 806 - 940 m. None of the tows had significant catches of large gorgonians (≥ 0.6 kg/tow).

Small Gorgonians: Small gorgonians were recorded in 15 tows (8.15 % of total tows analyzed), with depths ranging between 567 - 1250 m. No significant catches (> 0.2 kg/tow) were recorded.

Sea Pens: Sea pens were recorded in 59 tows (32% of total tows analyzed), with depths ranging between 182 - 1423 m. No significant catches (> 1.3 kg/tow) were recorded.

NAFO undertook a review of the areas closed to protect VMEs in 2013/2014 (NAFO, 2013). They created operational definitions (NAFO, 2013) for VME indicators, VME elements, higher concentration observations of VME indicator species (i.e., “significant concentrations”) and VMEs (see Text Box). To quantitatively identify significant concentrations of VME indicator taxa in the NRA, kernel density estimation (KDE) was applied to trawl survey data from research vessels. In response to a request from the NAFO Commission and following the procedures applied in 2013, these analyses were updated in 2019 using all available data from the Canadian and EU-Spanish trawl survey data in support of the current review of the closed areas (NAFO, 2020). KDE utilizes spatially explicit data to model the distribution of a variable of interest. It is a simple nonparametric neighbour-based smoothing function that relies on few assumptions about the structure of the observed data and uses minimal interpolation. It has been used in ecology to identify hotspots, that is, areas of relatively high biomass/abundance. With respect to marine benthic invertebrate species, it was first applied to the identification of significant concentrations of sponges in the NRA in 2009 (Kenchington *et al*., 2009) followed by an application to sea pens (Murillo *et al*., 2010). Since then it has been used to identify significant concentrations (VMEs) of corals, sponges and other VME indicators from research vessel trawl survey catch data in both Canada (Kenchington *et al*., 2016) and in the NRA (NAFO, 2013; Kenchington *et al*., 2014).

Available data for each VME indicator type were obtained from research vessel trawl surveys conducted between 1995 and 2019 (Table 7.2). These are the same data used to calculate the updated kernel density polygons (Kenchington *et al*., 2019) used to delineate the location of VMEs for the review of areas closed for their protection (NAFO, 2020):

Table 7.2. Data sources from contracting party research vessel surveys; EU, European Union; DFO, Department of Fisheries and Oceans; NL, Newfoundland and Labrador; IEO, Instituto Español de Oceanografia; IIM, Instituto de Investigaciones Marinas; IPMA, Instituto Português do Mar e da Atmosfera.

Programme	Period	NAFO Division	Gear	Mesh Size in Codend Liner (mm)	Trawl Duration (min)	Average Wingspread (m)
Spanish 3NO Survey (IEO)	2002 - 2019	3NO	Campelen 1800	20	30	24.2 – 31.9
EU Flemish Cap Survey (IEO, IIM, IPIMAR)	2003 - 2019	3M	Lofoten	35	30	13.89
Spanish 3L Survey (IEO)	2003 - 2019	3L	Campelen 1800	20	30	24.2 – 31.9
DFO NL Multi-species Surveys (DFO)	1995 - 2019	3LNO	Campelen 1800	12.7	15	15 - 20

Survey Name	Lead organization	NAFO Divisions	Data type	Comment	Report (if available)
Spanish 3NO Survey	Instituto Español de Oceanografía, Vigo, Spain	3NO	Trawl bycatch	Annual survey	Yellowtail flounder, redfish (*Sebastes* spp.), and witch flounder indices - report Greenland halibut, American plaice, and Atlantic cod - report
EU Flemish Cap Survey	Instituto Español de Oceanografía, Vigo, Spain; Instituto de Investigaciones Marinas; Instituto Português do Mar e da Atmosfera	3M	Trawl bycatch	Annual survey	Groundfish Assemblages on Flemish Cap - report
Spanish 3L Survey	Instituto Español de Oceanografía, Vigo, Spain	3L	Trawl bycatch	Annual survey	Results for the Spanish Survey in the NAFO Regulatory Area of Division 3L for the period 2003 – 2013 - report
DFO NL Multispecies Surveys	Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada	3LNO	Trawl bycatch	Annual survey	2014 assessment of Northern Shrimp - report Assessment of Thorny Skate - report
Benthic Surveys	Bedford Institute of Oceanography, Fisheries and Oceans Canada	NRA	Underwater imagery, grab samples, project-specific sampling tools	Regular surveys with a targeted research focus	
NEREIDA	Spain, Canada, United Kingdom, Russian Federation	NRA	Multibeam bathymetry, box corer samples, benthic dredge samples	2009-2010 multidisciplinary surveys targeting VME areas in the NRA	

d. Identify strengths and weaknesses of the scientific research projects/relevant programmes

NAFO is one of the few RFMOs to evaluate the effects of closed areas on VMEs through scientific surveys, however, these are done as part of trawl surveys for stock assessments and are in themselves destructive. As a result, the Commission has requested that Scientific Council continue its evaluation of the impact of scientific trawl surveys on VME in closed areas, and the effect of excluding surveys from these areas on stock assessments. Although not in place yet, WG-ESA has recommended that the Scientific Council investigates the use of non-destructive cost-effective sampling techniques to monitor VMEs and the options for integrating such techniques and the data they generate into the existing scientific trawl surveys, possibly through the establishment of an ad hoc WG on non-invasive survey methods (NAFO, 2019). The indroduction of these not non-destructive techniques would potentially strengthen scientific research programmes and could inform research in other regions.

The main weaknessess identified are related to the VME areas on the Tail of Grand Bank and the sea pen closures on Flemish Cap which require urgent management action. The former have completely unprotected VME (small gorgonian corals, sea squirts, sea pens, and erect bryozoans) while the latter have overlapping VMEs (2-4 habitats including glass sponges), and are too small to ensure protection from fishing and to enable connectivity among closures. New boundaries for seamount closures have been proposed and management action would be desirable (NAFO, 2019). In 2021, NAFO SC recommended the protection of such VMEs based on new data from trawl surveys. Since January 2022, NAFO closed several of these VME areas to bottom fishing.

e. Experience with data sharing and potential integration of new data in the RFMO advisory cycle, and remarkable consequences, if any

The NAFO Secretariat is a repository of information and meta-data related to the fishery, including catch statistics, scientific literature, fisheries management documentation and GIS (geographic information system) resources.

The NAFO Secretariat maintains the fishery catch statistics for FAO Area 21 (the Northwest Atlantic) which include both summary catch info and detailed catch and effort information. NAFO is also a founding member of the FAO's Coordinating Working Party on Fishery Statistics (CWP).

NAFO Secretariat also maintains geo-spatial data pertaining to NAFO Subareas and Divisions, the NAFO fishing footprint and NAFO closed areas. The NAFO Secretariat is also the centre for the Vessel Monitoring System (VMS). These data are confidential and are used mostly for compliance purposes. In recent years, some summarized data has been used by Scientific Council to advise on fisheries interactions with areas where VME indicator species (mainly sponges and corals) are known to occur.

NAFO also participates in FAO data projects such as FIRMS. NAFO has also contributed to D4-Science and is a contributor to the FAO VME database.

All of NAFO’s publications and documents are indexed in the ASFA Database, which provides the most comprehensive information to a global audience for abstracting and indexing services in the aquatic and fisheries field. ASFA’s ability to provide deep indexing, links to full text and the indexing of ‘grey literature’, ensures documents, publications and general information pertaining to aquatic sciences and fisheries is available to a wide audience: www.fao.org/fishery/asfa/en

f. Potential adverse impacts of scientific research activities and mitigation measures. Alternative methods.

Analysis conducted by the Working Group on Ecosystem Science and Assessment (WG-ESA) in 2016 concluded the risk of impact on VME arising from scientific trawls within VME closed areas was significant, especially with regard to the sponge VME. However, the analysis to assess the impact of removing survey sets from closed areas on stock assessment metrics has yet to be finalized. WG-ESA considers the need to investigate and develop alternative appropriate cost-effective non-invasive monitoring techniques essential to ensure the continuity in the monitoring and assessment of VMEs in the NRA (NAFO, 2019).

Discussions held by WG-ESA in 2016 concluded that "non-destructive" sampling surveys are preferred, for example, camera-based surveys, but there would be trade-offs to consider in regard to obtaining adequate biological sampling. Another consideration was whether calibration of non-destructive surveys with bottom trawl surveys was possible to enable a combined series of the data for monitoring purposes. The WG suggested an ad hoc WG be created to explore the feasibility of non-destructive monitoring surveys with the aim of developing objectives for future monitoring as well as, to the extent possible, enabling meaningful comparisons to existing bottom trawl surveys. Experts in both sampling methods should be sought".

WG-ESA, therefore, recommends that Scientific Council investigates the use of non-destructive cost-effective sampling techniques to monitor VMEs and options for integrating such techniques and the data they generate into the existing scientific trawl surveys, possibly through the establishment of an ad hoc WG on non-invasive survey methods (NAFO, 2019).

In the report of the 10th Meeting of the NAFO Scientific Council WG-ESA (2017), recommended monitoring tools are outlined for the use of non-destructive sampling techniques to monitor VMEs and options for integrating with existing survey trawl data. These are summarized in the table below:

Attribute	Data required	Recommended methods	Recommended tools	Comments
Distribution (regional scale to > 1-3 km)	• Geo-referenced presence and absence, abundance and biomass as well as size distributions • Identification to species level if possible	• Data from depth-stratified random stations as utilized in the RV multispecies surveys.	RV Trawl	Resolution scale appropriate to management actions
Distribution (small scale < 5 km)	• Geo-referenced presence and absence	• Geo-referenced imagery at appropriate scale. (Beware of observation bias and false absence, and	AUV, ROV, Drop Camera	Mismatch between KDE and in situ images due to fine scale distribution patterns within area.

Attribute	Data required	Recommended methods	Recommended tools	Comments
		how this could alter the analysis. Also behaviour responses of species to disturbance by gear)		
Mismatch between KDE and in situ images due to fine scale distribution patterns within area.	• Geo-referenced presence of benthic habitats • Identification of an/isotropic orientation of habitats	• Geo-referenced imagery at appropriate resolution and spatial extent. Consider isotropic effects especially for benthic filter feeders.	AUV, ROV, Drop Camera, Towed Camera	Limited use of this data to date. Potential to link scales: assemblages habitats regional distributions.
Spatial Structure within Habitats e.g. Patch size, Aggregations, Community composition, Species associations, and Spillover effect	• Geo-referenced presence and absence of epibenthic mega and macrofaunal species • Baseline spatial structure	• Geo-referenced imagery at appropriate resolution and spatial extent. Limitations: species identification from imagery is limited without corresponding samples. Many invertebrates cannot be identified from their dorsal surfaces or require dissection (e.g., sponges). Individual sizes can be difficult to estimate precisely. Previous fishing history is required to place data in context of disturbance.	ROV, Drop Camera Benthic samplers	Limited other uses of this data to date. Potential to link scales: assemblages, habitats, regional distributions
Abundance within Habitats	• Geo-referenced presence • Baseline damage	• Geo-referenced imagery	ROV, Drop Camera	Monitoring effectiveness of closed areas

Attribute	Data required	Recommended methods	Recommended tools	Comments
	• Size • Physical condition			
Biomass within Habitats	• Weight of physical specimens	• Targeted specimen collections (to convert image collected abundance and size data to biomass); collections need to be across environmental gradients and distribution to extend results beyond sampling locations	ROV, videograb	Monitoring effectiveness of closed areas
Size Distribution within Habitats recruitment, mortality, and population growth	• Geo-referenced presence • Size	• Geo-referenced imagery	ROV, Drop Camera	Monitoring effectiveness of closed areas

Currently, NAFO has not devised appropriate monitoring plans for VMEs and the above text indicates that tools other than trawls are more appropriate at small spatial scales (NAFO, 2017).

g. Other issues/recommendations that could be useful for providing options for the development of a framework for scientific research activities (not related to fisheries)

The Commission requests Scientific Council to continue to monitor and provide updates resulting from relevant research related to the potential impact of activities other than fishing in the Convention Area (for example via EU ATLAS project), and, where possible, to consider these results in the ongoing modular approach concerning to the development of Ecosystem Summary Sheets.

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NORTHEAST ATLANTIC FISHERIES COMMISSION (NEAFC)

Partner short name: IEO

a. Relevant scientific research projects

Implementation of the ecosystem approach to fisheries (EAF) through Regional Fisheries Management Organizations (RFMOs) is a priority as a result of UN General Assembly (UNGA) resolutions (UNGA, 2005, 2007). Research into ecosystems and fishery impacts, management measures (such as areas closed to bottom fishing to preserve habitats), and monitoring and assessments is necessary to underpin the formulation of policies and to develop management plans (FAO, 2003; García *et al*.,2003) to put the EAF (FAO, 2005) into practice. Moreover, UNGA Sustainable Fisheries Resolution 61/105 required both States and RFMOs to identify where VMEs occurred or where likely to occur and to them on the high seas, with a response no later than 31 December 2008, and called for the application of the EAF and the precautionary principle.

There are several relevant scientific research projects that were funded by EU to address DSFs management and VME conservation issues:

EU HERMES Programme[46] (Hotspot Ecosystem Research on the Margins of European Seas)

Funded by the European Commission under the 6th Framework Programme with an overall budget of € 22 728 199, being the EU contribution of € 15 563 458. It was an international multidisciplinary project with 50 partners, which started in April 2005 and finished in March 2009, coordinated by Natural Environment Research Council (UK).

HERMES was designed to gain new insights into the biodiversity, structure, function and dynamics of ecosystems along Europe's deep-ocean margin. It represented the first major attempt to understand European deep-water ecosystems and their environment in an integrated way by bringing together expertise in biodiversity, geology, sedimentology, physical oceanography, microbiology and biogeochemistry, so that the generic relationship between biodiversity and ecosystem functioning can be understood. Study sites extended from the Arctic to the Black Sea including open slopes, where landslides and deep-ocean circulation affect ecosystem development, and biodiversity hotspots, such as cold seeps, cold-water coral mounds, canyons and anoxic environments, where the geosphere and hydrosphere influence the biosphere through the escape of fluids, presence of gas hydrates and deep-water currents.

[46] https://cordis.europa.eu/project/id/511234

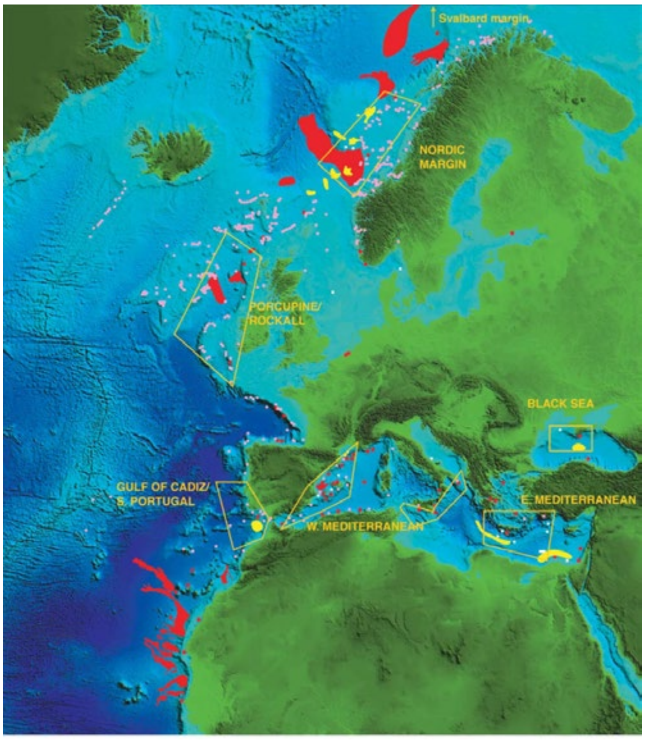

Figure 1. Map showing key study areas in the HERMES project. These areas were chosen specifically to include areas of cold-water coral (pink dots show known occurrences), landslides (red areas and red stars), areas with mud mounds (yellow areas), and areas of known fluid flow (white squares). They also include the anoxic Black Sea, low-productivity eastern Mediterranean, gateways between the East and West Mediterranean, and the West Mediterranean and Atlantic, canyoned margins of the Gulf of Lions and Portuguese margins and of the cold water, glaciated Nordic margin.

EU HERMIONE Programme[47] (Hotspot Ecosystem Research and Man's Impact on European seas)

Building on the success of HERMES, the European Commission funded HERMIONE project under the 7th Framework Programme with an overall budget of € 10 982 142, being the EU contribution of € 7 998 955. It was an international multidisciplinary project that started in April 2009 and finished in September 2012 and was coordinated by Natural Environment Research Council (UK). The HERMIONE project investigated the ecosystems at critical sites on Europe's deep-ocean margin, including the Mediterranean, Northeast Atlantic, and part of the Arctic Ocean. With 41 partners from the key deep-sea marine biology labs across Europe it was able to provide over 1000 days of shiptime. The data was used to produce 173 peer-reviewed papers and to supply over 100 PhD students.

The main objectives of HERMIONE were: (i) to investigate the dimensions, distribution and interconnection of deep-sea ecosystems; (ii) to understand changes in deep-sea ecosystems related to key factors including climate change, human impacts and the impact of large-scale episodic events; (iii) to understand the biological capacities and specific adaptations of deep-sea organisms, and investigate the importance of biodiversity in the functioning of deep-water ecosystems, and (iv) to provide stakeholders and policy-makers with scientific knowledge to support deep-sea governance aimed at the sustainable management of resources and the conservation of ecosystems.

[47] https://cordis.europa.eu/project/id/226354

The HERMIONE results have proved to be very timely and important to ongoing discussions within the EC (revision of the Common Fisheries Policy) and at the United Nations with regard to the impacts of bottom trawling. Results have been presented to the EU Commissioner responsible for Maritime Affairs and Fisheries (Maria Damanaki); to the Fisheries Attachés at the Permanent Representations to the EU; to the North East Atlantic Fisheries Commission and to the Joint Regional Advisory Council for Fisheries.

Results from HERMIONE on the impacts of bottom fishing in the deep-sea were presented to the United Nations General Assembly in New York in September 2009, and at the United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea in New York in June 2011, and at the United Nations General Assembly in New York in September 2011 where deep-water fishing resolutions 61/105 and 64/72 were debated. The results of HERMIONE were also used in the joint OSPAR/NEAFC/CBD Scientific Workshop on the identification of Ecologically or Biologically Significant Marine Areas (EBSAs) in September 2011. At this meeting attended by 3 HERMIONE partners the whole of the Hatton Rockall Bank and Basin in the NE Atlantic was proposed as an EBSA.

Figure 2. The HERMIONE study areas. Many study areas intentionally overlap with those of the HERMES project, enabling HERMIONE to build on and extend previous research, and allow much needed time-series data collection to continue.

The legacy of the project is to have contributed much needed data on the complexity of deep-sea ecosystems that is already being used in the international context to make laws to regulate the deep-water fishing industry, and to feed into the process of determining Marine Protected areas and Ecologically or Biologically Significant Areas.

SponGES[48] (Deep-sea Sponge Grounds Ecosystems of the North Atlantic an integrated approach towards their preservation and sustainable exploitation)

SponGES is a research and innovation project funded under the H2020 Blue Growth BG1 call aimed at "*Improving the preservation and sustainable exploitation of Atlantic marine ecosystems*" with an overall budget of € 10 275 365,25, being the EU contribution of € 9 994 302,75. The project started in March 2016 and finished in December 2020. SponGES brought together 25 partners, the USA and Canada and was led by the University of Bergen (Norway).

Its overarching goal was to develop an integrated ecosystem-based approach to preserve and sustainably use deep-sea sponge ecosystems of the North Atlantic. Its consortium, an international and interdisciplinary collaboration of research institutions, environmental non-governmental and intergovernmental organizations, focused on one of the most diverse, ecologically and biologically important and vulnerable marine ecosystems of the deep-sea – sponge grounds – that have received very little research and conservation attention to date. This initiative, supported by the consortium strong competence and its operational and (bio)technological capacity, specifically aimed at:

1. Strengthening the knowledge-base on North Atlantic sponge ground ecosystems by investigating their distribution, diversity, biogeography, function and dynamics;

2. Improving innovation and industrial application by unlocking the biotechnological potential of these ecosystems;

3. Improving the capacity to model, understand and predict threats and impacts and future anthropogenic and climate-driven changes to these ecosystems;

4. Advancing the science-policy interface and developing tools for improved resource management and good governance of these ecosystems from regional to international levels across the North Atlantic.

SponGES contributed to the implementation of major strategic instruments such as the Marine Strategy Framework Directive (MSFD), EU Maritime Strategy for the Atlantic Ocean Area, the Galway Statement on Atlantic Ocean Cooperation, as well as international agreements established to conserve Vulnerable Marine Ecosystems (VMEs) and Ecologically or Biologically Sensitive Areas (EBSAs).

Deep-sea sponge-dominated communities (grounds, aggregations and gardens) form a variety of Vulnerable Marine Ecosystems (VMEs) widespread throughout the North Atlantic in areas such as shelves, slopes, seamounts, mid- ocean ridges, canyons and fjords. To address SponGES objectives a number of case studies, covering the main types of sponge grounds ecosystems known to occur in the North Atlantic, were selected (Figure 3). These extend all the way from the Arctic Mid Ocean Ridge southwards to the Azores archipelago and include sites from both the western and eastern Atlantic.

[48] http://www.deepseasponges.org/

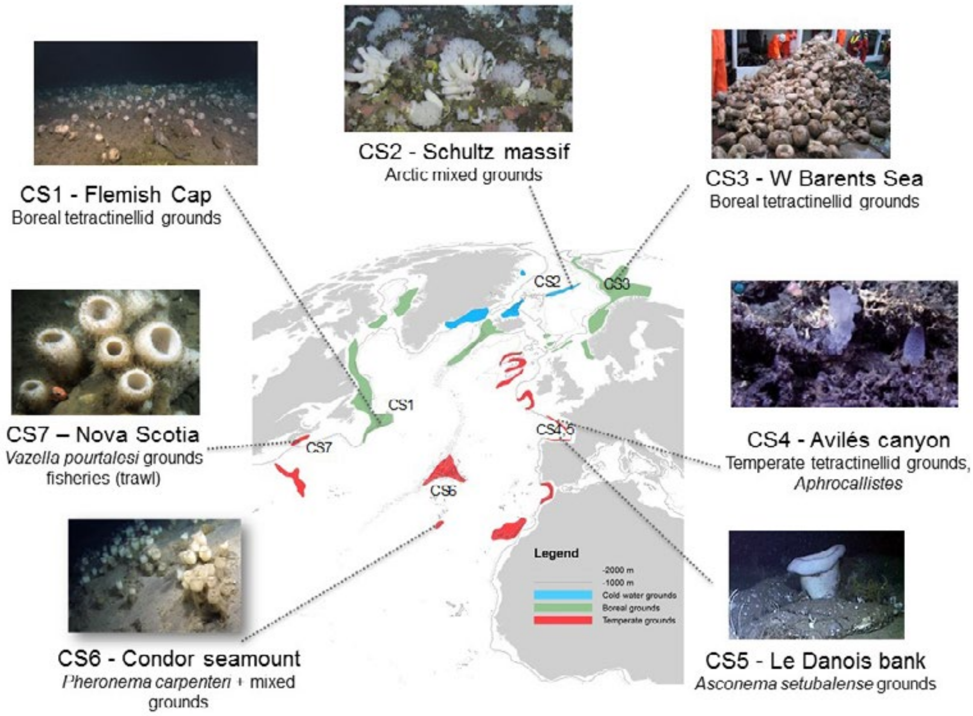

Figure 3. General distribution of different sponge-dominated ecosystems in the North Atlantic. SponGES Case Study areas are represented by CS1-7.

SponGES work was essential in high-resolution mapping and in the characterisation of habitats in deep-sea sponge grounds ecosystems. This data was necessary to understand how oceanographic and geological settings shape sponge grounds and the availability and distribution of linked ecosystem services.

SponGES mapped the past distribution of deep-sea sponges, which was useful to understand how present-day sponge grounds may respond to putative drivers of change. Work on biodiversity, for both deep-sea sponges and their associated microbial communities were conducted, which has led to the description of many new species. This work clarified biogeographic trends and how deep-sea sponge grounds create habitat for other macrofauna. Samples from 20 research cruises across the Atlantic Ocean unveiled a previously unknown sponge-associated microbial diversity, and gave light on the factors that influence such associations and their diversity.

Moreover, important research was done to describe patterns of evolution, distribution and connectivity of deep-sea sponges, which led to the largest sponge genomic dataset produced to date. This helps to understand the origin of Demosponges, as well as their evolution and biology. Particle-tracking models, paired with studies on the reproduction, connectivity and genetic structure of deep-sea sponges are improving our understanding of how deep-sea sponge grounds are maintained.

Mapping, biodiversity and connectivity are linked together by the integrative work based on enhanced and/or re-developed modelling tools (some of which were applied to sponge communities for the first time). Modelling enabled the first quantitative understanding of sponges' holobiont metabolism, and the identification of indicators to inform management.

Ecosystem functions, services and goods of deep-sea sponge grounds, focusing on their role in biogeochemical cycling, food webs and the metabolism of deep-sea ecosystems were also studied. This included an in-depth understanding of deep-sea silicon, nitrogen and carbon cycling (with implications for benthic-pelagic coupling and global biogeochemical cycles) that also links back to the role of microbes in the biology and ecology of deep-sea sponges. In practice, this meant being able to demonstrate what happens if deep-sea sponge grounds are degraded, with impacts on the provision of ecosystem services and ultimately on society (e.g. for the economies that rely on a healthy ocean).

Threats and impacts that may affect deep-sea sponge grounds, from individuals to ecosystem levels were also studied. Fishing may have long-lasting effects, but research shows that measures to protect both the economy and the habitats are possible. Additionally, exciting results in the field of blue biotechnology, ranging from potential paths and applications of deep-sea sponge-derived bioactive compounds, to advancements in sponge cell lines and in the development of innovative biomaterials inspired by deep-sea sponges were obtained.

The new knowledge generated by this project was key to inform resource management and conservation analyses. The economic valuation of deep-sea sponge grounds proved challenging but focusing on Ecosystem Services helped overcome the issue. Capacity-building and policy round tables and workshops, together with the release of practical documents like factsheets and policy briefs (integrated in FAO's portals, e.g. for Vulnerable Marine Ecosystems), have been instrumental in translating SponGES research into action.

In quantitative terms: more than 90 peer-reviewed publications and over 20 technical documents, involvement in ca. 200 events (scientific, industry-focused, for the public and schools), in the news 100+ times, and more than 2M people reached in 4 years (without considering websites and social media).

Six Policy Briefs have been released by FAO to address the main themes covered by project SponGES:

- Databases and models: new tools for management.
- Deep-sea sponges: Biotechnology and the blue economy.
- The economic value of deep-sea sponges.
- Threats and impacts on sponge grounds.
- The social and cultural value of deep-sea sponges.
- The ecological value of deep-sea sponges.

The Policy Briefs complete the long list of documents developed by FAO and SponGES partners, accessible from the SponGES website home page.

ATLAS[49] (A Trans-Atlantic assessment and deep-water ecosystem-based spatial management plan for Europe)

ATLAS was a four-year research and innovation project that received funding from the European Union's Framework Programme for Research and Innovation Horizon 2020, with an overall budget of € 9 167 816,86, being the EU contribution of € 9 100 316,86. It started in May 2016 and finished at the end of October 2020. ATLAS brought together 25 partners (and one linked third party) from 12 European countries, the USA and Canada and was led by the University of Edinburgh (Scotland, UK).

ATLAS aimed to advance our understanding of the North Atlantic's deep-sea ecosystems, including their connectivity, functioning and responses to future predicted changes in human use and ocean climate. Research activities were focused on waters 200-2000 m deep where the greatest gaps in our understanding lie and

[49] https://www.eu-atlas.org/

certain populations and ecosystems are known to be under pressure. As well as carrying out pioneering research and discovery, ATLAS developed a scientific knowledge base that could inform the development of international policies to ensure deep-sea Atlantic resources are managed effectively. This contributed to the European Commission's long-term Blue Growth strategy to support sustainable growth in the marine and maritime sectors as a whole.

ATLAS has assembled 12 Case Studies that follow the major Atlantic current patterns (Figure 4). These were selected on basis of: proximity to Blue Growth activities, presence of focal ecosystems, availability of existing data/samples and opportunities for offshore cruises during the ATLAS project. These all lie along critical paths of major Atlantic current patterns, with some case study areas currently proposed or classified as Vulnerable Marine Ecosystems (VMEs) or Ecologically or Biologically Significant Areas (EBSAs). The case studies give the biogeographic, regulatory and jurisdictional range needed to meet ATLAS' objectives.

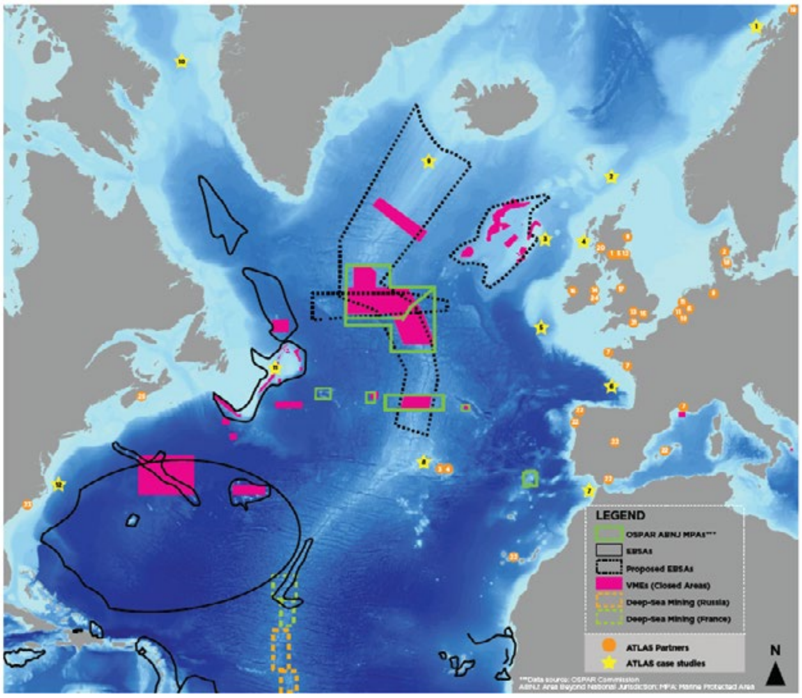

Figure 4. ATLAS Case Studies (yellow stars) plotted alongside areas recognized as VMEs (sold pink), confirmed EBSAs (solid black outline) and NE Atlantic proposed EBSAs (dotted black outline). To the south deep-sea mining areas of interest to Russia (orange dashed line) and France (green dashed line) are also shown.

These Case Studies are: LoVe Observatory (Norway); West of Shetland and W Scotland slope (UK); Rockall Bank (UK & Ireland); Mingulay Reef Complex (UK); Porcupine Seabight (Ireland); Bay of Biscay (France); Gulf of Cádiz/Strait of Gibraltar/Alborán Sea (Spain & Portugal); Azores (Portugal); Reykjanes Ridge (Iceland); S Davis Strait/Western Greenland/Labrador Sea (Canada); Flemish Cap (Canada) and SE USA (Bermuda transect).

The overarching objectives of ATLAS project were:

1. Improve understanding of deep Atlantic marine ecosystems and populations by collecting and integrating high-resolution measurements of ocean circulation with functioning, biological diversity, genetic connectivity and socioeconomic values.

2. Improve the capacity to monitor, model and predict shifts in deep-water ecosystems and populations in response to future change through a better understanding of the connections between physical parameters and biological characteristics to support sustainable exploitation in the North Atlantic.

3. Transform new data, tools and understanding into robust ocean governance in line with an adaptive ecosystem-based maritime spatial planning (MSP) approach to achieve ecosystem preservation, sustainable exploitation and Blue Growth.

4. Scenario-test and develop science-led, cost-effective adaptive management strategies for sustainable use of living and non-living resources that stimulate Blue Growth.

The table below summarises the projects that ATLAS has worked with, and how their objectives and outputs relate to the ATLAS workplan.

Table 1. List of FP7, H2020 and international projects directly involved with ATLAS.

Project and Partner(s)	Objectives and Outputs Related to ATLAS
MIDAS (€ 12M, 3 years) IMAR-UAz - GC - Seascape	*Identify scale and duration of possible impacts of mineral mining on deep-sea ecosystems; develop solutions and best practice codes for policy and legal frameworks.* Seabed mapping, biodiversity and distribution, impacts and maps of mining-related sediment plumes on fish and VMEs; draft Strategic Environment Management Plan for deep-sea mining in the Atlantic Basin; policy recommendations (due 11/2016) for the management of extractive activities.
BENTHIS (€7.8M, 4 years) - AU - IFREMER	*Assess the health status of EU marine benthic ecosystems for GES; develop new tools to assess effects of bottom trawling and sustainable management plans to reduce these impacts.* Maps of fishing impacts and a new framework to quantify gear-seabed interactions with VMS and logbook data.
DiscardLESS (€5.5M, 4 years) - IMAR-UAz - UIT	*Develop tools and strategies to reduce bycatch; draft new policy guidelines for bycatch mitigation.* Improved knowledge of deep-sea fish habitat use and new technical measures to reduce bycatch in areas with high fish habitat suitability.
AtlantOS (€21M, 4 years) - SAMS	*Develop* in-situ *Atlantic Ocean Observations for a better management and sustainable exploitation of maritime resources.* Integrated ocean observations supporting The Galway Statement on Atlantic Ocean Co-operation, and new Integrated Atlantic Ocean Observing System (IAOOS) as the *in-situ* observing backbone of the Copernicus Marine Monitoring system and European Earth Observation Programme.
NACLIM (€11M, 4.2 years) - SAMS	*Quantify predictability on inter-annual to decadal timescales of N Atlantic climate related to ocean surface state.* Model validity and uncertainty measured, and impacts on oceanic ecosystems and European urban societies predicted for climate forecast parameters to be used by stakeholders.
NEKTON (€5M, 4 years) - OXU, GC, HWU & 3rd party DFO	*Examine physics, habitats and fauna on complex habitats from Nova Scotia Canada to south-eastern USA with potential transect to Bermuda, and the role of the Gulf Stream in species biogeography.* Extensive seabed mapping, with surface to seafloor habitat and other environmental characteristics; human impacts, and potential VMEs identified.
COLUMBUS (€4M, 3 years) SC, AquaTT	*Ensure accessibility and uptake of research marine research knowledge outputs by end-users* ATLAS outputs will be accessible and used by a portfolio of end-users through WP9 (led by AquaTT)

ATLAS has been able to reveal remarkable facts about the North-Atlantic deep-sea ecosystem discovering and describing more than 30 benthic communities, including cold-water coral reefs and gardens, deep-sea sponge aggregations and hydrothermal vents in the North Atlantic. ATLAS has contributed to the identification of at least 12 new or putative new species to science, including the discovery of a bivalve, Myonera atlasiana (dedicated to the ATLAS project) at mud volcanoes on the northern Gulf of Cádiz. The project also found approximately 35 new records of species in areas where they were previously unknown. The ATLAS project has remarkably influenced the scientific marine data within the EU and international scale, as well as the ocean literacy and educational materials. The project's achievements have been reflected by worldwide news channels, such as ABC Australia, BBC and EuroNews. The project's results have affected many EU marine policies toward the identification and protection of biodiversity within the Vulnerable Marine Ecosystems, as well as the development of various indicators for the assessment of Good Environmental Status, supporting the EU Marine Strategy Framework.

Additionally, the new VME habitat records obtained through the ATLAS project have been added to the ICES VME database which is used to provide scientifically robust advice on the distribution of VMEs and to guide possible management solutions to protect VMEs.

iAtlantic[50] (Integrated Assessment of Atlantic Marine Ecosystems in Space and Time)

iAtlantic is a four-year research and innovation project that received funding from the European Union's Framework Programme for Research and Innovation Horizon 2020, with an overall budget of € 10 803 099, being the EU contribution of € 10 631 224. It is building on the pioneering work of ATLAS by using the latest technologies to assess the ocean's health, and helping governments create policies to better protect it. It started in June 2019 and will finish at the end of May 2023. The iAtlantic consortium comprises 33 partner organisations from Europe, Brazil, South Africa, Argentina, Canada and the USA, complemented by a wider network of associated partners. It is coordinated by the University of Edinburgh (Scotland, UK).

It is a multidisciplinary research programme seeking to assess the health of deep-sea and open-ocean ecosystems across the full span of the Atlantic Ocean. iAtlantic aims to deliver knowledge that is critical for responsible and sustainable management of Atlantic Ocean resources in an era of unprecedented global change. Involving marine scientists from countries bordering the north and the south Atlantic Ocean, this ambitious project will determine the resilience of deep-sea animals – and their habitats – to threats such as temperature rise, pollution and human activities.

The ambitious iAtlantic project will undertake an ocean-wide approach to understanding the factors that control the distribution, stability and vulnerability of deep-sea ecosystems. Work will span the full scale of the Atlantic basin, from the tip of Argentina in the south to Iceland in the north, and from the east coasts of USA and Brazil to the western margins of Europe and Africa. Central to the project's success is the international collaboration between scientists throughout the Atlantic region, with sharing of expertise, equipment, infrastructure, data and personnel placed at the forefront of iAtlantic's approach.

iAtlantic has 5 key objectives: (i) Align and standardize ocean observing in the north and south Atlantic to enable short, medium and long-term assessments of ocean circulation; (ii) Map deep and open-ocean Atlantic ecosystems at local, regional and basin scales; (iii) Assess the stability, vulnerability and tipping points of these ecosystems in relation to a range of stressors; (iv) Build and enhance human and technological capacities for cost-effective cooperation and planning across the Atlantic and; (v) Work with industry, regulatory and governmental stakeholders to use this knowledge in support of a sustainable Blue Economy.

To achieve these goals, iAtlantic focuses its ecosystem assessment efforts on 12 key areas of the ocean (Figure 5), using innovative approaches to upscale observations to address basin scale issues. Over 30 expeditions will study ecosystems most at risk of change. iAtlantic also builds human and technical capacities by creating iAtlantic Fellows through a capacity building programme including hands-on work at sea,

[50] www.iatlantic.eu

technology transfer, analytical techniques and data interpretation training and a mentoring programme.

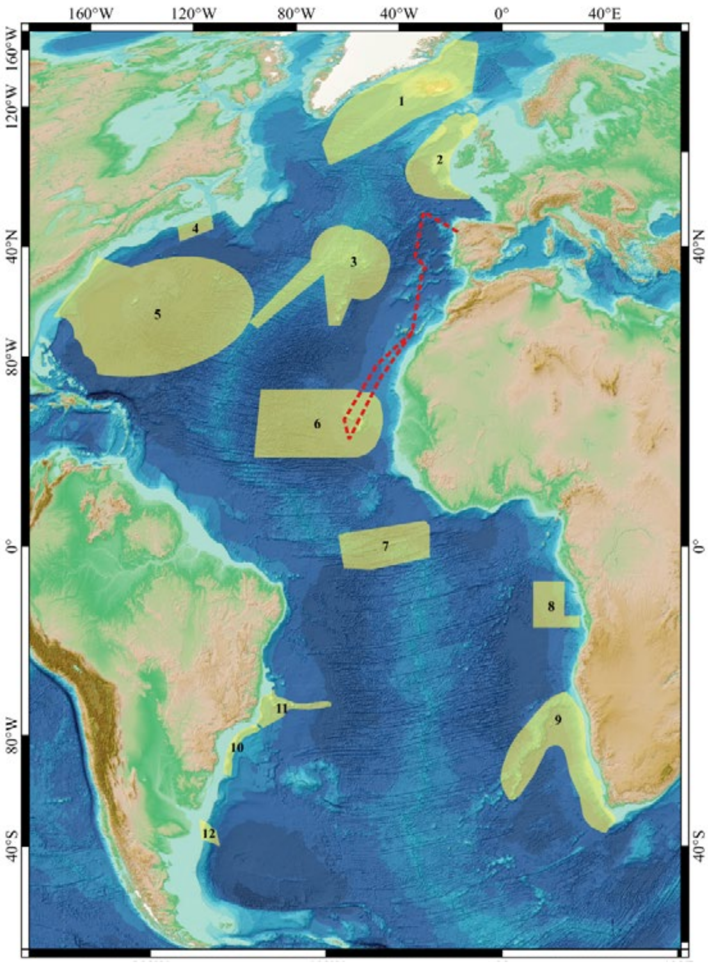

Figure 5. iAtlantic study areas: (1) Subpolar Mid-Atlantic Ridge (MAR) open-ocean ecosystem off Iceland; (2) Abyssal plain and deep-sea coral banks from the Rockall Trough to the Porcupine Abyssal Plain; (3) Deep-sea coral and hydrothermal vent ecosystems, central MAR; (4) Deep-sea canyons and open-ocean ecosystem, NW Atlantic; (5) Subtropical open-ocean ecosystem of the Sargasso Sea; (6) Eastern tropical North Atlantic, Cabo Verde; (7) Equatorial deep/open ocean fracture zones; (8) Continental slope, margin and cold seep ecosystems - Angola to the Congo Lobe; (9) Abyssal plains and deep-sea ridge ecosystems of the Benguela Current from the Walvis Ridge to South Africa; (10) Deep-sea continental slope, banks and cold seep ecosystems off Brazil; (11) Vitória-Trindade Seamount Chain off Brazil; (12) Deep-sea coral banks in the Malvinas Upwelling Current off Argentina.

Other projects developed within NEAFC Regulatory Area:

In 2005-2008, the Spanish Institute of Oceanography (IEO) developed the **ECOVUL/ARPA interdisciplinary research project ("*Estudio de los Ecosistemas Vulnerables en relación con los Artes de Pesca*")** with the aim of developing a methodology to identify VMEs and to select suitable areas to preserve cold-water corals threatened by high-sea fisheries (Durán Muñoz *et al*., 2007, 2009, 2012a). ECOVUL/ARPA project was funded by the Spanish Government, Secretaría General del Mar (SGM), Ministerio de Medio Ambiente, Medio Rural y Marino, and by the Spanish Institute of Oceanography (IEO), Ministerio de Ciencia e Innovación. The observer programme and cooperative surveys were co-funded by the European Union and Spain.

The study area, Hatton Bank (Figure 6), was located on the western slope Bank between 1000 and 1500 m deep, covering the main fishing grounds of deep-sea trawlers. The Hatton Bank is a large offshore bank, west of the European continental margin, situated in international waters of the Northeast Atlantic Ocean, within the NEAFC Regulatory Area (ICES Subdivision VIb1 and Division XIIb).

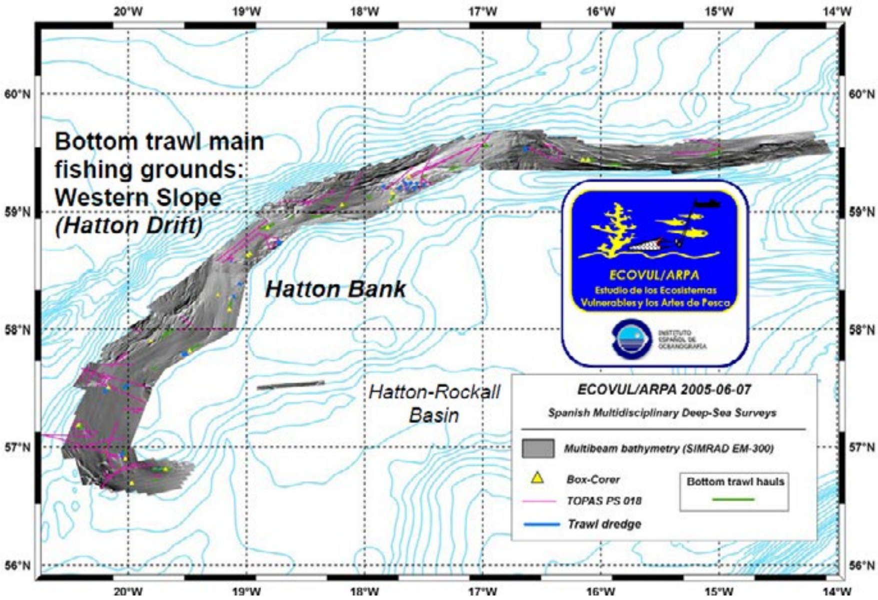

Figure 6. Map showing the sampling carried out during the ECOVUL/ARPA Spanish Multidisciplinary Deep-sea Surveys (2005-2007) on the Hatton Bank. The study area covers the main trawl fishing grounds in the bank. These grounds are generally positioned on the Western flank of the Bank, between 1000-1500m, over the sedimentary deposits (Hatton Drift).

The main scientific goals were to define practical criteria for the identification of VMEs, to identify the footprint of bottom deep-water fisheries and their effects, to map the habitats and the distribution of VMEs in relation to deep-sea fisheries, to advise on areas potentially to be closed to bottom fishing, to study the structure and function of deep-sea ecosystems and benthic communities, and to construct a Geographic Information System (GIS) database. The research began with a request from the Spanish Government to find ways to manage deep-sea fisheries on the high seas better. Two main questions posed were: (i) are there VMEs on the Hatton Bank, particularly for cold-water corals, in the common grounds used by the Spanish bottom-trawl fleet (Bensch *et al*., 2008), and (ii) what data and methodology are required for accurately identifying VMEs and selecting of cold-water coral protection areas, taking into account the deadline imposed by UNGA Resolution 61/105?

The ECOVUL/ARPA project identified the deep-water bottom trawl fishery footprint on the Hatton Bank Western slope (NEAFC Regulatory Area), mapped the main fishing grounds and related seabed habitats and studied the interactions between fishing and cold-water corals. The interdisciplinary approach was used to suggest, with a high level of precision, the spatial limits of an area closed to bottom fishing, as an essential conservation measure to protect the cold-water corals in the framework of the Ecosystem Approach to Fisheries Management (Durán Muñoz, *et al.,* 2009).

Results obtained within this project were provided to the Working Group on Deep-water Ecology (WGDEC) and therefore were used by ICES to produce the advice on closed areas required by NEAFC (ICES 2007, ICES 2008). These results allowed to propose closure of bottom fishing in the area known as the Hatton Bank outcrop, located on the western slope of Hatton Bank (Northeast Atlantic), as a conservation measure to protect coldwater corals.

b. Relevant research programmes

Since 1974, the United Nations Environment Programme (UN Environment) Regional Seas Programme has brought together more than 143 countries to conserve and sustainable manage the shared marine and coastal environments. The 18 Regional Seas programmes across the world are an important part of the implementation of Part XII of the United Nations Convention on the Law of the Sea (UNCLOS), which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of "The future we want" (UN Environment, 2017).

Five Regional Seas Conventions currently include Areas Beyond National Jurisdiction (ABNJ) within their geographical coverages: the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention); the Convention on the Conservation of Antarctic Marine Living Resources (CAMLR Convention); the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention); the Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (Noumea Convention); and the Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific (Lima Convention)[51].

Under two other Regional Seas programmes, namely the Abidjan Convention for Cooperation in the Protection, Management and Development of Marine and Coastal Environment of the Atlantic Coast of the West, Central and Southern Africa Region (Abidjan Convention) and the Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Western Indian Ocean (Nairobi Convention), member States started examining the issues related to marine biodiversity in Areas Beyond National Jurisdictions[52].

Under the **OSPAR**[53] **Convention** is the mechanism by which 15 Governments and the European Union cooperate **to protect the marine environment of the North-East Atlantic**. It started in 1972 with the Oslo Convention against dumping and was broadened to cover land-based sources and the offshore industry by the Paris Convention of 1974. These two conventions were unified, updated and extended by the 1992 OSPAR Convention. The new annex on biodiversity and ecosystems was adopted in 1998 to cover non-polluting human activities that can adversely affect the sea. Under its Ministerial Strategy; The North-East Atlantic Environment Strategy, OSPAR is taking forward work related to the implementation of the Ecosystem Approach, with a suite of five thematic strategies to address the main threats that it has identified: (i) Eutrophication, (ii) Biodiversity and Ecosystem, (iii) Hazardous substances, (iv) Offshore industry, and (v) Radioactive substances.

OSPAR work is organized in six work areas (https://www.ospar.org/work-areas):

(i) Biological Diversity & Ecosystems (species & habitats, marine protected areas and biodiversity monitoring and assessment), (ii) Hazardous Substances and Eutrophication, (iii) Human Activities (marine litter, underwater noise, offshore renewables shipping and ballast water, dredging and dumping, dumped chemical and conventional munitions, fisheries and mariculture, other human activities such as deep sea mining), (iv) Offshore Industry, (v) Radioactive Substances, and (vi) Cross-Cutting Issues.

Participating countries are: Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

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[51] Lima Convention Article 1 defines the inclusion of the High Seas "*up to a distance within which pollution of the high seas may affect that area*" within its geographical coverage

[52] For further details, See: the Written Submission by the United Nations Environment Programme (UNEP), Available at: http://www.un.org/depts/los/biodiversity/prepcom_files/UNEP_and_BBNJ_PrepCom2.pdf

[53] https://www.ospar.org

OSPAR Convention Article 1 (a) defines that " 'Maritime area' means the internal waters and the territorial seas of the Contracting Parties, the sea beyond and adjacent to the territorial sea under the jurisdiction of the coastal state to the extent recognised by international law, and the high seas, including the bed of all those waters and its sub-soil, situated within the following limits: (i) those parts of the Atlantic and Arctic Oceans and their dependent seas which lie north of 36° north latitude and between 42° west longitude and 51° east longitude, but excluding: (1) the Baltic Sea and the Belts lying to the south and east of lines drawn from Hasenore Head to Gniben Point, from Korshage to Spodsbjerg and from Gilbjerg Head to Kullen, (2) the Mediterranean Sea and its dependent seas as far as the point of intersection of the parallel of 36° north latitude and the meridian of 5° 36' west longitude; (ii) that part of the Atlantic Ocean north of 59° north latitude and between 44° west longitude and 42° west longitude. "

The OSPAR maritime area encompasses extensive areas in the Wider Atlantic (OSPAR Region V) and the Arctic Waters (OSPAR Region I) that are beyond the limits of national Exclusive Economic Zones (EEZs). This Area Beyond National Jurisdiction (ABNJ) covers approximately 40% of the OSPAR maritime area. OSPAR has agreed to designate Marine Protected Areas (MPA) in ABNJ with the aim of achieving an ecologically coherent and well managed network of MPAs.

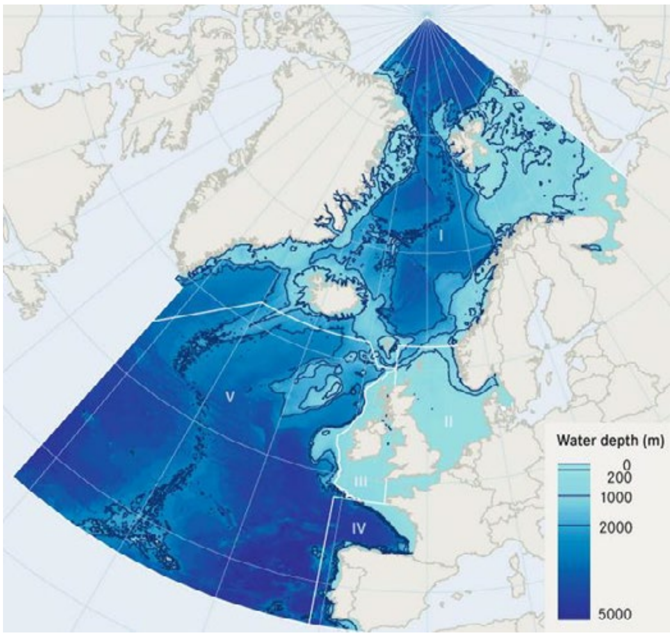

Figure 7. Map showing the OSPAR five regions: I. Arctic waters; II. Greater North Sea; III. Celtic Seas; IV. Bay of Biscay and Iberian Coast and V. Wider Atlantic

Jurisdiction of MPAs in areas beyond the limits of national EEZs of the OSPAR area

By the end of 2018 the OSPAR Network of MPAs comprised ten MPAs situated in areas beyond the limits of national Exclusive Economic Zones (EEZ) (Figure 8). An eleventh MPA is sometimes referred to, namely, The *North West Rockall SAC* (SAC - Special Area of Conservation) is sometimes referred to as an eleventh MPA as it partly extends into the area beyond EEZ and is included here for clarity and comprehensiveness, however for calculations of MPA coverage this MPA is assigned to the category of MPAs in UK national waters.

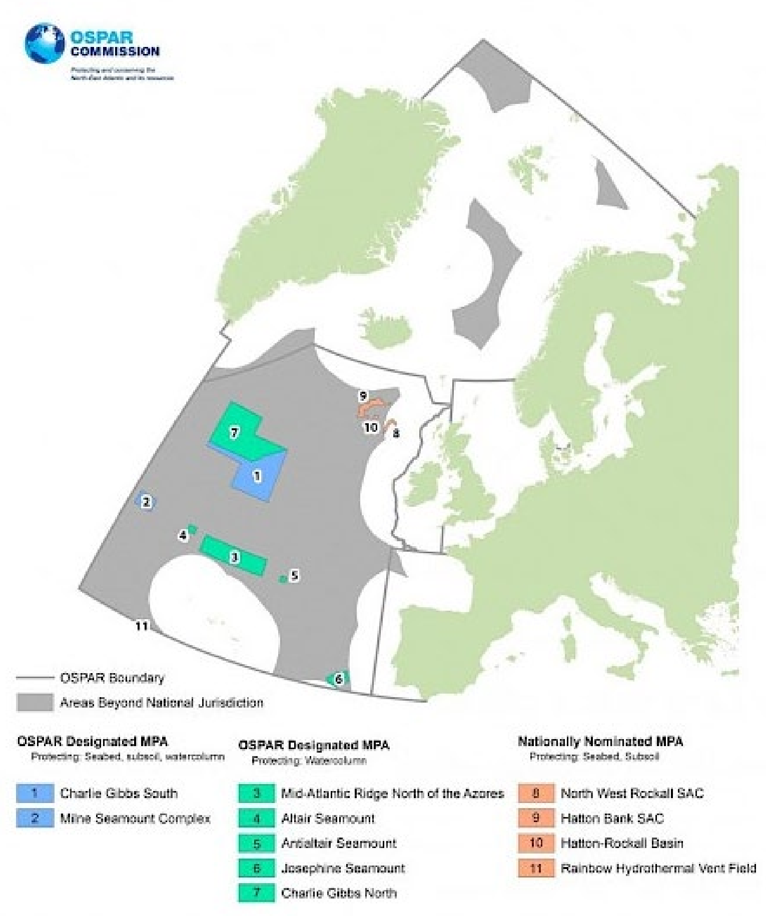

Figure 8. OSPAR Network of MPAs

OSPAR/NEAFC Collective Arrangement[54]

The 'collective arrangement between competent international organisations on cooperation and coordination regarding selected areas in areas beyond national jurisdiction in the North-East Atlantic' adopted by the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) and the North-East Atlantic Fisheries Commission (NEAFC) in 2014 is a formal agreement between legally competent authorities managing human activities in the Areas Beyond National Jurisdiction (ABNJ) in the North-East Atlantic. The essential aim of the collective arrangement is to become a collective and multilateral forum composed of all competent entities addressing the management of human activities in this region.

The foremost objective of the collective arrangement is to facilitate cooperation and coordination on area-based management between legally competent authorities, promoting the exchange of information on each other's activities and achievements and taking into consideration all conservation and management measures taken in relation to the North-East Atlantic. In addition to keeping under review a joint record of areas subject to specific measures and informing each other of any modification of existing measures or any new measures or decisions, the competent authorities have an opportunity to discuss subjects of common interest and concern.

54 https://www.neafc.org/collective-arrangement

From the OSPAR perspective, the aim of institutional cooperation is to help deliver an ecosystem approach to the management of all relevant human activities in the marine environment. The objectives of NEAFC in adopting measures to protect the marine ecosystem from the potential adverse impacts of fisheries are of great interest to OSPAR in the context of protective, restorative and precautionary measures aiming at protecting and conserving species, habitats and ecosystems of the North-East Atlantic marine environment.

For NEAFC, cooperation can also highlight measures within the broader ecosystem that OSPAR can take within its competence to support NEAFC's objective to ensure the long-term conservation and optimum utilisation of fishery resources, providing sustainable economic, environmental and social benefits.

The need for a collective arrangement in the North-East Atlantic

The initially informal relationship between OSPAR and NEAFC's Secretariats allowed a reciprocal understanding of each organisation's work and led to an aim to enlarge the scope of cooperation. In 2008 this relationship evolved into a Memorandum of Understanding which states the complementary competences of both organisations, including in areas beyond national jurisdiction, and also allows for a reciprocal participation in each other's relevant committees.

Policy coherence is also one of the key drivers for NEAFC and OSPAR to work together, enabling common Contracting Parties to better align their activities under both conventions. The process of working, for instance, on protective measures on marine protected areas and the collective arrangement, has been beneficial, not only in dealing with policy coherence between the two organisations, but also in driving better coordination at the national/ministry level in the Contracting Parties common to both organisations.

However, NEAFC and OSPAR are neither the only international organisations with legal competence relevant to the ABNJ in the North-East Atlantic nor do they have the exclusive legal competency on human activities impacting on the marine environment of the North-East Atlantic. A widening process was initiated in 2010 to seek for the participation of other competent authorities to join in efforts to cooperate and coordinate. Many organisations have been involved in discussions on a wider cooperation of work in ABNJ in the North-East Atlantic.

The process resulted in the collective arrangement between competent authorities in ABNJ in the North-East Atlantic. To date, the collective arrangement has been adopted by NEAFC and OSPAR. There are continued discussions to bring additional organisations into the collective arrangement which to date have not yet been formalised. Organisations that are invited to join meetings under the collective arrangement include e.g. the International Seabed Authority (ISA), the International Maritime Organization (IMO) and the International Commission for the Conservation of Atlantic Tunas (ICCAT).

Acting within their own fields of competence OSPAR and NEAFC's collaboration is an example of a regional platform to address matters relating to the oceans' protection and the sustainable use of the marine environment.

In 2015, the United Nations Environment Programme (UNEP) asked the Secretariats of NEAFC and OSPAR to prepare an information paper to describe an overview of the process that led to this cooperative mechanism, from first contact to the implementation of the collective arrangement. The purpose of the paper has been to document the experience so far and to share this with other Regions.

c. Surveys at sea

There have been several scientific cruises and ad hoc surveys carried out by ICES member countries in the NE Atlantic, some of which provide information for assessing deep-water resources and VMEs in the NEAFC RA. These results together with fishery independent survey catch data form the basis for implementing fisheries closures (Durán Muñoz *et al*., 2012a).

The NEAFC general approach since 2008 has been to identify areas where VMEs are known or likely to occur, and to close these areas to bottom fishing activities to protect the VMEs from SAIs (FAO, 2016). ICES has advised NEAFC towards the identification of VMEs and assessing where VMEs are likely to occur. To minimize risks to VMEs, areas where VMEs have been identified (e.g. on the Rockall Bank) and areas where VMEs have been considered likely to occur (e.g. on the MAR) have been closed to commercial bottom fisheries (NEAFC, 2008).

There have been many scientific surveys within NEAFC area, many of them focusing on the identification and mapping of sensitive species and habitats. Here is a summary of some of the scientific surveys conducted within NEAFC area:

In the Rockall Bank there have been visual ground truthing surveys (RVs L'Atlante and Meteor), multibeam bathymetry surveys (NOC and Irish Seabed Survey), surveys within the EU HERMES programme (Duyl and Gerard, 2005), and dedicated UK video surveys (ICES, 2010; 2011; 2012). Hatton Bank has been the object of Spanish multidisciplinary mapping surveys (Durán-Muñoz, *et al*., 2009; 2012a), UK biological and geophysical surveys (Howell *et al*., 2007) and Dutch surveys conducted by NIOZ (ICES, 2010). In the Hatton-Rockall basin, UK video surveys collected data on sponge aggregations (ICES, 2013) and towed camera transects from Marine Scotland ecological research survey. These have confirmed the presence of cold seep habitat and coral gardens (ICES, 2016). On the Mid-Atlantic Ridge, VMEs areas were identified based on information from the Mar-ECO programme, EcoMar surveys (UK) (e.g. Bell *et al*., 2016), as well as published observations made by cameras on ROVs and bycatches in scientific bottom trawls (ICES, 2014). VMEs areas were identified on and around Josephine Seamount, based on available historical data on octocorals (ICES, 2012a).

On the Rockall Bank, ICES identified VMEs indicators based on by-catch data collected from Scottish fish stock assessment bottom trawl surveys (ICES, 2015).

Portions of the Hatton Bank and surrounding areas have been identified by ICES as VMEs areas based on by-catch data collected by observers from Spanish ad hoc science-industry cooperative surveys (Durán Muñoz *et al*., 2011; 2012b). Coral data from Rockall (ICES, 2007) and Hatton Banks are available from Russian scientists and observers onboard fishing vessels (ICES, 2014).

Moreover, European funded projects such as SponGES have established fruitful collaborations with other ongoing or planned projects and institutions operating in areas where sponge grounds ecosystems occur, creating research synergies at European and International levels. In this regard, some cruises dedicated to SponGES were conducted in 2016 as the Schultz massif onboard G.O Sars together with other three smaller cruises performed in Swedish and Norwegian fjords onboard the R/V Hans Brattstrøm (UiB), R/V Gunnerus (UiB) and R/V Nereus (UU). The Schultz massif seamount is located in the Arctic mid-ocean ridge and has been subject of several multidisciplinary surveys made by the University of Bergen (UiB) between 2008 and 2014 during which oceanographic data, biological samples, sediment cores and high-definition video imagery were collected. A total of 35 different operations were performed during the cruise, including 6 ROV dives, 4 multibeam transects, 3 AUV deployments, 2 lander deployments, 11 CTD casts, 5 box cores, 3 gravity cores and 1 beam trawl (Agassiz trawl)

SponGES partners also participated in a cruise with RV Polarstern to the Karasik seamount on the Gakkel Ridge, and with RV Pelagia to Azorean waters. Several fisheries surveys were also performed in the Azores between April and July 2016.

Other SponGES offshore cruises were conducted in 2017 and 2018. They were dedicated to investigating: (i) boreal sponge grounds in fjord and shelf areas in Western Norway onboard "Kristine Bonnevie; (ii) arctic sponge grounds on a seamount on the Arctic Mid-Ocean Ridge, the Schulz Bank as well as boreal grounds on the Norwegian shelf and Sognefjorden, as well as in the western Barents Sea; (iii) boreal sponge grounds off Northern Norway, in the Western Barents Sea as well as arctic grounds on the Schulz Bank, Arctic Mid-Ocean Ridge.

On the other hand, MEDWAVES (MEDiterranean out flow WAter and Vulnerable EcosystemS) is a research cruise conducted by the Spanish Institute of Oceanography (IEO) within the framework of the H2020 European ATLAS project, with the aim to better understand and characterise the connectivity between the Mediterranean Sea and the Atlantic Ocean. This cruise was conducted in 2016, on board RV Sarmiento de Gamboa, targeting areas under the potential influence of the Mediterranean water flows out from Gibraltar (MOW) within the Mediterranean and Atlantic realms, including seamounts where Cold-water corals (CWCs) have been reported but that are still poorly known, and which may act as essential "stepping stones" connecting fauna of seamounts in the Mediterranean with those of the continental shelf of Portugal, the Azores and the Mid-Atlantic Ridge (Orejas *et al*., 2017).

MEDWAVES sampling was conducted through two of the case studies of the ATLAS project: Case study 7 (Gulf of Cádiz-Strait of Gibraltar-Alboran Sea) and Case study 8 (Azores) being the main goals (i) to characterize physically and biogeochemically the MOW Path and understand its interaction with the general Atlantic Meridional Overturning Circulation (AMOC) stream, from the Alboran Sea to the Azores, through the Gulf of Cádiz, and the Ormonde Seamount, exploring the relationship between the oceanographic settings of these target areas and the ecosystems therein and (ii) to characterize communities associated with the transition area, and sample for population genetic analysis aiming at understanding the way the populations located in the target areas contribute or have contributed to connectivity between the Mediterranean Sea and the Atlantic Ocean. During the cruise, physical and chemical oceanographic data were collected together with live specimens of CWC and recording of video transects.

In April 2018, ATLAS funded researchers boarded the RV Pelagia for a two-week expedition to Rockall Bank as part of the Netherlands Initiative Changing Oceans (NICO) part of the Netherlands Initiative. During this research expedition, they deployed instruments in the water column above the CWCs to study the processes that govern the delivery of organic matter towards the deep reefs. In addition, they used targeted sampling of reef organisms by the remotely operated vehicle Genesis (www.vliz.be/nl/rov-genesis) to determine how much and which food sources these organisms are utilising.

The MSM96-MetalML expedition was conducted in October 2020. A systematic, multi-scale sampling and analysis for geochemistry and seafloor features across the North East Atlantic deep sea. A spatially hierarchical sampling scheme – from local, via regional, to basin-scale – was applied to map the heterogeneity of benthic geochemical solid-phase and pore-water composition and seafloor substrate types along a transect crossing the NE Atlantic Ocean from the Porcupine Abyssal Plain (PAP) via the Central Western European Basin (CWEB) to the Mid-Atlantic Rise (MAR).

In January 2021, the IceDivA expedition, aboard the German research vessel *Sonne*, studied the diversity of marine organisms in the deep sea, connecting two deep-sea projects in this regard: IceAGE (Icelandic marine Animals: Genetics and Ecology) and

DIVA (Latitudinal Gradients in BioDIVersity in the deep Atlantic) as well as the EU project iAtlantic. IceAGE is an established international project that was initiated in 2011 and builds on the preceding project BIOICE (Benthic Invertebrates of Icelandic Waters). By connecting to the southernmost IceAGE3 station, IceDivA adds a latitudinal gradient, which in turn forms a link to the BIODIAZ project (Controls in benthic and pelagic BIODIversity of the AZores). The study area is located in one of iAtlantic's regions of interest (the Porcupine deep-sea plain and the Azores plateau). A contiguous and comprehensive mapping of the ocean floor by means of hydroacoustics is an indispensable prerequisite for identifying habitats – one of the iAtlantic project's primary tasks, and an equally important objective in the IceDivA project.

The iMAR expedition "*The Integrated assessment of the distribution of Vulnerable Marine Ecosystem along the Mid-Atlantic Ridge in the Azores region*" took place aboard RV Pelagia of the Royal Netherlands Institute for Sea Research on 18 May – 2 June 2021. This expedition is funded by the SEA OCEANS program of Eurofleets+ and the European project iAtlantic. Of particular interest are vulnerable marine ecosystems (VMEs) in this area: groups of species, communities or habitats that may be vulnerable to impacts from fishing activities. This mission has mapped and characterised deep-sea coral and sponge communities discovered on hitherto unexplored seamounts and ridges, seeking to identify new areas that fit the UN Food and Agricultural Organization's definition of VME. The condition of benthic communities was assessed by looking at evidence of fishing damage to fauna, presence of lost fishing gear and marine litter, in order to gain new knowledge on the environmental drivers that determine the spatial distribution of deep-sea benthic biodiversity on and around the Mid-Atlantic Ridge (MAR). The results of this mission directly contribute to iAtlantic's aim to understand the factors that control the distribution, stability and vulnerability of deep-sea ecosystems, and consequently inform sustainable management throughout the Atlantic.

Cruise statistic were: 13 working days at sea, 2,500 km of transits, 12 areas visited, 5,000 km2 of mapped seabed, 19 dives with the NIOZ video system that resulted in 54 hours of deep-sea images over 48 km of the seabed, 10 stations for the analysis of water mass properties and to collect sediments, which resulted in 360 samples for environmental DNA, 260 samples for nutrient analyses, 27 sediment samples for geological analyses, 24 for microplastic analyses, and 10 samples for bacteriological and meiofauna analyses.

Future expeditions in the NE Atlantic, linked to the iAtlantic project are:

DY116: The primary purpose of this cruise is to service the Porcupine Abyssal Plain observatory, take biological samples and carry out benthic surveying.

iMirabilis_2: The cruise will take place on the Spanish RV Sarmiento de Gamboa (SdG) from July to August 2021. The expedition was postponed from 2020 due to the Covid-19 situation. The ship will travel from Vigo (Spain) to Las Palmas (Canaries, Spain), and from there will move to Cabo Verde waters to carry out the main research work. The transit between Vigo and Las Palmas will also be used for different training and capacity building activities. The expedition will finish in Las Palmas (Canaries, Spain). At-sea activities will study both the water column and the seafloor. iMirabilis_2 mobilises state-of-the-art seabed survey equipment including the Autonomous Underwater Vehicle (AUV) Autosub6000 and the Remotely Operated Vehicle (ROV) Luso. This advanced technology allows iAtlantic to explore benthic ecosystems in great detail producing large high-resolution photographic results that will be processed automatically using new machine learning approaches. The results of these surveys will be used to produce high resolution habitat maps in Cabo Verde. Moreover, the ROV Luso will allow the collection of selected specimens for taxonomic purposes and for dating.

iAtlantic's work programme is underpinned by more than 30 research expeditions that will explore NE Atlantic over the next 4 years. Further information on theseexpeditions can be found at: https://www.iatlantic.eu/our-work/expeditions/?region=ne-atlantic

Running expeditions like these are essential for improving our deep sea knowledge and they require substantial technical and financial support.

d. Identify strengths and weaknesses of the scientific research projects/relevant programmes.

NEAFC have signed a Memorandum of Understanding (MoU) with ICES and OSPAR. Such MoUs strengthen the collaboration between these organizations.

ICES is the scientific advisory body of NEAFC, as NEAFC does not undertake research of its own. ICES, supported by the Permanent Committee on Management and Science (PECMAS) of NEAFC, develop appropriate research programs to meet longer-term issues raised by NEAFC. Moreover, ICES maintains an extensive VME database available for the assessments conducted by their expert groups. ICES advice includes Ecosystem considerations (e.g. fisheries impacts on marine mammals, sea birds and sensitive hábitats, etc.). The involvement of ICES strengthens the advisory process: ICES advice is independent and free from political influence and subject to the best international quality procedures for research.

NEAFC has not adopted any specific actions to minimise the impacts of research as there has been no suggestion of relevant adverse impacts associated with scientific investigations. NEAFC recommendations contain only general provisions on this issue and this could be considered a weakness. However, if the need to set measures to control scientific research should arise, Article 10 of the NEAFC Convention ensures that there is a legal competence for NEAFC to do so.

There is a good cooperation between NEAFC and OSPAR over the adoption and delineation of high seas MPAs and bottom fisheries closures (as well as other closures), based on data from scientific research. Both are often held up as examples of cross-organizational cooperation and coordination, it should also be noted that the conditions that enable and facilitate NEAFC and OSPAR's cooperation do not exist in most other areas of the world; while lessons can be learned from their approach, its model could not be successfully replicated across the globe. It is worth noting that the OSPAR Area overlaps with the NEAFC Area and that OSPAR has adopted the non-legally binding "Code of Conduct for Deep Sea and High Seas Scientific Research of the Maritime OSPAR Area" with the aim of mitigating the impacts of research.

e. Experience with data sharing and potential integration of new data in the RFMO advisory cycle, and remarkable consequences, if any

A Memorandum of Understanding (MoUs) sets the framework for dialogue and formal communications that provides advice on matters of mutual interest, draw questions of concern to attention and fosters a closer relationship between organisations.

NEAFC has signed two bilateral Memorandums of Understanding (MoU): one with the International Council for the Exploration of the Sea (ICES) (NEAFC, 2007) and other with OSPAR (OSPAR, 2008):

In 2007, ICES signed the following Memorandum of Understanding with NEAFC. ICES and NEAFC consult on ways in which cooperation between them can be further improved and extended. The work undertaken under the recurring and non-recurring requests is fully funded by NEAFC, but also noting national experts from Contracting Party states will be involved in the ICES process. Under the MoU, NEAFC can observe at the ICES annual Science Conference, the Statutory Meeting and the Council's Advisory Committees. ICES is also an observer at the NEAFC Permanent Committee on Management and Science and the Commission’s Annual Meeting. Both organisations exchange documents and reports of mutual interest. Under the MoU, ICES provides NEAFC with scientific information and advice, which is independent and free from political influence and subject to the best international quality procedures for research and research based advice. This MoU was updated at the end of 2019, ensuring the incorporation of the latest ecosystem considerations:

Provision of Scientific Information and Advice:

1. ICES will provide NEAFC with scientific information and advice, which is independent and free from political influence and subject to the best international quality procedures for research and research based advice. The basis for the advice and the process through which it is produced will be transparent and the quality of the technical basis is ensured through internal and external peer review. The geographical scope of the Memorandum of Understanding is the Northeast Atlantic (FAO statistical area 27 excluding the Baltic Sea)

2. ICES and NEAFC will continue to consult on ways in which cooperation between them can be further improved and extended. A regular bilateral meeting should be held by ICES and NEAFC in this regard. Further improvements may include joint activities, e.g. seminars, symposia or other meetings. Such meetings can include discussions on long-term developments, such as possible multispecies advice, possible climate effects and other ecosystem considerations. ICES could use this information to guide research programs and take these issues into account in presenting its advice to NEAFC. Other more short-term issues, such as the form the advice is presented in and the timing it is released, might also be discussed at such meetings with ICES.

3. NEAFC will ensure that requests for advice from ICES are submitted in a timely manner (Annex 3)

4. NEAFC and ICES will work together to arrange for any relevant data for scientific analysis to be provided to ICES, while ensuring the NEAFC's confidentiality obligations.

   a. All relevant VMS and catch data for scientific analysis are provided to ICES under the separate NEAFC-ICES arrangement[55] ICES follows an open data policy, exclusions to the ICES data policy are listed on the ICES Data Policy web page[56] and specific policies[57] [58] are in place to ensure the confidentiality obligations of the data provider. NEAFC will provide data to ICES according to

[55] https://www.ices.dk/about-ICES/Documents/Cooperation%20agreements/NEAFC/20190201-NEAFC-ICES-agreement-VMS-Logbook_2019.pdf

[56] https://www.ices.dk/data/guidelines-and-policy/Pages/ICES-data-policy.aspx

[57] https://www.ices.dk/sites/pub/Publication%20Reports/Guidelines%20and%20Policies/Data_Policy_RDB-2020.pdf

[58] https://www.ices.dk/data/Documents/VMS_DataAccess_ICES.pdf

the relevant current Recommendation to Provide VMS and Catch Data to ICES for Scientific Purposes as updated/amended from time to time. See also the document: 'Agreement between NEAFC and ICES on VMS and catch data.'

b. The ICES Data Policy states that the quality assurance of data is the responsibility of the data provider. ICES may perform additional quality control of the aggregated data used in assessments and shall decide which data are considered a useful basis for advice.

c. ICES will in the background documentation for the advice describe which data were used and qualitatively describe sources of uncertainty affecting the assessment. ICES will also explain both the internal and external quality control procedures used for all advice;

d. Should a National data provider not be in a position to deliver its data and would ICES as a result not be able to deliver advice as agreed, ICES will inform NEAFC about the issue. NEAFC understands that ICES will be unable to fulfil the Agreement should this occur.

5. ICES agrees to provide NEAFC with:

a. annual standard "recurring" advice on the state and management of the main commercial stocks in the NEAFC convention area listed in Annex 1 and the state of the marine ecosystem according to the farm established in Annex 1. In particular, ICES will focus on resources in NEAFC regulatory area as set out in list in Annex 1;

b. annual standard "recurring" advice to help ensure the implementation by NEAFC of effective measures to prevent significant adverse impacts of bottom fishing activities on vulnerable marine ecosystems known to occur or likely to occur in the NEAFC Regulatory Area. This should include all available new information on the distribution of vulnerable habitats in the NEAFC Convention Area and fisheries activities in and in the vicinity of such habitats. The advice should also consider subareas of the Regulatory Area that are closed to fishing for other purposes than VME protection.

c. "non-recurring advice" as may be agreed between NEAFC and ICES in response to requests from NEAFC;

d. the information on which the advice is based (inter alia, Expert Group Reports including peer review reports) will be made available to NEAFC following the full ICES review process. Any other relevant reports and journals published by ICES will be made available to NEAFC; and

e. the advice should be given in the context of the NEAFC Convention as amended in 2006. NEAFC will, when requesting advice, specify objectives and guidelines relevant to the formulation of the ICES advice

f. in its address[advice] to the annual meeting as a regular item, a review on progress on science and advice related to multispecies issues and climate change effects for the ecosystems and stocks relevant to NEAFC. [ICES should provide an overview far NEA as a whole in addition (incorporating) to existing ecosystem overviews and fisheries overviews in the region]

g. information on new and rapidly expanding deep sea fisheries, even if no stock-specific advice can be provided

h. estimates of catch by country within the NEAFC convention area for inclusion in NEAFC's Finance Briefing. Total tonnages caught by each country for each of the last three years are to be provided no later than the first week of August each year, including based on official nominal catches available in Eurostat or national statistics.

6. ICES agrees to present the scientific information and advice at NEAFC PECMAS and at NEAFC's Annual Meeting by the Chair of a relevant Advisory group or a designate. An appropriate ICES Secretariat member/representative and ACOM representative will also be invited to the meetings.

7. The scientific information and advice will be made available immediately after its adoption by ICES. The scientific information and advice for special request advice will be sent to NEAFC as with due regard to the timings set out in the Annual Request for that year.

8. According to the Schedule in Annex 2, NEAFC may make special requests for advice as appropriate.

9. In the event that scientific work necessary for ICES to fulfil its obligations under this agreement is not completed, ICES shall inform NEAFC of the nature, detail and consequences of such shortfalls in a timely manner/as soon as it is aware.

10. The requests by NEAFC will be accompanied by the best endeavours to provide ICES with relevant data, background information, links to relevant legislation etc.

The MoU with OSPAR applies from 1 September 2008 and recognizes NEAFC and the OSPAR Commission both have an interest in conserving the living resources of the seas including those located in areas beyond national jurisdiction and have therefore reached the following understanding:

1. To promote mutual cooperation towards the conservation and sustainable use of marine biological diversity including protection of marine ecosystems in the North-East Atlantic, through cooperation in the following areas:

a. NEAFC and the OSPAR Commission will ensure that there is a free flow of mutually useful information (including data) between the two organisations. The OSPAR Commission will draw to the attention of NEAFC any concerns that are raised during the course of its work concerning the need for protection of marine ecosystems in the North-East Atlantic and NEAFC will draw to the attention of OSPAR any concerns related to other human activities than fishery impacting on marine ecosystems;

b. NEAFC and the OSPAR Commission will discuss jointly their respective concerns over the management of human activities that impact on the marine environment and the living marine resources in the North-East Atlantic including in areas beyond national jurisdiction and possible actions and measures to address them;

c. NEAFC and the OSPAR Commission will work together to develop a common understanding of the application of the precautionary approach/ principle;

d. NEAFC and the OSPAR Commission will cooperate regarding marine spatial planning and area management;

e. NEAFC and the OSPAR Commission will encourage the funding and conduct of marine science in the sea areas of the North-East Atlantic, including in areas beyond national jurisdiction that will contribute towards the enhancement of knowledge on:

(i) the distribution, abundance and condition of vulnerable deep water habitats;

(ii) the status of populations of marine species;

(iii) the effectiveness of measures aimed at the conservation of marine biological diversity in the North-East Atlantic, including in areas beyond national jurisdiction.

(iv) the costs of non-action.

f. NEAFC and the OSPAR Commission may cooperate on specific projects through ICES;

g. NEAFC and the OSPAR Commission will establish reciprocal observer arrangements according to their respective internal rules;

h. NEAFC will provide the OSPAR Commission with reports of meetings of NEAFC or its subsidiary bodies that are relevant to the OSPAR Commission's work;

i. the OSPAR Commission will provide NEAFC with reports of its meetings or meetings of its subsidiary bodies relevant to NEAFC's work.

2. Working relations between NEAFC and the OSPAR Commission will be maintained at an appropriate level, complemented by review meetings between the Secretary of NEAFC and the Executive Secretary of the OSPAR Commission, at a frequency established by them. Other relevant international organisations may be invited to attend these meetings;

3. NEAFC or the OSPAR Commission may propose changes, or withdraw from this Memorandum of Understanding. Any such proposal will be made at least 10 weeks before the annual meeting of the OSPAR Commission, if proposed by NEAFC or at least 10 weeks before the annual meeting of NEAFC, if proposed by the OSPAR Commission. Cooperation on specific issues within the scope of this Memorandum of Understanding may, if necessary, be specified in further detail through the development of separate sub-agreements between NEAFC and the OSPAR Commission.

4. Any change will come into effect on 1 January in the calendar year after the change has been agreed by both NEAFC and the OSPAR Commission. Any withdrawal will come into effect one complete calendar year after the meeting in advance of which notice of the proposed withdrawal was given.

f. Potential adverse impacts of scientific research activities and mitigation measures. Alternative methods.

NEAFC's objective is to ensure the long-term conservation and optimum utilisation of the fishery resources in the Convention Area, providing sustainable economic, environmental and social benefits. To this end, NEAFC adopts management measures for various fish stocks and control measures to ensure that they are properly implemented. NEAFC also adopts measures to protect other parts of the marine ecosystem from potential negative impacts of fisheries.

Mitigation measures, applicable to exploratory bottom fishing, are given in several Articles of the Recommendation 10:2021 (NEAFC, 2021) that is in force from February 6, 2021. In addition to the regime regarding bottom fisheries included, NEAFC has a number of measures that link to broader ocean science, in particular on biodiversity and ecosystems to minimise the adverse impact of fisheries including the following:

1. Area management regulations: In addition to the areas that have been closed to bottom fishing to protect VMEs, there are other area closures, such as the so-called haddock box which is used in the management of Rockall haddock.

2. Seasonal closures: NEAFC has closed certain fishing areas to protect juveniles or spawning aggregations, in particular, NEAFC has adopted a seasonal closure for blue ling fisheries in a specified area south of Iceland.

3. Prohibitions to fish with certain fishing gear: these include the prohibition to deploy gillnets, entangling nets and trammel nets in the NEAFC Regulatory Area in any position where the charted depth is greater than 200 metres.

4. Minimising the impacts of research: NEAFC recommendations contain general provisions obliging Contracting Parties who intend to conduct scientific research in areas closed to protect VMEs to notify NEAFC of their intended research programmes. So far, NEAFC has not adopted any specific actions to minimise the impacts of research, as there has been no suggestion of relevant adverse impacts associated with scientific investigations. However, if the need to do so were to arise, Article 10 of the NEAFC Convention provides for measures to be adopted relating to fishing operations conducted solely for the purposes of scientific investigation.

5. Information from catches of non-target species and discards: NEAFC has adopted measures regarding catches and discards. All catches of regulated resources, including those taken for scientific purposes, must be counted against quotas (regardless of what is the target species). The NEAFC Scheme of Control and Enforcement obliges all Contracting Parties' vessels to keep an accurate record of catches and discards in their logbooks. NEAFC does not however collect statistics on the catches of unregulated resources and therefore relies on ICES for advice on the effects of fisheries on other parts of the marine ecosystem.

6. Catches by lost or abandoned gear: Under the NEAFC Scheme of Control and Enforcement vessels fishing with fixed gear must have equipment on board to retrieve lost gear and attempt to retrieve such fishing gear as soon as possible. If lost gear cannot be retrieved, the flag State needs to be notified which then notifies the Secretary of NEAFC. All Contracting Parties are required to retrieve lost gears on a regular basis.

Groundfish surveys demonstrated to have several advantages as data sources helping us to improve our knowledge on VMEs identification, distribution and extent, and being crucial for the proposal and implementation of conservation and management measures.

Nevertheless, groundfish surveys have a main disadvantage: despite the occasional trawling in VME areas and the short duration of the scientific survey trawls, they can produce impacts on cold-water corals and deep-sea sponges. This poses an ethical dilemma between the need for data for the assessments and the "*Precautionary Principle*" (ASTEC, 1998): groundfish surveys in ABNJ can be a potential harm to VMEs (Warner, 2014), but can significantly contribute, in the long term, to the sustainability of commercial deep-sea fisheries, thanks to the management measures based on survey data series (e.g. Total Admissible Catches of fish stocks, VME protection areas).

A similar kind of tensions were identified by Crozier *et al*., (2015) regarding ecological research. To move forward in solving this concern, there are several studies within NAFO area that are in progress, focused on the effects on fish stock assessments of excluding groundfish surveys trawls from the VME closed areas, and if this exclusion compromises the quality of index data used in the assessments (González-Troncoso *et al*., 2016; Rideout and Ollerhead, 2017).

In VME areas, non-invasive sampling methods (e.g. drop cameras, towed cameras, remotely operated vehicles, autonomous underwater vehicles, benthic samplers, etc.) could be an alternative for monitoring of VME (Eleftheriou and McIntyre, 2008; Chimienti *et al*., 2018; Ludvigsen *et al*., 2017). These methods are generally expensive and more appropriate at small spatial scales (NAFO, 2017). Particularly, visual methodologies are more accurate and efficient for studying the abundance of benthic populations in small areas (e.g. seapens), but they are often not appropriate for studying their biomass and size structure (Chimienti *et al*., 2018; Chimienti *et al*., 2019). They suggested that trawl data is still necessary to identify areas of high concentrations of cold-water corals (e.g. sea pen fields) at a large scale, but ROV images could be used afterwards to monitor these concentrations in a non-invasive way, consistent with the precautionary approach.

g. Other issues/recommendations that could be useful for providing options for the development of a framework for scientific research activities (not related to fisheries)

In VMEs areas, the use of alternative non-invasive sampling methods must be investigated with the aim of addressing their current limitations and developing them in the near future.

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SOUTH EAST ATLANTIC FISHERIES ORGANISATION (SEAFO)

Partner short name: IEO

a. Relevant scientific research projects

The ABNJ Deep Seas Project

This is one of four projects under the FAO-led ABNJ Program/Common Oceans (www.commonoceans.org). Topic: *Sustainable fisheries management and biodiversity conservation of deep-sea ecosystems in areas beyond national jurisdiction.*

The FAO started the development of the project in December 2012, with SEAFO being a partner involved in the project development process.

The project involves four main components:

i. improved application of policy and legal frameworks for sustainable fisheries and biodiversity;
ii. Reduced significant adverse impacts on vulnerable marine ecosystems (VMEs) and ecologically or biologically significant areas (EBSAs);
iii. improved planning and adaptive management for deep-sea fisheries; and
iv. development and testing of a methodology for area-based planning (led by UNEP).

The project is global in scope, but includes focal areas for specific activities which are preliminarily identified as the SE Atlantic region, the Indian Ocean region, and as well as the SE Pacific.

SEAFO-FAO-EAF Nansen Project

The main objective is to provide knowledge to partner countries, and regional organizations or partnerships (e.g. regional fisheries bodies and large marine ecosystem commissions or projects) on marine fishery resources and ecosystems, in partnership with the Programme.

Two research surveys have been carried out under this project with the R/V Dr. Fritjof Nansen in the SEAFO Convention Area, in 2015 and 2019 (IMR, 2015, 2019). The objective is the analysis of the occurrence and abundance of benthopelagic fish and sessile epibenthos, including indicators of Vulnerable Marine Ecosystems (VMEs). Because of the collaboration with FAO, the vessel flies the flag of the United Nations, making the vessel a neutral platform for international collaboration in fisheries research.

Spanish-Namibian multidisciplinary habitat mapping project

Within this research, one of the study areas was the Walvis Ridge and adjacent seamounts. Three research surveys from 2008 to 2010 were made (Durán Muñoz *et al.*, 2012).

FarFish project (www.farfish.eu)

This is a four-year Research & Innovation project that started in 2017 andfinished in 2021. It is funded by the European framework programme HORIZON 2020 under the topic H2020-SFS-21-2016: Advancing biological knowledge and improving management tools for commercially important fish and other seafood species. The focus of the project is on providing knowledge, tools and methods to support responsible, sustainable and profitable EU fisheries outside European waters. Main efforts are awarded to six non-European waters, one of which covers the SEAFO convention area. One of the deliverables of the FarFish Project includes a proposal for implementing a pilot e-logbook project with a Namibian vessel that conducts deep-sea red crab fishing operations in the SEAFO CA.

FAO-GEF-ABNJ Project "CSIRO Component on a Risk Assessment to Biodiversity from Deep Sea Fishing Gears"

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) was contracted by FAO to provide a risk assessment for deep sea fishing gears on biodiversity. This will require adapting the Productivity-Susceptibility Analysis (PSA) methodology to work with new statistical models that CSIRO has developed. CSIRO used these finite mixture models to estimate the distribution of biodiversity and then applying a modified version of PSA methods to assess risk in the SEAFO, SIOFA and SPRFMO areas. Some concerns were expressed by the SEAFO Scientific Council regarding the potential benefits of this study for SEAFO, but also expressed doubts concerning the application of these methodologies. The SEAFO Commission in 2018 requested that more clarity be provided by CSIRO before any data can be shared.

MARISMA Project

Under the framework of the Benguela Current Convention (BCC), the three Contracting Parties (i.e. Angola, Namibia & South Africa) are advancing the work on Ecologically or Biologically Significant Marine Areas (EBSAs) under a regional project called the "Marine Spatial Management and Governance Project", formally known as the "MARISMA Project". The Walvis Ridge was identified as an EBSA in 2013 with the participation of SEAFO.

South Atlantic MAR-ECO (SA MAR-ECO) initiative

It started in 2006 as a spin-off project of "MAR-ECO: Patterns and Processes of the Ecosystems of the Northern Mid-Atlantic". SA MAR-ECO was conceived to expand the MAR-ECO project into the South Atlantic being also supported by other CoML field projects, primarily CenSeam (A Global Census of Marine Life on Seamounts) and others.

iAtlantic Project

It is underway with an extensive field programme comprising more than 30 research expeditions in the Atlantic Ocean. Their efforts focus mainly (but not exclusively) on 12 locations in the deep sea and open ocean that are of international conservation significance and of interest to Blue Economy and Blue Growth sectors, one of them being the abyssal plains and deep-sea ridge ecosystems of the Benguela Current from the Walvis Ridge to South Africa. Due to the COVID the survey in Walvis ridge that was expected in 2020 and subsequently extended in 2021 has been cancelled.

b. Relevant research programmes

SEAFO is an important partner of the ABNJ Deep Seas Project. SEAFO has been involved in the design and development of the Project and has agreed to contribute to activities that promote collaboration and sharing of experiences in deep-sea fisheries and associated biodiversity, as well as specific activities on capacity building for developing countries (FAO,2018). This contribution is coordinated by the SEAFO Secretariat.

The ABNJ Deep Seas Project cooperation has been focused on the organization of workshops such as the Regional workshop on vulnerable marine ecosystems (VMEs) in the southeast Atlantic Ocean. Swakopmund, Namibia, 15-17 April 2013, an Orange roughy workshop in 2018 (with attendees from SEAFO partners) or a red crab desktop study in 2018. The activities of interest to SEAFO stakeholders could be:

- Collaboration and support on the development and testing of improved fishing systems
- An electronic application for reporting at-sea observations from deep-sea fishing vessels is being developed by the Information Technology Division of FAO
- Support for the trialing of electronic monitoring systems on deep-sea fishing vessels operating in the ABNJ to collect information on VMEs.
- Support for activities related to improving the assessment of orange roughy and other deep-sea species.
- A global review of traceability in deep-sea fisheries
- An examination of monitoring control and surveillance practices in deep-sea fisheries in the ABNJ
- An analysis of the EAF practices implemented by regional bodies with a mandate for the management and conservation of deep-sea fishing in the ABNJ.

The second ABNJ Common Oceans programme follows on from the first Common Oceans Programme (2014-2019). The programme and project are currently being developed with an anticipated submission date to GEF of July 2021 and a start date planned for January 2022.

c. Surveys at sea

Earlier in 2021 a survey to Walvis Ridge hotspot took place by the International Ocean Discovery Program (Sager *et al*., 2021). The Methodologies used were drilling the Walvis Ridge to test models of ridge-hotspot interaction, isotopic zonation, and the hotspot reference frame. This survey was preceded by a prospective one from December 2019-January 2020 to gather magnetic data around Walvis Ridge (Sager *et al.*, 2020).

An iAtlantic survey expected to be carried out in 2020 on Walvis ridge has been cancelled due to the COVID situation. A video prospection using ROVs among other activities was planned.

2019 R/V Dr. Fritjof Nansen survey. Five seamounts were prospected using an ROV, namely Shannon, Heardman, Tablemount and Schwabenland seamounts. Some of the areas studied are currently closed to fishing whereas others are being or have been fished for Patagonian toothfish.

The RRS James Clark Ross survey to Tristan da Cunha and St Helena ran several research surveys. These surveys were conducted to investigate the marine environments of these areas and address gaps in knowledge identified during discussions with local governments and stakeholders. They also offered to collect acoustic data on the survey in March/April 2019 while in transit through the SEAFO CA. A report was submitted to 2019 SEAFO SC (Bell, 2019). Both St Helena and Tristan da Cunha are in the process of declaring a reformed marine protection strategy, which may be of relevance to ecosystem management practices in the wider SEAFO Convention are.

2015 R/V Dr. Fritjof Nansen survey in Walvis ridge. The objectives were to analyse the occurrence and abundance of benthopelagic fish and sessile epibenthos, including indicators of VMEs, in selected 'existing fishing areas' and areas closed to fishing within the SEAFO CA using bathymetry, ROV and bottom trawl (Bergstad, 2019a and 2019b)

A 2014 GEOMAR cruise with the R/V SONNE, SO-233 WALVIS II (Hoernle, 2014) conducted geological, morphological, and biological studies in the area of the aseismic Walvis Ridge and the adjacent ocean floor (South Atlantic).

In 2012 the US "MV1203 Expedition" cruise in Walvis Ridge was aimed to dredge 40 seamounts along the southwest portion of the Walvis Ridge. (https://earthref.org/ERESE/projects/MV1203/).

In 2008, 2009 and 2010 three multidisciplinary Spanish-Namibian surveys were made in Walvis ridge. The objectives were to locate and characterise VMEs associated with seamounts in the SEAFO Regulatory Area, to improve information about seabed bathymetry, associated ecosystems, vulnerable species distribution and bottom fisheries impact.

Previously, all the research in the area had been carried out by Russian Federation cruises.

d. Identify strengths and weaknesses of the scientific research projects/relevant programmes

The FAO ABNJ Deep Seas Project is providing useful assistance to SEAFO on VME database, best practices for VMEs, work on sponges, ecosystem approaches, and the potential for facilitating fisheries sector representation in international fora among other issues. It is of paramount importance their collaboration with SEAFO.

It has been discussed in SEAFO forums about the potential for extending the Namibian orange roughy surveys into the SEAFO CA, however, given the current Namibian financial state a survey is not likely in the immediate future.

The spatial distribution of VME indicators such as corals and sponges (i.e. as given in the FAO Deep-Sea fishery guidelines, 2009) is however not well known in SEAFO, hence a need for further information from scientific investigations at sea has been recognized. Additionally, there are 11 fishing closures within the SEAFO CA, and a new area on the Valdivia was closed to other gears than pots and longlines. These closures were likely to represent locations and features inhabited by VMEs. Some of these closures had previously been fished. Research aimed to validate these potential VMEs locations is highly recommended. The Spanish-Namibian surveys between 2008-2010 and the Nansen surveys (2015 and 2019) have contributed to this although more research is needed.

e. Experience with data sharing and potential integration of new data in the RFMO advisory cycle, and remarkable consequences, if any

There is a policy on the access and use of data and samples collected in the framework of the EAF-Nansen Programme including through the R/V Dr Fridtjof Nansen surveys (Nansen Data Policy) DOC/SC/18/2019.

At the 2019 meeting, ACAP Parties noted with concern that despite all the research and attention devoted to the development of best practices concerning the seabird bycatch mitigation measures, these have not been sufficiently implemented to halt the decline of many albatross and petrel populations. This included a lack of compliance with measures required by regulatory bodies. The recently adopted MoU between SEAFO and ACAP (Dec 2018 - 2024) provides a useful mechanism to facilitate a cooperative approach to minimise the incidental bycatch of albatrosses and petrels that occur within SEAFO's Convention Area.

There is a proposal from CEFAS for data sharing between ongoing deep-sea research projects in the South-East Atlantic with the intention to extend the spatial coverage of the habitat suitability models already under development for the UKOTs. , involving the following organisations: Modelling the distribution of VMEs in the South Atlantic. The proposal established the conditions for such collaboration (DOC/SC/16/2019).

The transboundary fish stocks, such as toothfish, between CCAMLR and SEAFO, needs collaboration between them. At the moment there is no MoU signed between the two organizations but a request at the SEAFO-SC meeting in 2016 that recognises the value of the tagging program and the collaboration with CCAMLR. The Commission report in 2019 noted that any RFMO (including SEAFO) needs to co-operate fully with other RFMOs by sharing data and information, in order to be able to achieve its objectives. In this regard, it is encouraging to note that SEAFO has taken steps to enter into cooperation agreements with CCAMLR.

f. Potential adverse impacts of scientific research activities and mitigation measures. Alternative methods

Research surveys plans are designed to cause the least harm to the ecosystem and usually, a potential impact assessment should be carried out. Pros and cons need to be assessed by both the proponent and the SEAFO-SC.

g. Other issues/recommendations that could be useful for providing options for the development of a framework for scientific research activities (not related to fisheries)

There is a guideline for fisheries research and basic marine science activity in the SEAFO Convention Area. The primary purpose of these guidelines is to facilitate that high-quality science may be conducted freely and to the benefit of all while also ensuring that the activity is conducted in a manner that does not cause significant adverse impacts (SAI) on the marine ecosystems and organisms, including fisheries resources.

One of the points of the guidelines is that cruise reports, at least those made available in the public domain, should be provided to SEAFO as soon as possible after the completion of the cruise. It can be seen that although some investigations have a high value for the work of the SC they have not been reported to SEAFO, probably because they were not related to marine living organisms but to abiotic studies.

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GENERAL FISHERIES COMMISSION FOR THE MEDITERRANEAN (GFCM)

Partner short name: IEO

a. Relevant scientific research projects

The GFCM WGVME (2018) drafted a catalogue of projects working on Essential Fish Habitats and Sensitive Habitats in the Mediterranean Sea. Most of these projects are related to the identification of areas in which certain parts of the exploited resources (nurseries and spawning grounds) are more abundant or to the design of a network of MPAs. GFCM does not support or coordinate scientific research projects focused on DSGs management and/or VME conservation but carries out specific actions that may help the protection of these habitats. In 2005, the GFCM adopted a binding recommendation to prohibit bottom trawling below 1,000 meters for the protection of seabeds and to reduce the impacts of these fisheries on deep-sea ecosystems. The GFCM in 2006 adopted fisheries restricted areas (FRAs), a specific area-based management tool to protect VMEs in the region. Four areas have been closed to bottom fishing as a result of FRA designations. The GFCM has since adopted a mid-term strategy (2017-2020) towards the sustainability of Mediterranean and Black Sea fisheries. This includes:

- The promotion of the identification and establishment of new FRAs to protect priority areas within ecologically or biologically significant marine areas (EBSAs), VMEs, etc. from harmful fishing activities, and the implementation of monitoring and control systems to ensure the efficiency of these spatial measures. This action should aim to achieve at least the protection of 10% of the coastal and marine areas. The CPCs should be closely involved in the definition of new FRAs.

- The adoption of a comprehensive regional management plan for red coral, based on previous technical work carried out in the context of the GFCM subsidiary bodies, including relevant GFCM guidelines, and updated advice.

b. Relevant research programmes

Since 2018, GFCM research programmes have been included, through specific recommendations[59], in the GFCM work plan. They are being launched to address data and management issues. These programmes not only allow for the collection of scientific data in support of new and/or enhanced fisheries management measures, but also provide a platform of cooperation and networking towards capacity building and the effective cooperative management of shared resources. They also facilitate the transfer of knowledge where needed, paving the way for effective cooperative management.

[59] Recommendation GFCM/43/2019/4 on a management plan for the sustainable exploitation of red coral in the Mediterranean Sea. https://gfcm.sharepoint.com/:b:/g/CoC/EW3w-GWBZoVLtxUVE_cOIsQBeuC112a4GvUWvIKHPLHeeA

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Such programmes are implemented in those cases where an improvement in the sustainability and management of a specific fishery is expected to benefit from dedicated actions towards improving the quality and quantity of information on the resource, while addressing previously identified knowledge gaps and shortcomings in the relevant scientific/technical advice. The first research programme to be implemented was on the non-indigenous rapa whelk (*Rapana venosa*) in the Black Sea. Managed by the GFCM through the BlackSea4Fish project[60] since 2019, it was closely followed by research programmes on European eel (*Anguilla anguilla*) and red coral (*Corallium rubrum*), both launched in 2020, and the planning of a similar initiative for blue crab (*Portunus segnis* and *Callinectes sapidus*). The red coral programme includes remotely operated vehicle (ROV) surveys. Moreover, a programme on common dolphinfish, has been requested. In all cases, the core principle is to take full advantage of ongoing research at the country level by providing a platform for coordination and filling the gaps with new activities and/or capacity-building support, generally aimed at providing the scientific basis for the determination of the most appropriate management measures.

c. Surveys at sea

The GFCM published the "Technical guidelines for scientific surveys in the Mediterranean and Black Sea" (Carentieri *et al.*, 2020). The publication describes procedures and sampling for demersal (bottom and beam) trawl surveys and pelagic acoustic surveys. This publication presents a methodology that aims to support the planning and implementation of regional demersal (bottom and beam) trawl and pelagic acoustic surveys, increase comparability between existing surveys and define minimum requirements towards sustainability and management objectives. These protocols are based on the surveys already in place in the EU, such as the Mediterranean International Bottom Trawl Survey (MEDITS), the Solea Monitoring Survey (SoleMon) and the Mediterranean International Acoustic Survey (MEDIAS). Aside from these surveys carried out in EU waters, some other members of GFCM (namely Morocco, Algeria or Tunisia) have launched their own national surveys, carried out with the support of the GFCM and the FAO regional projects and based on a standard methodology. Specific surveys at sea have been launched for species such as rapa whelk in the Black Sea and red coral.

d. Identify strengths and weaknesses of the scientific research projects/relevant programmes

Although different activities are being carried out at GFCM, there are no scientific research projects of scientific surveys carried out under their coordination. In European waters, several projects are carried out whose results can be used for these activities, as well as the Data Collection of commercial and survey data funded by the EU, which includes both demersal bottom trawl surveys and acoustic surveys. They are carried out under internationally agreed protocols which are also followed by non-EU countries such as Morocco and Algeria.

e. Experience with data sharing and potential integration of new data in the RFMO advisory cycle, and remarkable consequences, if any

GFCM makes different Data Calls during the year. The DCRF (GFCM, 2018) is the GFCM framework for the collection and transmission of the fisheries-related data that are requested as per existing GFCM Recommendations and are necessary for relevant GFCM subsidiary bodies to formulate advice in accordance with their mandate.

60 http://www.fao.org/gfcm/activities/fisheries/blacksea4fish/es/

f. Potential adverse impacts of scientific research activities and mitigation measures. Alternative methods

n.a.

g. Other issues/recommendations that could be useful for providing options for the development of a framework for scientific research activities (not related to fisheries)

n.a.

References

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NORTH PACIFIC FISHERIES COMMISSION (NPFC)

Partner short name: MRAG EU

a. Relevant scientific research projects

Emperor seamounts, NW Hawaiian Islands – Oceanic Ecosystem Group, National Research Institute of Far Seas Fisheries, Japan Fisheries Research and Education Agency

This study was conducted as part of the "Project on Evaluation of the Status of the Sea Floor Environment of Fishing Grounds in the High Seas" of the Fisheries Agency, Japan (see Miyamoto and Kiyota, 2017).

Commercial bottom fisheries in the Emperor Seamounts area are managed by the NPFC, and scientific surveys on bottom habitats have been conducted to establish science-based management measures. Four orders of corals (Gorgonacea, Alcyonacea, Antipatharia, and Scleractinia) are tentatively assigned as VME indicator taxa in the NPFC convention text. However, the effectiveness of these four taxa as VME indicators has not yet been verified quantitatively.

Miyamoto and Kiyota (2017) assessed the representativeness of the candidate VME indicator taxa, while focusing on the functional significance as habitat and structural complexity among the VME characteristics. The study examined biological samples collected by scientific bottom tow-net surveys to assess the co-occurrence tendencies of benthic taxa and the characteristics of benthic communities in the area. The results demonstrated that gorgonians and Scleractinia are effective VME indicators in the study area because they co-occur with many other benthic animals and represent VME characteristics such as functional significance as habitat and structural complexity as well as the fragility and slow recovery from physical damage.

Northwestern Hawaiian Ridge seamounts and the Emperor Seamount Chain – Florida State University *(Baco et al., 2020)*

Imaging surveys from four of these seamounts provide evidence of vulnerable marine ecosystems (VMEs) on all surveyed features including dense patches of octocorals, scleractinian reefs, and sponges. Crinoids and brisingids occurred patchily in high abundance.

These results, records from precious coral fishery takes, and habitat suitability modelling collectively indicate an extremely high probability that deep-sea coral VMEs are widespread on all of the ESC-NHR seamounts. Evidence for significant adverse impacts (SAIs) from bottom contact fisheries was also observed on all surveyed seamounts and included large areas of barren hard substrate, with scars from bottom contact gear in 19–29% of AUV images. Stumps from arborescent corals and rubble from reef-forming corals were observed. Evidence of SAIs is further supplied by many observations of coral rubble associated with lost fishing gear. Finally, coralliid octocorals, once sufficiently abundant on the targeted seamounts to support the world's largest precious coral fishery, were extremely rare on all features despite the large survey area. Based on observations of VMEs, SAIs to these VMEs, and the potential for recovery, the results presented here would indicate a closure of all NHR and ESC seamounts to bottom contact fisheries until it can be demonstrated that the gear being used does not cause SAIs. Closures should include both untrawled areas and currently fished areas to allow for recovery.

b. Relevant research programmes

Department of Fisheries and Oceans (DFO) and National Oceanic and Atmospheric Administration of the United States of America (NOAA) (FAO, 2019)

These organizations have both separate and joint expeditions to study VMEs in Canada. The deepest research shows a high diversity of predominantly non-endemic species, where the majority of benthic communities are typified by large structure-forming cold-water corals and glass sponges, and communities are defined by other species known to be vulnerable (e.g. hydrocorals and sponges), in addition to the presence of the current four NPFC VME indicator taxa.

Other ongoing Canadian research includes long-term variability studies in the oxygen minimum zones in the northeast Pacific, lost fishing gear and cumulative impacts on seamount communities, submarine islands of benthic biodiversity within and adjacent to an offshore transitional area, biogeography and beta-diversity studies for northeast Pacific seamounts within and outside the Canadian EEZ.

c. Surveys at sea

A list of available data, taken through dedicated surveys and from commercial fisheries, that could be used for VME assessments was compiled and presented at the 4th meeting of the Small Scientific Committee on Vulnerable Marine Ecosystems (NPFC-2019-SSC VME04-Final Report). These are summarised in Annex D of the report and include historical and current research. It includes trawl survey, image and acoustic surveys undertaken by Japan, Korea, Canada and the USA in both areas managed by the NPFC.

d. Identify strengths and weaknesses of the scientific research projects/relevant programmes

A fundamental aspect of VME research is the development of a standard field guide for coral identification for all Members to use. There has been an active collaboration among Japan, the Republic of Korea and the United States of America on this task. A standard field guide has also been drafted in all three languages for use by observers and scientists at sea (FAO, 2019).

A large focus on VME research in NPFC has focused on coral species rather than vulnerable fish and invertebrate species (e.g. Miyamoto and Kiyota, 2017; Baco *et al*., 2020).

Both CMM 2019-06 and 2021-05 have identified the need to collect follow up data collection and research to determine whether fished seamounts contain VME taxa. This includes the use of ROV or drop cameras and biological samples collected during research activities or through observer programmes. While this has been recommended it is unclear whether this is being done on a systematic basis.

In addition, there are no detailed mitigation measures that are specific to research activities not related to bottom fisheries outlined in CMM 2021-05 or CMM 2019-06.

e. Experience with data sharing and potential integration of new data in the RFMO advisory cycle and remarkable consequences, if any

No indication of NPFC experience with data sharing and potential integration of new data in the NPFC advisory cycle.

f. Potential adverse impacts of scientific research activities and mitigation measures to be adopted/proposed. Alternative methods

To date, the NPFC has not documented any adverse impacts from scientific research activities. Potential adverse impacts of scientific research activities from deep-sea bottom trawling are direct physical disturbance from the incidental removal of VMEs species (e.g. corals). Indirect impacts from these activities will likely arise from sediment plumes, which may smother VME species within the vicinity of the trawl path. Non-intrusive sampling methods such as seabed mapping are not likely to have adverse impacts on VMEs. VMEs are sensitive to disruptive activities such as bottom trawling, often being fragile and typically have little resistance to survive damage caused by passing fishing gear. Some species are likely to be more vulnerable due to their distribution and depth. VMEs that attract commercially important species are more vulnerable as research activities take place in them. Coral-based VMEs generally have low resilience, are long-lived, have slow maturity rates, and low recruitment rates. Speedy recovery from disturbance for these VMEs is highly unlikely (FAO, 2019).

As outlined above, there are no detailed mitigation measures that are specific to research activities not related to bottom fisheries outlined in CMM 2021-05 or CMM 2019-06. However, to facilitate scientific work associated with the implementation of CMMs, each Member of the Commission should collect data in the Convention Area on (a) physical, chemical, biological, oceanographical, meteorological, etc. factors; (b) ecosystem surveys; (c) seabed mapping (e.g. multibeam or other echosounders), seafloor images by drop camera, remotely operated vehicles (ROV) and/or autonomous underwater vehicles (AUV).

Scientific research activities for stock assessment purposes are to be conducted in accordance with a research plan that has been provided to SC prior to the commencement of such activities.

g. Other issues/recommendations that could be useful for providing options for the development of a framework for scientific research activities (not related to fisheries)

More research needs to be done to enhance current NPFC measures to avoid SAIs on VMEs. Some example research needs are site reconnaissance, habitat parameters, and habitat suitability modelling to determine the extent of VME habitats that cannot yet be surveyed.

References

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NPFC-2019-SSC VME04-Final Report. 4th Meeting of the Small Scientific Committee on Vulnerable Marine Ecosystems. 15-16 April 2019.

SOUTH PACIFIC REGIONAL FISHERIES MANAGEMENT ORGANISATION (SPRFMO)

Partner short name: IEO

a. Relevant scientific research projects

South Pacific Vulnerable Marine Ecosystems Project (2012-2015)

This project (https://marinedata.niwa.co.nz/south-pacific-vulnerable-marine-ecosystems-project/) was funded by New Zealand (period 2012-2015) with the involvement of the National Institute of Water & Atmospheric Research (New Zealand), Victoria University of Wellington (New Zealand) and Marine Conservation Institute (USA).

Various international bodies have called for the development of predictive models and their use in designing effective management of fishing on the high seas. This project aimed to produce such models for VMEs in the South Pacific, in the area adjacent to New Zealand's exclusive economic zone (SPRFMO area), and evaluate their effectiveness for potential management and conservation scenarios to protect VMEs. The project collated all available biological and environmental data for building habitat suitability models at two large spatial scales. The largest South Pacific-scale model was ground-truthed by a survey from RV Tangaroa, and the New Zealand-regional model was subsequently refined. Using information from seafloor images collected on the ground-truth survey[61], a small-scale model using abundance data was used to predict the occurrence and characteristics of VMEs on seamounts of the Louisville Seamount Chain. Archived data and new analyses were also used to reveal the genetic connectivity of populations for a range of VME indicator animals in the New Zealand region. The regional-scale habitat suitability models were used, together with other relevant data, to demonstrate the utility of the decision-support tools for designing spatial management measures that protect high priority conservation areas for VMEs, while still allowing for fishing in areas valuable to the fishing industry. Results from this project can be found in Owen *et al*., (2016a, 2016b), Rowden *et al*., (2017) and Zeng *et al*., (2017)

The ABNJ Deep Seas project (2014-2019) *(FAO, 2020a)*

SPRFMO was an important partner of the *"Sustainable Fisheries Management and Biodiversity Conservation of Deep-Sea Living Resources in Areas beyond National Jurisdiction Project* (ABNJ Deep Seas Project)". SPRFMO was involved in the design of the Project and contributed to activities that promoted collaboration and sharing of experiences in DSF and associated biodiversity as well as specific activities on capacity building for developing countries. This contribution was coordinated by the SPRFMO Secretariat.

This is a five-year project supported by the Global Environment Facility (GEF), and implemented jointly by the Food and Agriculture Organization of the United Nations (FAO), and the United Nations Environment Programme (executed by the World Conservation and Monitoring Centre: UNEP-WCMC). The total budget was USD 87 million, of which USD 7 million was funded by the GEF. The remaining USD 79 million represented the co-financing from the project's 20 main stakeholders. The Project was designed to enhance sustainability in the use of deep-sea living resources and biodiversity conservation in the areas beyond national jurisdiction (ABNJ) through the systematic application of an ecosystem approach. It brought together over 20 partners who worked on deep-sea fisheries and conservation issues in the ABNJ

61 https://niwa.co.nz/news-and-publications/blogs/tangaroa-voyage-blog-surveying-the-louisville-seamount-chain

globally. The Project aimed to: (i) strengthen policy and legal frameworks for sustainable fisheries and biodiversity conservation in the ABNJ deep seas (led by FAO); (ii) reduce adverse impacts on VMEs and enhance conservation and management of components of EBSAs (led by FAO); (iii) improve planning and adaptive management for deep-sea fisheries in the ABNJ (led by FAO); and (iv) develop and test methods for area-based planning (led by UNEP-WCMC).

The fifth and final meeting of the Project Steering Committee (PSC) was held in January 2020. The PSC reviewed the project's progress, terminal evaluation and preparations for a second phase of the Project. The Project closed in December 2019.

Key project outputs from the ABNJ Deep Sea Project (2014-2019) are summarized in FAO (2020a):

Worldwide Review of Bottom Fisheries in the High Seas in 2016 (FAO 2020b)

This is an extended update of the review published by FAO in 2009 (Bensch *et al*., 2009). The new review summarizes the status of high seas bottom fisheries worldwide using 2016 data. It highlights the changes that have occurred in the monitoring and management of the high seas DSF by RFMOs, including the regulation relating to total allowable catches and reducing impacts on both target and bycatch species.

Economic Value of Ecosystem Services from the Deep Seas and the Areas Beyond National Jurisdiction (Ontaviani, 2020)

This study estimates the total economic value (TEV) of services provided the deep sea. 92% of the TEV originates from abiotic resources, 5% from biotic resources, 2% from cultural services, and 1% from carbon sequestration.

Deep Sea meeting (FAO, 2020c)

A Deep Sea meeting on 7-9 May 2019 highlighted project results. Over 40 participants, including representatives from partners and other stakeholders, attended the meeting. Key topics (governance and policy, deep sea science and monitoring, and deep sea management) were presented and discussed (e.g. SPRFMO case study about the existing spatial measures was presented). While significant progress has been made in the management of DSF and VMEs protection, the ABNJ still faces threats from climate change, ocean acidification, biodiversity loss, and pollution.

Global review of Orange roughy their fisheries, biology, and management (Tingley *et al*., 2018)

The Project supported a workshop to collate data and information on orange roughy, including SPRFMO fisheries.

Side events at the Third BBNJ Inter-Governmental Conference

FAO organized two side events at the Third BBNJ Inter-Governmental Conference on 19-30 August 2019 in New York. The first side event focused on the role of RFMOs in the 21st century. The second side event's theme was Science to Policy in Practice -- Multi-Institutional Collaboration in ABNJ.

Updating the FAO VME Portal and DataBase (http://www.fao.org/in-action/vulnerable-marine-ecosystems/en/)

The Portal provides general information on VMEs. The VME Data Base contains information on VME-related measures in ABNJ for each regional fisheries body, including SPRFMO. The Project supports the maintenance and updating of the systems

Regional VME processes and experiences

The report *Vulnerable Marine Ecosystems – processes and practices in the high seas* (FAO, 2016) was published in 2016. It summarizes the regional processes and practices in place for VMEs and their management.

Deep-sea fisheries and VME regional workshops

The ABNJ Deep Sea Project collaborated with several RFMOs (e.g. SIOFA, GFCM, CECAF) to organize VME Workshops (2012-2016):

- Indian Ocean 2012 (http://www.fao.org/3/a-i3311e.pdf),
- Southeast Atlantic 2013 (http://www.fao.org/3/a-i4923e.pdf),
- North Pacific 2014 (http://www.fao.org/3/a-i5319e.pdf),
- Western Central Atlantic 2014 (http://www.fao.org/3/a-i4329e.pdf),
- Mediterranean 2016 (http://www.fao.org/3/a-i6685e.pdf),
- Eastern Central Atlantic 2016 (http://www.fao.org/3/a-i7609b.pdf)

Climate change and deep-sea ecosystems (FAO, 2018)

The ABNJ Deep Sea Project partnered with the Deep-Ocean Stewardship Initiative and its working group of climate change experts to better understand the consequences of climate change for deep sea ecosystems and deep-sea fisheries in different areas including SPRFMO. The project supported scientists and experts from the regional bodies managing deep-sea fisheries to participate in the workshop.

Catch documentation schemes (CDS) for DSF

A report on CDS for DSF has been published by FAO (Hosch, 2018). The report considers options, taking into account the FAO Voluntary Guidelines on CDS. It explores and makes recommendations on the organisational and institutional modalities that could be applied.

Rights-based management (RBM) in deep-sea fisheries (FAO, 2020d)

A workshop on the application of RBM to ABNJ deep-seas fisheries met on 10-12 April 2019. The workshop evaluated the potential contribution of RBM to DSF in ABJN, including SPRFMO area as a case study.

Monitoring, Control, and Surveillance (MCS) for deep-sea fisheries (FAO, 2019)

A workshop on ABNJ deep sea MCS met on 10-12 December 2018 focused on SIOFA and SEAFO (MCS frameworks, identification of gaps and actions to address them).

DEEP-FLIP (Fisheries Law in Practice) training on international instruments relevant to DSF fisheries and associated biodiversity

The project has partnered with legal consultants to develop a step-wise guide for the integration of international legal instruments related to DSF and biodiversity in the ABNJ into national legislation of selected pilot countries. The first DEEP-FLIP training workshop took place on 22-24 October 2018, with participants from selected countries from the SIOFA and SEAFO regions.

Area-based planning

Reviews of institutional arrangements and legal instruments in the Southeast Pacific (Weatherdon *et al*., 2016a) and Western Indian Ocean (Weatherdon *et al*., 2016b) have been completed. Global marine datasets of biodiversity importance to these regions have been identified and published. Area-based planning workshops were held in such areas resulting in capacity development assessments.

Deep-sea sponges in the North Atlantic

FAO is collaborating with the Horizon 2020 SponGES project (http://www.deepseasponges.org), which aims to develop an integrated ecosystem-based approach to preserve and sustainably use deep-sea sponge ecosystems of the North Atlantic. The ABNJ Deep Sea Project is assisting the SponGES Project by identifying the types of information needed to improve understanding of the economic elements of the sponge resources in this region.

The ABNJ Deep Sea Fisheries (DSF) project (2022-2027) *(*SPRFMO, 2020)

The second phase of the ABNJ Deep Sea Fisheries Project will support the implementation of an ecosystem approach to fisheries, with a focus on data-poor stocks, significant adverse impacts on VMEs, and deepwater sharks. SPRFMO's expertise in these matters will make a strong contribution to the DSF Project. Expertise from other regions will also be brought to SPRFMO, allowing for the global development of these areas of concern. The DSF Project will also contribute to an understanding of the application of international instruments by RFMOs and fishing nations, including the implications of the Biodiversity Beyond National Jurisdiction (BBNJ) negotiations, to position the fisheries sector as key players in ocean governance.

The goal of the DSF Project's partnership strategy is to bring together skills, expertise and resources from a diversity of stakeholders to achieve the DSF Project's objective. SPRFMO, with its history of managing fishery resources in the South Pacific, is a key DSF Project partner (FAO, 2020a). The DSF Project will identify how SPRFMO's ongoing and planned activities could support the Project's objectives. The DSF Project will consult with SPRFMO to establish if SPRFMO is willing to commit these activities as in-kind contributions to the DSF Project. In 2020, the SPRFMO SC requested that the SPRFMO Secretariat assists and coordinates activities relevant to supporting the work of the SC during the planning phase of the DSF Project.

Potential project on Automatic Identification System (AIS) data

In October 2020, FAO and Global Fishing Watch (GFW) presented to the SPRFMO SC their interest in developing a collaborative project between SPRFMO, FAO, and GFW on the use of AIS data to improve the monitoring of high seas fisheries (FAO-GFW, 2020). The SC noted that this seemed a worthwhile initiative and important in relation to the development of SPRFMO management measures. FAO will lead the project and will contribute scientific capacities (data analysis or interpreting results). If it progresses the project will be based on in-kind resources from FAO, GFW and SPRFMO for the supervision and the provision of data, complemented with the computing infrastructure and the financial resources of the EU H2020 Blue Cloud project to support specific consultancy needs.

The project was presented by FAO-GFW (2021) during the 9th Annual Meeting of the SPRFMO Commission (SPRFMO, 2021) but there was no consensus about the development of this research and FAO was invited to take note of the interventions, questions and concerns raised during the meeting, and reconsider at a future stage.

b. Relevant research programmes

Comisión Permanente del Pacífico Sur (CPPS)

The Comisión Permanente del Pacífico Sur (CPPS) is the Executive Secretary of the 1981 Lima Agreement and of the Action Plan for the protection of the marine environment and the coastal areas of the Southeast Pacific. Its main activities include scientific studies related to the "Niño" in order to timely forecast and alert the climatic risks associated with this event. This activity is developed through research cruises, coordinated by the CPPS, constituting a joint action, unique at the international level. In 2019, SPRFMO signed a Memorandum of Understanding (MoU) with the CPPS, with the objective to establish a consultation and cooperation framework on matters of mutual interest (e.g. scientific data, monitoring, VMEs, etc.). Since 1952, the CPPS (http://www.cpps-int.org) is the maritime organization that coordinates regional maritime policies in order to adopt concerted positions of its Member States (Chile, Colombia, Ecuador and Peru) in international negotiations, development of the Law of the Sea, International Environmental Law and other multilateral initiatives. CPPS is engaged in a capacity-building process at the national and regional levels in the areas of science, socio-economic policy and the environment. CPPS's strategic objectives include strengthening science-based policy-making, and contributing to an informed society with social and environmental responsibility. The area of competence of CPPS extends to the territorial seas and EEZs of member countries, including their islands in the Pacific, covering all living resources within its area of competence (http://www.fao.org/fishery/rfb/cpps/en). The Secretariat of the CPPS collaborates with the STRONG High Seas project (https://www.prog-ocean.org/our-work/strong-high-seas/), a five-year project that aims to strengthen regional ocean governance for the conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction (BBNJ). The project aims to develop and propose targeted measures to support the coordinated development of integrated and ecosystem-based management approaches for ocean governance in the Southeast Pacific. A series of five Dialogue Workshops has been organised under the STRONG High Seas project in the Southeast Pacific region. The workshop series aims to bring together stakeholders to discuss current challenges as well as opportunities for global and regional ocean governance, foster the exchange of knowledge and information, and build new networks. These Dialogue Workshops apply an interactive approach to enable information exchange between participants and explore various topics relevant to the conservation and sustainable use of BBNJ. All workshops and events under the project are planned in close consultation with the CPPS Secretariat, its member States and other stakeholders in order to identify topics of relevance, need and interest for the Southeast Pacific region as well as adequate methodological approaches.

The SPRFMO research programme

The development of a research programme within a Regional Fisheries Management Organization (RFMO) is essential to facilitate collaboration and coordination within and between different organizations and contracting parties. These programmes should prioritise research in line with clearly defined objectives and should have a short, medium and long term scope. The SPRFMO research programme was delineated in 2013 (See annex 6 of 2013 Scientific Committee meeting in https://www.sprfmo.int/assets/Meetings/Meetings-2013-plus/SC-Meetings/1st-SC-Meeting-2013/Report/SC-01-2013-Report-amended-16-Dec-13-a.pdf). According to the programme, research should incorporate, as much as possible, the different components of the exploited resources and their associated ecosystems, and encompass both the Precautionary Approach and the Ecosystems Approach to Fisheries Management. Five main components are proposed:

1. Environmental variability at different temporal and spatial scales. The South Pacific is impacted by environmental variability from seasonal to secular scales, including El Niño - La Niña oscillations and the Pacific Decadal Oscillation (PDO) among other variables. The following research topics were identified: (i) determination of different environmental scenarios, (ii) identify patterns of seasonal, inter-annual variation in environmental conditions and (iii) investigate their effects on fisheries resources.

2. Chilean Jack mackerel. The main research areas are as follows: (i) Biology and Ecology, (ii) stock structure, (iii) stock assessment and (iv) conservation, rebuilding plan and management procedures. These components are interdependent and should be linked as progress is made. Acoustic and egg surveys should be routinely undertaken to provide data for the stock assessment.

3. The Deepwater Research Programme. The level of deepwater fishing activity in the SPRFMO Area is currently low. However, fishing effort levels have the potential to increase; and relatively low levels of demersal fishing effort can have rapid and long-lasting impacts on VMEs and the sustainability of DSF resources. This part of the programme is focused on (i) Biology and (ii) assessment of target species, as well as (iii) identification and mapping of VMEs.

Minimum biomass estimates might be derived from acoustic surveys. Moreover, multibeam acoustics and acoustic optical systems (AOS) enable the resolution of mixed species targets according to their backscatter.

4. The Squid Research Programme. There are three species of squid that have been identified as of interest within the SPRFMO Area: jumbo flying squid (*Dosidicus gigas*), purple-back flying squid (*Sthenoteuthis oualaniensis*) and neon flying squid (*Ommastrephes bartrami*). The key areas of research required for squid are to do with improving understanding of the biology of the different species, including growth, mortality, migrations, stock structure and population dynamics. That these are very short-lived species requires a somewhat different approach to both science and fisheries management.

The need for stock assessment surveys, both swept area bottom trawl and acoustic surveys have been considered as a key area of science (collection of fisheries independent data).

5. Ecosystems Approach to Fisheries Management. The Ecosystem Approach to Fisheries Management (Garcia *et al*., 2003) should consider the interaction between the fishing activity and the marine ecosystem. Fisheries are surrounded by and are part of the environment and should not be managed in isolation. Impacts on species associated with certain fisheries should be considered but also on other species occurring in the ecosystem such as seabirds, marine reptiles and marine mammals that might be accidentally caught or experience direct or indirect competition for resources. For this reason, research should be focused on the assessments of the impact of fishing on non-target, associated or dependent species. In this context, data collected by observer programmes are essential.

c. Surveys at sea

The research activities conducted by SPRFMO Members and Cooperating non-Contracting Parties are summarized in their corresponding "Annual Reports". Such reports are submitted to the SC on an annual basis in order to keep the SC informed, in a concise format[62] of their fishing, research and management activities over the previous year. A "nil report" is still required in cases where there was no fishing inside the Convention Area.

[62] https://www.sprfmo.int/assets/Fisheries/Science/SPRFMO-SC-Guidelines-for-Annual-Reports-2019.pdf

The reports (see https://www.sprfmo.int/meetings/scientific-committee/) contain a brief description of the fisheries data collection systems implemented, and the research and assessment activities conducted, including: (i) Description of the statistical data collection systems in use, and how these have changed or been improved over the past year; (ii) Description of surveys conducted, scientific analyses and stock assessments undertaken, or other relevant research activities conducted; (iii) Description and coverage levels for fisheries sampling programmes (e.g. self-sampling or conducted in port), and how these have changed or been improved over the past year; (iv) Information on other SPRFMO-related research activities over the past year.

In 2019, the habitat monitoring working group (HMWG) agreed to develop an inventory of research programmes currently being developed by industry and scientific institutions regarding data collection and monitoring of marine habitats (SPRFMO, 2019). The lack of a public SPRFMO database on research cruises makes it difficult to summarize an inventory of such activities. According to the information provided by the "Annual Reports", during the period 2013-2020 a variety of surveys at the sea were conducted:

Type of surveys	2013	2014	2015	2016	2017	2018	2019	2020
Biological condition (Jack mackerel)				Chile				
Aerial/ground count (seabirds)								New Zealand
Photographic/multibeam/coral sample (seamounts)		New Zealand						
Hidroacoustic assessment (Jack mackerel)	Chile, Peru	Chile, Peru	Chile	Chile	Chile	Chile	Chile	Chile
Combined trawl/acoustic (orange roughy)	New Zealand					New Zealand		
Eggs/larvae (jack mackerel)						Chile		
Scientific research (squid)			Peru		Peru			

d. Identify strengths and weaknesses of the scientific research projects/relevant programmes

Main strengths have been identified:

- SPRFMO is taking advantage of the opportunities to engage in collaborative research or data sharing with other organisations. In this regard, SPRFMO, in collaboration with FAO and other international partners, is involved in research programmes such as the ABNJ Deep Seas project (completed) and the ABNJ Deep Sea Fisheries project (planned).
- Since 2014, SPRFMO has signed different Memoranda of Understanding (MoU) or Agreements[63] with adjacent RFMOs and other organisations. These initiatives provide opportunities to promote and facilitate cooperation,

[63] 2020: MoU with the US National Oceanic and Atmospheric Administration (NOAA); MoU with the Western and Central Pacific Fisheries Commission (WCPFC).
2019: MoU with Comisión Permanente del Pacífico Sur (CPPS); Extension of the 2016 Arrangement with the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR); MoU with Network for the Exchange of Information and Shared Experiences Between Latin American and Caribbean Countries to prevent, deter, and eliminate IUU fishing.
2016: Arrangement with CCAMLR.
2014: MoU with the Secretariat for the Agreement on the Conservation of Albatrosses and Petrels (ACAP).

including collaborative research and capacity building, as well as sharing of experiences and data on matters of mutual interest.

- The SPRFMO research programme, delineated in 2013, considers the incorporation of different components of the exploited resources and their associated ecosystems, and encompasses both the Precautionary Approach and the Ecosystems Approach to Fisheries Management.
- Research priorities are set out in the SPRFMO SC work plan (SPRFMO, 2018), and this provides a level of coordination for research that strengthens support for SPRFMO goals.

Nevertheless, some weaknesses have been noted by the SPRFMO Performance Review Panel (Ridings *et al.,* 2018):

- Research and associated activities to support the scientific work of SPRFMO are primarily funded and conducted by Members and consequently, SPRFMO is dependent on those Members to report on these activities to SPRFMO (the Review Panel noted that a dedicated science programme funded and owned by SPRFMO would facilitate a more integrated and consistent approach).
- Fishing research activities in the SPRFMO Convention Area are undertaken on an ad hoc basis and, at present, there is no mechanism for notifying non-fishing research and for approval of fishing research.
- SPRFMO does not have a standardised database for Members to submit catch, effort and associated biological data from research cruises, or other scientific research activities (sharing of research data is therefore undertaken on an ad hoc basis and through SC's Working Groups).

Moreover, the SPRFMO SC noted the current lack of a mechanism to provide for research activities in the SPRFMO Convention Area. This represents a weakness in terms of sustainability, risks and opportunities for the fishery resources and impacts on resources and ecosystems. For this reason, the SC recommended that the Commission adopt conservation and management measures to address this issue (see section g.)

e. Experience with data sharing and potential integration of new data in the RFMO advisory cycle, and remarkable consequences, if any

Research activities conducted by SPRFMO Members are routinely reported to the SPRFMO SC (see section c). Results of acoustic surveys are used to support stock assessment efforts (e.g. orange roughy on the Challenger plateau, See FAO, 2016). Moreover, results from international research projects such as the South Pacific Vulnerable Marine Ecosystems project (2012-2015) and the ABNJ Deep-Sea project (2014-19) were shared with the SPRFMO for scientific advice purposes. Particularly, results from the benthic survey conducted by New Zealand on the central Louisville Ridge in 2014[64], assisted in the mapping of VMEs and the validation and improvement of initial predictive modelling results (FAO, 2016). On the other hand, SPRFMO was a key partner of the ABNJ Deep-Sea project and made valuable contributions to help meet the project's objectives (FAO, 2020a).

In February 2020, the SPRFMO's ongoing work related to the conservation and sustainable use of BBNJ was presented at the III Dialogue Workshop held in Lima, Perú. This initiative for the Southeast Pacific region was organized under the STRONG High Seas project in collaboration with CPPS (see section b).

f. Potential adverse impacts of scientific research activities and mitigation measures to be adopted/proposed. Alternative methods

[64] http://fs.fish.govt.nz/Page.aspx?pk=113&dk=23779

Currently, the issue of the potential impacts of research activities in the SPRFMO Area is a matter of concern and discussion to the SC (SPRFMO, 2018, 2019). The SC agreed to define low-impact research as a research meeting in either of two scenarios: (a) where there is not expected to be any additional impact on SPRFMO target species or the wider ecosystem, noting that 'additional impact' will need to be clearly defined, or (b) where the research will be carried out during normal fishing operations and all catch will be accounted for within current impact assessments and catch limits. SC suggested that criteria to define 'additional impact', should consider (a) a maximum catch of species for which there is a SPRFMO catch limit, (b) a limit on the amount of bottom contact, (c) a limit on total fish catch in the research, and (d) impact on the ecosystem in the course of a year.

Moreover, there is a discussion about the definitions of 'scientific research' and the various categories of 'fishing for fisheries resources for scientific purposes', in relation to whether or not the research activities involve catches of fishery resources of commercial value, whether it exceeds or not catch limits/national allocations, and if it complies with all relevant SPRFMO management measures.

g. Other issues/recommendations that could be useful for providing options for the development of a framework for scientific research activities (not related to fisheries)

In 2018, New Zealand presented to the SC (SPRFMO, 2018), a proposal for the development of a draft conservation and management measure (CMM) to enable research in the SPRFMO Convention Area, including proposed principles to guide research, criteria for defining types of research, and reporting and/or approval requirements for each type of research. The SC noted the current lack of a mechanism to provide for research activities in the SPRFMO Convention Area and recommended that the Commission adopt a CMM to provide such mechanism, considering several key principles (sustainability, types of research in terms of risks and opportunities for the fishery resources, impacts on resources and ecosystems, and catch of fishery resources). The SC agreed to define two categories of research (low-impact research and fishing research) and recommended that research that is expected to have 'additional' impact on target species or the wider ecosystem be assessed by the SC against the key principles, and the Commission consider each proposal based on advice from the SC, noting that 'additional impact' will need to be clearly defined. In the case of low-impact research, it should be notified to the Secretariat in advance (i.e. information on the planned activities). The SC also agreed that New Zealand will work intersessionally with other members to provide advice on a definition of 'additional impact' to inform the development of a future draft CMM.

In 2019, New Zealand presented an update on the intersessional progress towards the development of a CMM to promote scientific research in the SPRFMO Convention Area, including a proposal to establish procedures for the conduct of fishing for fishery resources for scientific purposes (SPRFMO, 2019). Some hypothetical examples were provided to illustrate a possible application of the proposed framework. In the light of the intersessional progress, the SC noted that: i) there is a large amount of scientific research occurring across fisheries in the SPRFMO Convention Area, and any CMM aiming to promote scientific research and manage fishing for fishery resources for scientific research purposes should not prevent or hinder research; ii) agreed that there may be situations regarding scientific research and the conduct of fishing for fishery resources for scientific purposes that may benefit from a specific CMM setting out a framework for such activity, and iii) agreed that a review of approaches and relevant definitions used by other RFMO/As should be considered by the SC at its annual meeting in 2020.

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SOUTHERN INDIAN OCEAN FISHERIES AGREEMENT (SIOFA)

Partner short name: IEO

a. Relevant scientific research projects

FAO ABNJ Deep Seas Project

The Southern Indian Ocean Fisheries Agreement (SIOFA) was signed in 2006 and until its entrance into force in 2012, it has been under the umbrella of FAO.

In the first SC meeting, FAO offered to provide assistance to SIOFA through the ABNJ Project that may assist or inform the Scientific Committee on several items such as VMEs. This project includes elements on deepwater sharks, such as the development and dissemination of identification guides (FAO, 2016).

In SC-2 (SIOFA, 2017) the SC requested the Executive Secretary engage with FAO ABNJ Project on:

- The planned mapping work, to accelerate the availability of these maps to the SC,
- The planned assessment of the likely impact of gear types, and
- Possible support for the ERA work.

The ABNJ Deep Seas Project (Sustainable fisheries management and biodiversity conservation of deep-sea living marine resources and ecosystems in areas beyond national jurisdiction), in association with other projects of the FAO Deep-seafisheries Programme, has produced a range of publications including technical papers on the biology and assessment of alfonsino (www.fao.org/3/a-i5336e.pdf), a report on VME – processes and practices (http://www.fao.org/3/a-i5952e.pdf), or an introduction to marine datasets of biodiversity importance in the Western Indian Ocean (http://wcmc.io/WIOdata).

In January 2017, the Project supported a workshop to review the methodological approach and uncertainties associated with the use of acoustics data in the assessment of orange roughy in the Southern Indian Ocean. Other project activities relevant to SIOFA include: training for countries on international obligations related to deep-sea fisheries and biodiversity conservation in the ABNJ; a review of traceability in deep sea fisheries; a review of rights-based management; and an examination of monitoring control and surveillance practices (including capacity development opportunities for SIOFA countries). The project also worked with the Cook Islands to trial the use of cameras on its deep sea fishing vessels operating in the SIOFA Area to collect information on VMEs.

Another support from the FAO ABNJ Deep Seas Project has been an observers training programme, as the one held in 2017 at the Sealord port facility in Nelson.

The second ABNJ Common Oceans programme follows on from the first Common Oceans Programme (2014-2019). It will operate through the Global Environment Facility (GEF) GEF-7 mechanism receiving funding from their International Waters priority area (SIOFA, 2020). The Concept Notes for the Common Oceans programme and five projects were approved by GEF Council in June 2020. The projects are:

- Sustainable management of tuna fisheries and biodiversity conservation in the areas beyond national jurisdiction
- Deep-sea Fisheries under the Ecosystem Approach (DSF project)
- Building and Enhancing Sectoral and Cross-Sectoral Capacity to Support Sustainable Resource Use and Biodiversity Conservation in Marine Areas Beyond National Jurisdiction

- Strengthening the stewardship of an economically and biologically significant high seas area – the Sargasso Sea
- Global Coordination Project for the Common Oceans ABNJ Program (GCP Project)

The programme and project are currently being developed with an anticipated submission date to GEF of July 2021 and a start date planned for January 2022 (FAO, 2020). Some aspects of the project of particular relevance to SIOFA include data collection; data-limited stocks, such as alfonsino; deepwater sharks; bottom fishing measures and VMEs; collaboration and coordination across RFMOs, industry, other stakeholders, and BBNJ negotiations; and an ecosystem approach including economic and human pillars.

The IUCN Seamounts Project

The Atlantis bank is being studied as part of the IUCN (2013) Seamounts Project: An Ecosystem Approach to Management of Seamounts in the Southern Indian Ocean (SIOFA, 2019).

EU grant for supporting the scientific work of SIOFA

In the SC-6 has been outlined the EU grant for supporting the scientific work of SIOFA on key stocks, ecosystems and data (EU, 2021). Each project is a 'stand-alone' activity that does not impact on other projects. However, each project will be cross-linked and integrated with other ongoing projects and the work of the SC and its WGs.

b. Relevant research programmes

The FAO Deep Seas fisheries Programme, where the ABNJ Deep Seas Project, in association with the other projects of the programme is crucial for the SIOFA scientific work.

The Nansen Programme has been active for more than four decades. It undertook surveys of fish resources and ecosystems, facilitating capacity development through training, and supporting fisheries management and policy implementation.

The Benthic Protected Area (BPA) program of the Southern Indian Ocean Deepwater Fisheries Association (SIODFA) was organised in association with the International Union for Conservation of Nature (IUCN) and the Cook Islands (SIOFA, 2015). It has been published as FAO Technical Report 1020 (FAO,2016) and the declarations of the BPAs were announced to the signatories of SIOFA by Cook Islands at the opening of the Agreement in Rome 2006.

c. Surveys at sea

The SC-1 (SIOFA, 2016) states that a number of habitat impact surveys have been carried out by Australia and New Zealand in the South Pacific region since 2006.

Cook Islands has a number of acoustic surveys on orange roughy and alfonsino in SIOFA (Cook Islands, 2016a). The recent progress in acoustic surveys for deepwater species on the high seas using commercial vessels was noted, with FAO convened an experts workshop to advise on ways forward.

A survey to evaluate the efficacy of preliminary habitat suitability model Vulnerable Marine Ecosystems of the Louisville Seamount Chain was made in 2016 (Cook Islands, 2016b).

In 2008 a survey covered the Mascarene Plateau with the RV Dr *Fritdjon Nansen* (Nansen, 2009)

In late 2009, the RV *Dr Fritdjon Nansen* carried out a 6-week multidisciplinary survey of six seamounts in the Southwest Indian Ocean. The sampling stations included an Off ridge station, Atlantis Bank, Samper Seamount, Middle of What Seamount, an Off ridge cold water station, Coral Seamount, Melville Bank and an unnamed Seamount at Walters Shoal. The aims of this survey were to document both physical and biological features and to obtain pelagic samples from the seamounts.

In the SC-3 (SIOFA, 2018a), the Executive Secretary gave an update on the EAF-Nansen program, reporting that the RV *Dr Fridtjof Nansen* is currently undertaking scientific surveys in the southern Indian Ocean focusing on fisheries impacts, oil and gas pollution impacts and climate change impacts.

From the 4th May to 4th June 2018 a bottom habitat survey under the EAF-Nansen Programme took place on the Saya de Malha bank with the aim of helping to assess habitat and VMEs in this area. Seychelles and Mauritius were involved in this survey.

In the SC-4 (SIOFA, 2019) is noted that there have been extensive tectonic studies since the 1950s, including as a drilling site within the Ocean Drilling Programme, with several marine expeditions in the Atlantis Bank. Large populations of lobsters, crabs, sharks, sea fans, siphonophores, orange roughy and big-eye dory have been reported from surveys (Rogers & Taylor 2012).

The Middle of What (MOW) area was surveyed by the R.V. James Cook during November - December 2011 and by RV *Dr Fridtjof Nansen* in 2009.

There is a long history of scientific research associated with the WaltersShoal feature. More recently, the IUCN undertook a research voyage in 2016 on the shallows of the Madagascar Ridge MAD-Ridge 2016 Expedition, South-West Indian Ocean to analyse the hydrodynamics, hydrology and trophic levels (first and intermediate), and in April–May 2017 undertook a 26 day research trip to Walters Shoal to obtain information on the benthic component and "water column", and the pelagic and avian fauna (Payne, R, 2015).

On the other hand, the Indian Ocean Observing System (IndOOS) comprises five *in situ* observing networks: RAMA, profiling floats (Argo program), surface drifters (Global Drifter Program, GDP), repeat temperature lines (XBT network), and tide gauges. Augmenting these networks are remotely sensed observations of surface winds, sea level, SST and salinity, rainfall, and ocean color, as well as a coarse network of decadal hydrographic survey lines (The Global Ocean Ship-Based Hydrographic Investigations Program, GO-SHIP).

d. Identify strengths and weaknesses of the scientific research projects/relevant programmes

SIOFA is a relatively new RFMO when compared with other existing RFMOs. Although much progress has been made in their scientific management, a number of issues remain to be addressed.

Results of the projects outlined above are noteworthy. For instance, the FAO ABNJ Deep Seas Project is providing assistance to the VME database, best practices for VMEs, work on sponges, ecosystem approaches, the potential for facilitating fisheries sector representation in international fora, as well as a prospective work on the electronic monitoring system with the Cook Islands.

Most of the SIOFA scientific activity is carried out by external consultants that are financed by the SIOFA budget, with the support from members/operators or through projects such as the ABNJ Deep Seas Project from FAO. To promote greater involvement of the scientists from the parties to provide more robust and transparent advice to the Meeting of the Parties would be recommended instead of delegating scientific work to external consultants. Projects or grants could finance thematic workshops, training courses etc.

There is a limited amount of information available on indicator species in the SIOFA Area. The objectives of most research surveys in the SIOFA CA have been focused either on the study of oceanographic variables and the pelagic ecosystem or within the coastal ZEEs that are not part of SIOFA CA. There is a need to collect more data from the benthic ecosystem, including via the use of photographic/video surveys. Multidisciplinary research surveys designed to develop SIOFA definition of VME indicator species and to assess the impact of fishing gears on the seafloor would be of great interest and could serve to analyse different encounter thresholds for VMEs and taxonomic studies within the SIOFA CA. Results from these surveys could help to develop a VME habitat mapping and to progress with the benthic bioregionalization.

Acoustic surveys devoted to the abundance population estimates for orange roughy/Alfonsino would be of great interest. There is information available from commercial surveys but independent surveys would enhance this research.

The lack of detailed data in most of the fisheries makes difficult to have an integrated stock assessment for most of the commercial species. Although the progress in the last years has been significant, work remains. To fund these research activities and to promote the data acquisition would be advisable.

Marine mammal depredation on fish catch had been identified as a major concern in the SC4 report, and by many CCAMLR CCPs. Research and commercial surveys could be used as platforms to collect data on sightings and potential catch depredation.

e. Experience with data sharing and potential integration of new data in the RFMO advisory cycle, and remarkable consequences, if any

There is a Memorandum of Understanding for data sharing for transboundary fish stocks, such as toothfish, between CCAMLR and SIOFA (SIOFA, 2018b). The EU has also suggested the organisation of a joint WG between these two organisations to focus specifically on the management of toothfish.

Several SIOFA CMMs have been transposed or inspired from the CCAMLR or SPRFMO such as the VMEs encounter protocol. Also, the benthic taxa identification guide is the one used in CCAMLR.

At the 2019 meeting, the Agreement for the Conservation of Albatrosses and Petrels (ACAP) Parties noted with concern that despite all the research and attention devoted to the development of best practices concerning the seabird bycatch mitigation measures, these have not been sufficiently implemented to halt the decline of many albatross and petrel populations. This included a lack of compliance with measures required by regulatory bodies. The recently adopted MoU between SIOFA and ACAP (2018-2024) provides a useful mechanism to facilitate a cooperative approach to minimise the incidental bycatch of albatrosses and petrels that occur within SIOFA's Convention Area.

There is also suggested a collaboration between the Southwest Indian Ocean Fisheries Commission (SWIOFC) and SIOFA. The potential areas for collaboration are provided: a) Research on Saya de Malha bank fisheries; b) Fight against IUU; and c) Promotion of SIOFA’s CMM among SWIOFC Member Countries.

There is a willingness of sharing data and management protocols between different organizations but they would still need to be enforced.

f. Potential adverse impacts of scientific research activities and mitigation measures to be adopted/proposed. Alternative methods

A continental shelf extending beyond the EEZ in the Indian Ocean for some countries such as India has caused them to claim jurisprudence beyond 200 miles in the UN. The quest for resources continues to interest mankind and ocean minerals are no longer an exception. The potential impact of these activities on the ecosystem should be assessed.

There is information about Chinese research vessels working for the last few years over the Ninety degree east Ridge, an underwater mountain range with cuts across the Indian Ocean. Their disciplined racetrack patterns are indicative of mapping the seabed. Potential effects on Marine Mammals that likely not cause direct damage to whales but could still cause harm by triggering behavioural changes should be evaluated.

The use of no intrusive gears by research vessels shall be recommended when studying potential VMEs, such as ROVs instead of rock dredges or bottom trawls.

g. Other issues/recommendations that could be useful for providing options for the development of a framework for scientific research activities (not related to fisheries)

RFMOs management work should be based on transparency. The data reported by members should be at a level that allows their use to ensure that the advice is of the highest quality.

The data sharing between members and other RFMOs used to be regulated by MoUs taking care of the confidentiality. Marine resources have no RFMOs boundaries, and so neither should advice. Collaboration between organisms should be equitable.

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COMMISSION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES (CCAMLR)

Partner short name: MRAG EU

a. Relevant scientific research projects

Currently, there are no scientific research projects supported or coordinated by CCAMLR which are specifically focused on DSFs management or VME conservation. However, under CM 22-06, paragraph 14, if any VME is encountered during the course of scientific bottom fishing research activities, the location and type of VME must be reported to the Secretariat, consistent with existing reporting requirements in CM 24-02, paragraph 4.

A workshop on VMEs was held in 2010 (e-sc-vvviii-a10) to discuss methods that could be used by individual members when conducting research surveys to indicate potential VME areas. It discussed VME notifications from fisheries-independent research and noted that there are many different forms of evidence that can be used to indicate the presence of a VME. These include, inter alia, photographic images, acoustics and catches from research sampling gear. The workshop went on to recommend that the rationale and as much supporting information as possible should be provided when a VME notification is submitted through this research.

Individual members will propose surveys, either themselves or in collaboration, which are reviewed at the various working groups and endorsed by the Commission. These are funded by the Member States themselves. To date, the majority of VMEs have been notified through research surveys, most notably the USA in Subareas 48.1 and 48.2 and Australia in Division 58.4.1. These were VME's encountered using *in-situ* photography (still and video) as well as benthic bottom trawls, although these are relatively shallow, the deepest being 695m. This puts them mostly out of the range of CCAMLR bottom fisheries which don't allow fishing shallower than 550m in exploratory fisheries. Research surveys have also been undertaken by the Italians around the Terra Nova Bay (Subarea 88.1), identifying a number of VME areas through dredging, although these were again in shallow water (42m). These are evaluated at WG-EMM (Working Group Ecosystem, Monitoring and Management) and endorsed through the Scientific Committee (WG-EMM-09/32, WG-EMM-09/08, WG-EMM-12/51, WG-EMM-18/35, WG-EMM-18/36, WG-EMM-12/23, SC-CAMLR-XXXVII).

Research has also been undertaken with regards to designating MPAs within the CCAMLR region. While the designation of these MPAs has fallen behind schedule there has been a great deal of research put into developing evidence of the ecological benefits of ensuring these areas are protected in some form. Much of this is based around protecting the benthic environment. To date, there are two MPAs designated, one in the South Orkney Islands (in 2009) proposed by the UK, and one in the Ross Sea (established in 2017) by the USA and New Zealand (RSRMPA). While the aims of the South Orkney MPA are not specific in the CM (91-03) it does ban all fishing in the designated area and only allows scientific research activities including ROV work which has identified the VMEs outlined above. The Ross Sea MPA has more specific objectives, as required under CM 91-04 and highlights as one of them 'to protect known rare or vulnerable benthic habitats', the research done in support of this was outlined in SC-CAMLR-XXXIII/BG/23 Rev. 1. Continued research is undertaken by the USA in collaboration with other Member States and funded through the United States Government, which includes research into benthic representativeness, and benthic habitats in selected areas, SC-CAMLR-39/BG/17. Research is also undertaken by New Zealand and Italy, summarized in SC-38- BG/25 Rev.1. Other proposals are also underway for establishing other MPAs, including an East Antarctic MPA proposed by the EU, its Member States, Uruguay and Norway.

b. Relevant research programmes

The regional seas convention related to this geographical area is the Conservation of Antarctic Marine Living Resources (CCAMLR). As part of the Scientific Committee, there are various Working Groups established to review scientific programmes undertaken in the Convention Area. However, none of these have been dedicated to DSFs management and/or VME conservation, with the exception of the programme to set up a series of MPAs (see "section a" above).

Much of the data on benthic organisms, including VMEs, is managed through SCAR (Scientific Committee on Antarctic Research) and data on it can be accessed at www.marinespecies.org/rams, although a login is required for some areas.

c. Surveys at sea

Summaries of the notifications for all scientific surveys should be submitted to the Secretariat for review by the relevant Scientific Committee and approval by the Commission. Reports on surveys relevant to benthic research and VMEs are WG-EMM. The latest EMM took place in 2019 (e-sc-38-a5), 2020 was postponed, during which a number of surveys were reviewed and documents related to benthic research were reviewed.

WG-EMM-2019/48 Norwegian Cruise to Kong Håkons VII Hav. Part of a multi-year cruise including mapping using ROVs and core sample collection in a relatively data poor area.

WG-EMM-2019/05. Gave links to data layers collected as part of the research conducted in support of the Weddle Sea MPA, which are part of a data repository (PANGAEA) set up by the Alfred Weneger Institute (AWI). Under advice from CCAMLR, these data are publicly available and include a layer on zoobenthos (https://doi.pangaea.de/10.1594/PANGAEA.899645).

WG-EMM 2019/50 Describes how a baited remote underwater camera (BRUV) can be used for benthos coverage, as well as toothfish abundance. This is part of a regular survey being undertaken by Italy in support of the RSRMPA (SC-38- BG/25 Rev.1).

WG-FSA-2019/24 Outlines a study of how cameras and sensors attached to longlines can monitor the behaviour of the longline and its impact on the benthic environment. This research was done as part of the commercial fishing operations in Subarea 48.3.

Other fish and invertebrate surveys are summarized below.

Survey	**Participant(s)**	**Area, Subarea or Division**
Trawl survey for *Dissostichus eleginoides* and *Champsocephalus gunnari*	Australia	58.5.2
Longline toothfish survey	Ukraine	48.1
Groundfish trawl survey	UK	48.3
Longline *Dissostichus mawsoni* survey	Japan, South Africa and Spain	48.6
Longline toothfish survey	UK	48.2 and 48.6
Longline potting vessel for craboids (Anumora, Decapoda)	Russia	88.2 and 88.3

Survey	Participant(s)	Area, Subarea or Division
Longline research survey on *Dissostichus mawsoni,* includes work on VME mapping through use of Benthic Video Cameras (BVC)	Australia, France, Japan, Republic of Korea and Spain	East Antarctica (58.4.1 and 58.4.2)
Longline *Dissostichus eleginoides* survey, including analysis of bycatch.	France	58.4.4b
Krill synoptic survey (to date only two have been undertaken in 2000 and 2019)	Norway, Chile, China, Korea.	48

Finally, CCAMLR established a Marine Debris programme in 1989 (https://www.ccamlr.org/en/science/marine-debris) and developed a set of forms for sightings at sea and beach surveys. Surveys of marine debris are regularly conducted on the Antarctic Peninsula and on a number of Sub-Antarctic islands.

d. Identify strengths and weaknesses of the scientific research projects/relevant programmes

A major strength of the CCAMLR programmes is that collaborative research is encouraged and many of the research proposals submitted are joint proposals from a number of Members. The recent krill synoptic survey for example required a large amount of cooperation between members and scientists to coordinate a survey between several vessels over a large area, including collecting, standardising and analysing the data at the end.

However, the main weakness that has been identified is due to the large number of different research programmes being undertaken by the different Member States. These take place in a variety of areas within CCAMLR and there has been some concern over the standardisation of gear and vessels and how this may affect any conclusions that can be drawn from research data (WG-FSA-2018 report).

e. Experience with data sharing and potential integration of new data in the RFMO advisory cycle and remarkable consequences, if any

Rules for access to CCAMLR data can be found here https://www.ccamlr.org/en/system/files/e-pt11_2.pdf and state that:

- work specifically outlined and endorsed by the Commission or Scientific Committee;
- work not specifically endorsed by the Commission or the Scientific Committee.

If data are requested then the owners of the data have the right to be consulted and approve the use of their data in any documents. Requests are normally made formally to the Secretariat through the requesting Member's Scientific Committee representative outlining what the data will be used for.

However, this is more related to commercial data and reports from the surveys conducted are presented to the various Working Groups and available on the CCAMLR website. A login is required or reports can be requested from the Secretariat. The date from research in the Weddle Sea has been made publicly available by AWI (https://doi.pangaea.de/10.1594/PANGAEA.899645). VME data, from both research and commercial fishing, is publicly available and can be downloaded from the CCAMLR website (https://www.ccamlr.org/en/document/data/ccamlr-vme-registry). Data from current and proposed MPAs is held in the CCAMLR MPA Information Repository (CMIR) and can be downloaded from their website (https://cmir.ccamlr.org/). There are also Spatial Management Resources for CCAMLR members which include GIS shapefiles and data layers for the original nine planning MPA domains that can be accessed from the website (https://www.ccamlr.org/en/science/spatial-management-resources-ccamlr-members). There is also limited benthic information available in the fishery reports by area (http://fisheryreports.ccamlr.org/) although these mainly provide links to other areas. There is also an online GIS facility (https://gis.ccamlr.org/) that can be used for spatial planning. Other benthic data from the CCAMLR area can be accessed through www.marinespecies.org/rams.

The data from the Marine Debris programme are not publicly available, however, the data are summarised in various reports.

Other information on marine debris has been presented in some survey reports, for example, WG-IMAF-11/12 describes debris sighted during aerial marine mammal surveys. These reports are available on the CCAMLR site but require a login or a request to the Secretariat.

f. Potential adverse impacts of scientific research activities and mitigation measures. Alternative methods

Most of the surveys undertaken in CCAMLR waters are relatively low impact, there are only two regular trawl surveys undertaken in Subarea 48.3 and Division 58.5.2. Other surveys are undertaken using longlines and benthic surveys use ROVs with the use of BRUVs also being developed, although their use is more limited as they will only cover a small area at any one-time WG-EMM-2019/50. Information on the impact on longlines is always under review (WG-FSA-2019/24).

g. Other issues/recommendations that could be useful for providing options for the development of a framework for scientific research activities (not related to fisheries)

There has been a large amount of work undertaken in relation to marine spatial planning and the development of the proposed development of a representative system of MPAs in the CCAMLR area. Proposals for developing an MPA should contain the following components:

- specific objectives;
- spatial boundaries;
- list of activities that are restricted, prohibited, or managed;
- management plan, including administrative arrangements;
- research and monitoring plan, and research and monitoring arrangements, and;
- period of designation.

These requirements are also clearly defined in CM 91-04. This has required a large amount of cooperative research between Member States, to ensure the correct data are collected to provide the information required to meet the above components.

The research proposals are also examined by the various working groups for their scientific merit, which in turn advise the Scientific Committee which will forward its recommendations to the Commission. There is therefore a good structure in place to ensure the validity of the research.

Data on spatial planning from these surveys is made publicly available on the CCAMLR site for transparency and, in the case of the Weddle Sea, available on a separate portal developed by AWI.

Due to the controversial nature of some of the MPAs a large amount of time has been spent at meetings discussing and debating them. This has often been at the detriment of other issues related to fisheries and has meant that the designation of the MPAs has fallen behind schedule with only one of the proposed ones (RSRMPA) so far being set up (the Orkney Island MPA had been previously declared).

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WG-FSA-2019/24 Use of cameras and sensors to monitor the behaviour and benthic impact of longline gears. Derby, C.

WG-IMAF- 11/12 Sighting of marine debris during aerial marine mammal surveys conducted in Antarctic waters in austral summer 2010/11. Lehnert L.S., Kock K.H. and Siebert U

ANNEX 8

Deliverable 4:

TASK 5 – CRITICAL REVIEW OF THE EFFECTIVENESS OF EXISTING MANAGEMENT TOOLS FOR VMEs CONSERVATION AND IDENTIFICATION OF BEST PRACTICES

TABLE OF CONTENTS

Objectives

The objective of task 5 is to provide a critical review of the effectiveness of existing management tools, including the move-on rule, and measures to assess impacts and/or combinations thereof (including spatial management tools) for the conservation of VMEs and identify best practices in RFMOs.

Task 5.1 undertakes a review of current management approaches for fishing vessels carrying out fishing activities with bottom gears in the high seas. Measures include those adopted or under discussion by RFMOs. Additional measures and decisions making tools, including spatial management tools, that close areas to bottom fishing, and other Area-Based Fisheries Management Measures (ABFMs) are discussed.

Task 5.2 provides recommendations on the appropriateness of existing approaches, and identifies potential alternatives based on best practice. This will serve as a baseline for other management bodies, help when conducting future reviews, and in any future updating of Regulation 734/2008. Emphasis is on RFMOs where such approaches are actively under development, e.g., SIOFA and SPRFMO. The study shall critically address the articulation between the VMEs protection process and the protected areas process under discussion in SIOFA and the so-called 'regional approach' of SPRFMO, and where applicable, propose actions to improve the regulatory framework in those organizations.

Institutes and researchers

- Task Leader: **MRAG EU** (Laurence Kell)
- Participating Institutes/Researchers: **IEO** (Pablo Durán Muñoz; Mar Sacau; Beatriz Guijarro; Francesc Ordinas; Roberto Sarralde, **MRAG EU** (Laurence Kell; James Moir Clark and Stephen Mangi) and **CSIC** (Francisco Saborido, Rebeca Rodriguez).

The list of Partners involved on Deliverable 4 and the main role played by each Partner is in Table 1.

Table 1. List of Partners involved in the Deliverable 4 and main role played.

Partner no.	Role	Consortium Partner name	Partner acronym / short name	Country
5	Task Leader; Templates preparation for data collection to be used by partners; Review, collect and summarize the information on: **NPFC, CCAMLR, SPRFMO;** Integration of the information provided by partners; Prepare and review the Deliverable.	MRAG Europe Ltd.	MRAG EU	Ireland
3	Review, collect and summarize the information on: **SEAFO, GFCM** and **SIOFA**	Instituto Español de Oceanografía	IEO	Spain
2	Review, collect and summarize the information on: **NEAFC** and **NAFO**	Consejo Superior de Investigaciones Científicas	CSIC	Spain

5.1 Critical review of the effectiveness of existing management tools for VMEs conservation and identification of best practices

This review focuses on management measures adopted and proposed, as well as resolutions and recommendations, made by the RFMOs. A diverse set of literature sources were collated and analysed, including Scientific Committee meeting reports, FAO documents, peer-reviewed papers, and information contained in RFMOs websites and other relevant data sources. The practices adopted by the RFMOs are either familiar or have been summarised by other Tasks. Therefore the aim is to build on the work of the other tasks, summarise approaches, methodologies and decision-making tools, and identify scientific proposals and suggestions yet to be acted upon.

It was proposed to build a Compendium of Management Recommendations and Resolutions. However, during this review it was found that this has been accomplished by the FAO VME database. Therefore, recognising that any compendium produced by this task will be out of date once the task is finalised, the information contained in the FAO VME was updated and used in this review.

The adoption of measures dealing with bottom fishing in the UNGA Resolutions on Sustainable Fisheries 61/105 in 2006, 64/72 in 2009 66/68 in 2013 and 71/123 of 2016 , signals the continued importance accorded by the international community towards the management of bottom fisheries and the protection of deep-sea ecosystems on the high seas. UNGA Resolution 61/105 calls on high seas fishing nations and RFMOs to take urgent action to protect vulnerable marine ecosystems (VMEs) from destructive fishing practices. In particular, inter alia, Resolution 61/105 called on States to:

> (a) To assess, on the basis of the best available scientific information, whether individual bottom fishing activities would have significant adverse impacts on vulnerable marine ecosystems, and to ensure that if it is assessed that these activities would have significant adverse impacts, they are managed to prevent such impacts, or not authorized to proceed;
>
> (b) To identify vulnerable marine ecosystems and determine whether bottom fishing activities would cause significant adverse impacts to such ecosystems and the long-term sustainability of deep sea fish stocks, inter alia, by improving scientific research and data collection and sharing, and through new and exploratory fisheries;
>
> (c) In respect of areas where vulnerable marine ecosystems, including seamounts, hydrothermal vents and cold water corals, are known to occur or are likely to occur based on the best available scientific information, to close such areas to bottom fishing and ensure that such activities do not proceed unless conservation and management measures have been established to prevent significant adverse impacts on vulnerable marine ecosystems;
>
> (d) To require members of the regional fisheries management organizations or arrangements to require vessels flying their flag to cease bottom fishing activities in areas where, in the course of fishing operations, vulnerable

marine ecosystems are encountered, and to report the encounter so that appropriate measures can be adopted in respect of the relevant site;

A best-practices guide for the management and prevention of impacts from bottom fishing on VMEs has not been developed, however, Thompson et al., 2016, identified what has been done to address UNGA Res. 61/105 (para 83) and the FAO DSF Guidelines, by region. This includes methods used for defining fishing areas and indicator species, the establishment of exploratory fishing and, encounter protocols, and establishing thresholds. The report was intended to facilitate a better understanding of work that has been done in the different ocean regions. The report is a sister volume to the revised second edition of the Worldwide Review of Bottom Fisheries in the High Seas (Bensch et al., 2020), which was updated in 2020 to update the focus year to 2016.

Regulations and management measures in place, are available on the RFMO websites and in the following sections we review these by region. We first summarise the measures taken by region to protect VMEs, then review the methods used to define fishing areas and indicator species, then summarise exploratory fishing and encounter protocols, and thresholds.

Information is uneven since some RFMOs such as NEAFC and NAFO are well established and have scientific committees which are well resourced with scientists who are conducting field and modelling studies, and published in the peer review literature and so have been subjected to higher levels of scrutiny. The intention is to learn from best practice and so more emphasis has been given on RFMOs where procedures are advanced. This helps when summarising strengths and identifying how weaknesses can be addressed in task 5.2.

5.1.1. NORTH ATLANTIC FISHERIES ORGANIZATION (NAFO)

NAFO governance is organized around two main constituent bodies, the Scientific Council (SC), which is responsible for the assessment of fisheries resources and the provision of scientific advice, and the Commission (COM), which is responsible for taking management decisions (Koen-Alonso et al., 2019). NAFO's fishery regulation measures are published annually in a compendium of the NAFO Conservation and Enforcement Measures (NCEM). This document contains all currently applicable regulations, including quotas, closed areas, limits on gear types and mesh sizes, inspection and reporting requirements, and data confidentiality issues (Koen-Alonso et al., 2019).

FAO provides in its VME database a summary of the actions taken by NAFO to protect VMEs (FAO, 2021): NAFO started developing protocols for protecting vulnerable marine ecosystems from possible significant adverse impacts resulting for the use of bottom contact fishing gears in the NAFO Regulatory Area (NRA) in 2006. Initially, four seamount areas were closed as a precautionary measure and a request made for contracting parties to submit their benthic survey data. The NAFO Scientific Council (SC) established the Working Group on an Ecosystem Approach to Fisheries Management (WGEAFM) and also worked jointly with ICES Working Group on Deep-water Ecology (WGDEC) to provide advice to the NAFO Fisheries Commission (FC). Extensive data sets from Canadian Government fisheries surveys, EU Flemish Cap survey and EU Spanish 3NO survey were used to provide initial distributions of corals and sponges and these were later supplemented by dedicated Canadian and Spanish NEREIDA project cruises in 2008-2010. Early fishing and benthic surveys undertaken in the 1970s by Russia provided much of the historical seamount information. In 2012, the FC-SC Working Group on Ecosystem Approach Frameworks to Fisheries

Management (FC-SC WGEAFFM) was created, and in 2013 the SC WGEAFFM renamed to SC WGESA. In 2014, SC undertook a comprehensive review of their closures to protect benthic habitats. In 2015, the decision was made to remove the potential for exploratory bottom fishing in seamount closures (NAFO, 2015). The boundary of the New England Seamounts VME was modified in 2018 to include more seamounts and less abyssal depths. The Eastern Flemish Cap 14 VME that was established in 2017 to protect sea pens was de-notified in 2019 (NAFO, 2019). The NAFO VME closures were reviewed by the SC this year (NAFO, 2021c).

Regarding the identification and assessment of VMEs, Article 23 of the NAFO Conservation and Enforcement Measures (NAFO CEM —NAFO, 2021a) states that the Scientific Council, at request of the Commission, shall conduct a reassessment of bottom fishing activities. This reassessment shall:

> (a) identify VMEs, on the basis of best available scientific information and with the co-operation of Contracting Parties;
> (b) map sites where these VMEs are known to occur or likely to occur; and
> (c) provide such data and information to the Executive Secretary for circulation to all Contracting Parties.

This Article also states that the Commission shall:

> (a) conduct a reassessment of bottom fishing activities in 2021 and every 5 years thereafter, or when there is new scientific information indicating a VME in a given area, other new scientific information becomes available, or there is significant change in the fishery, in collaboration with the Scientific Council and the Joint Commission-Scientific Council Working Group on Ecosystem Approach Framework to Fisheries Management; and
> (b) take the necessary actions to protect VMEs, including potential adjustment of closed areas, following the reassessment specified in paragraph 2(a) of this Article.

The assessment carried out in 2021 (NAFO, 2021c) included three main parts:

Part (i) Assessment of the risk of SAI from bottom fishing activities on VMEs in the NRA. The assessment was based on estimates of the biomass distribution of VMEs, the distribution of fishing effort (VMS data), and a set of assessment metrics that considers ecosystem function and fragmentation.

Part (ii) Potential management options in relation to VME closures. SC considered carefully the review of existing closures and the outcome of the SAI assessment in evaluating possible trade-offs required to achieve appropriate conservation measures, whilst minimizing the possible consequences to ongoing bottom-contact fisheries.

Part(iii) Review of seamount closure boundaries. This revision incorporated new information on VMEs in the seamounts from the NRA that has been published since the last seamount assessment in 2019 (SCS Doc. 19/25). As a result of this review, the SC recommended changes to the existing boundaries for the Fogo, Newfoundland and Corner Rise Seamount closures, as well as the implementation of seven new individual seamount closures in the NRA north of Orphan Knoll.

Since 2013, the Scientific Council has considered that management through the closing of areas with significant concentrations of VME indicator species is the most effective measure for protecting VMEs in the NRA and that the need to implement encounter protocols gradually becomes redundant as the locations of the benthic

VMEs becomes increasingly well-defined. This avoids issues associated with the implementation of complex move-on rules (NAFO, 2013).

Within its Convention Area, NAFO has identified 20 areas as being vulnerable to bottom contact gears and subsequently closed these areas to bottom fishing (Article 17 of the NAFO CEM). NAFO has also delineated existing bottom fishing areas (footprint) to regulate bottom fisheries that cause a significant adverse impact on vulnerable marine ecosystems.

The VME closed areas are divided into two categories, the blue areas in the map below (Figure 1) represent the seamount closures, and the red areas represent the sponge, coral, and sea pen closures. As reflected in Article 17 of the NAFO CEM, no vessel shall engage in bottom fishing activities in any of these areas. The coordinates for these areas are provided in Article 17 of the NAFO CEM.

Potential management options in relation to VME closures

The recent review of existing closures (NAFO 2021c), as part of the reassessment of bottom fishing activities, revealed that increased protection was needed for several VMEs in the NRA. Specifically, this protection was deemed "essential" for five of seven VMEs in the NRA which were characterised by small gorgonian coral, sea squirts (*Boltenia ovifera*), erect bryozoans, black coral and sea pens and "desirable to beneficial" for large gorgonian coral and large-sized sponge VMEs. As a result, expert groups with diverse scientific and fisheries management expertise evaluated the benefits and consequences of extensions to existing closures, as well as the addition of areas in instances where no protection existed. Estimates of biomass and areas of high concentration of large-sized sponges, sea pens, sea squirts, erect bryozoans, black coral, large gorgonian coral and small gorgonian coral generated from the output kernel density raster surfaces, with an increased resolution of 1 km^2, served as the foundation in the development of management options.

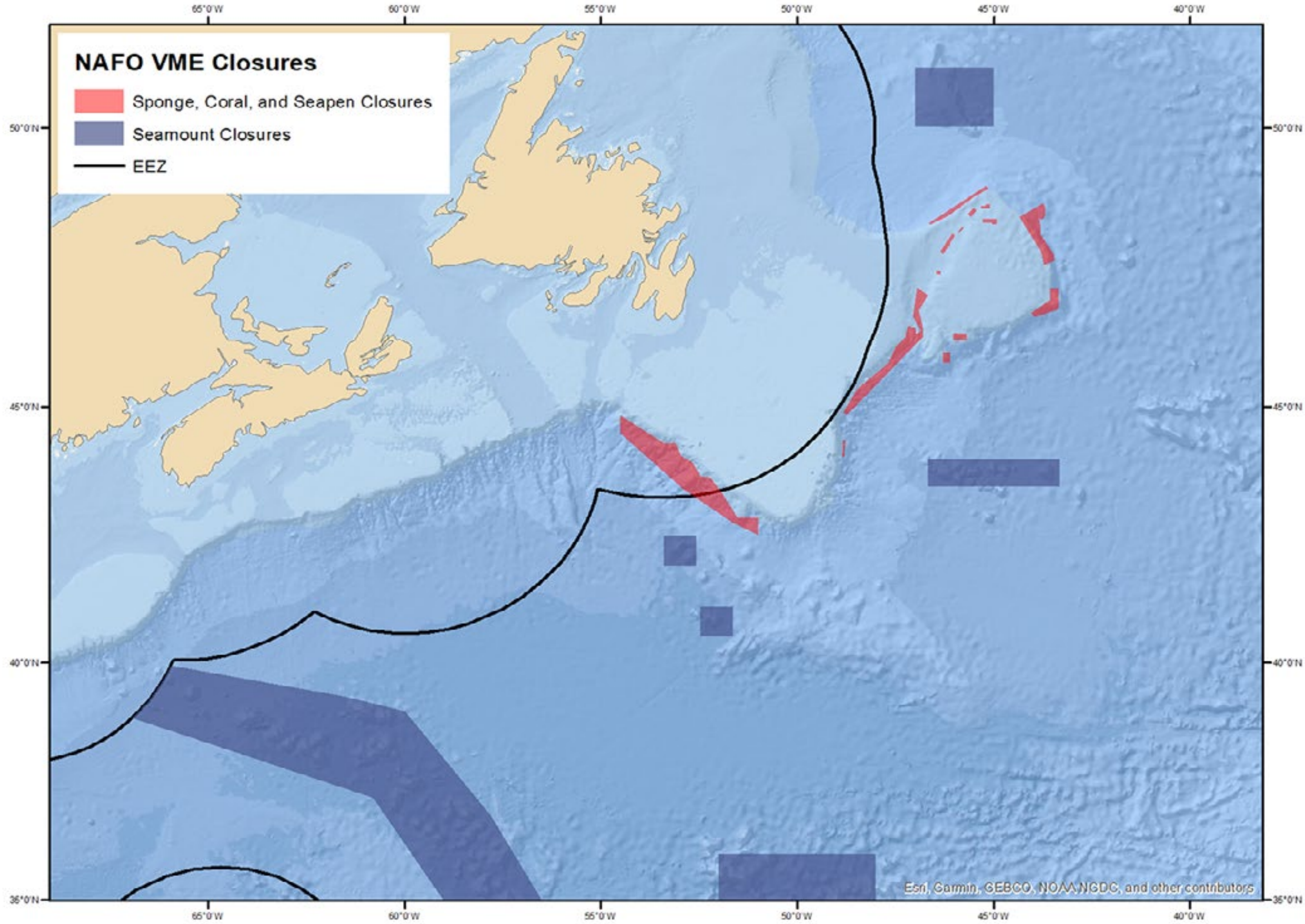

Figure 1 Current NAFO VME closures. (Source: NAFO 2021 https://www.nafo.int/Fisheries/VME).

In evaluating potential management options for the protection of VMEs in the NAFO Regulatory Area, the SC gave careful consideration to the review of existing closures and to the outcome of the SAI assessment in evaluating possible trade-offs required to achieve appropriate conservation measures, whilst minimizing the possible consequences to ongoing bottom-contact fisheries. Collectively, the proposed management options resulted in NAFO achieving 'good' VME protection status for six VMEs and 'limited' protection status for one VME. At the same time, the recommended measures result in a less than 1% overall impact on current fishing activities. The recommended measures take a system perspective, and include ten extensions to existing closures, the creation of three new closures and modifications to Area 14, See Figure 2. Specifically, the SC recommended the following changes to the existing VME closures (NAFO, 2021c):

- Extension of Area Closure 1 (Area 1a), to protect large-sized sponges;
- Establishment of two new closures (Areas 17 and 18) on the tail of the Grand Bank, to protect sea squirts;
- Establishment of a new closure (Area 16) on the tail of the Grand Bank, to protect erect bryozoans;
- Creation of a new closure (Area 15a) to the northeast of the 3O Closure in the NRA, to protect important concentrations of small gorgonian coral, sea pens and large gorgonian coral;

- Westward extension of the Area 2 closure, in the form of the closure of the "notch" on the northwestern side of the Area 2, to better protect large gorgonian coral (Area 2a);
- Northward extension of Area 2, to protect significant concentrations of sea pens and black coral (Area 2b);
- Extension of closures between Area Closures 4 and 5 (Area 4a), to increase protection of large gorgonian coral and large-sized sponges;
- Eastward extension of Area Closure 7, to provide greater protection for sea pens and black coral (Area 7a);
- Extension to Area Closures 8 and 9 (linking with Area Closures 8, 9 & 12), to provide a more continuous closure to protect sea pens and black coral (Areas 8a & 9a) and improve connectivity;
- Westward extension to Area Closure 10, to provide combined protection for sea pens and large-sized sponges (Area 10a);
- Northeastward extension of Area Closure 11, to provide enhanced protection for sea pens (Area 11a);
- Re-establishment of a modified Area Closure 14 (Areas 14a & 14b), over areas of high sea pen concentrations in the eastern portion of the Flemish Cap.
- No changes to Area Closure 3 and Area Closure 13 are necessary.

These proposed changes are shown in the figure below:

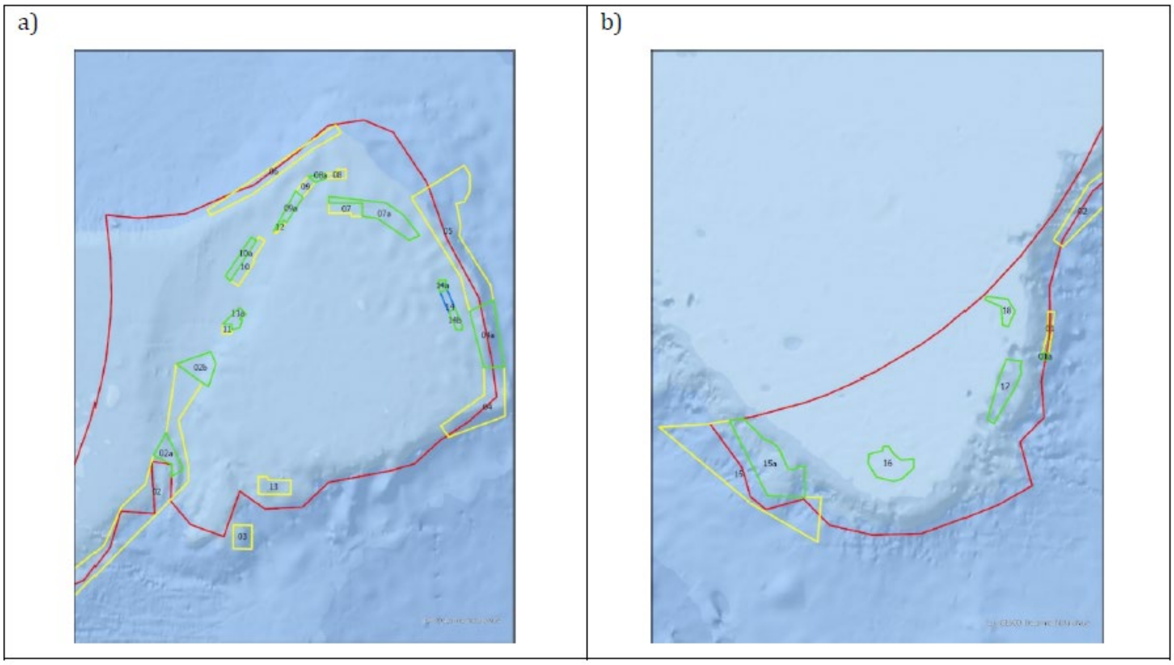

Figure 2 Location of existing closures (in yellow) proposed extensions and new closures (in green), and removals (in blue) in a) the northern, and b) the southern portions of the NRA. The fishing footprint is indicated in red. Numerals represent existing or proposed new closures; number-letter combinations represent extensions or modifications to existing closures (Source: NAFO 2021c).

Also, SC has recommended changes to the existing boundaries for the Fogo, Newfoundland and Corner Rise Seamount closures, as well as the implementation of seven new individual seamount closures in the NRA north of Orphan Knoll. The proposed revisions for all seamounts in the NRA supersede the 2020 SC advice on this topic. SC notes that current and proposed seamount closures have no impact on ongoing fishing activities. All seamounts and current seamount closures fall outside the NAFO fishing footprint. There are no bottom-contacting fishing activities outside the NAFO fishing footprint, and any exploratory bottom fishing activity in this area is subject to the provisions of Chapter 2 of the NAFO CEM, including the prohibition of bottom-contact fishing within seamount closures (NAFO 2021c).

VME data collection

Article 30 - Observer Program (NAFO, 2021a). The purpose of the Observer Program is to collect reliable information and data on activities in the NAFO Regulatory Area. The information and data collected through the Observer Program shall be made available to any NAFO body requesting it. Observers assigned to their vessels shall record for each haul/set, in the format indicated in Annex II.M, hereafter referred to as the observer trip report: the quantity of all catch, by species, including for discards and VMEs indicators as referred to in Annex I.E.VI.

Fishing areas

Article 16 addresses the map of the footprint (existing bottom fishing areas) (NAFO, 2021a). The map of existing bottom fishing areas shall be revised regularly to incorporate any new relevant information, in particular haul by haul catch data (Figure 3).

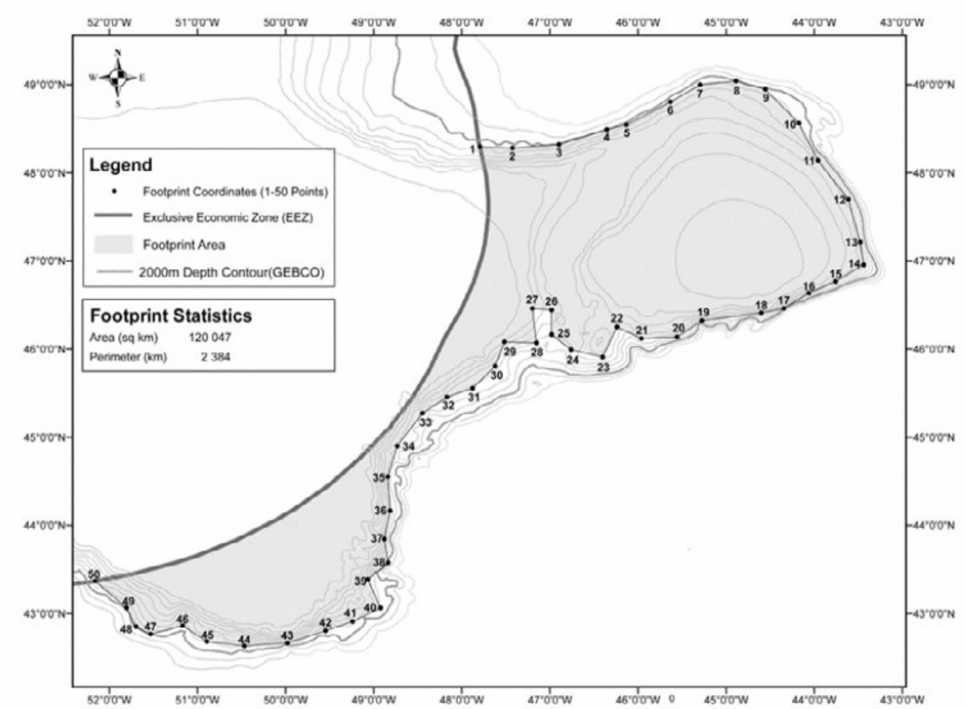

Figure 3 NAFO Regulatory Area footprint map (shaded area). (Source: NAFO 2021a).

NAFO's SC assesses the overlap of NAFO fisheries with VME through an analysis of haul-by-haul log-book data in combination with VMS data. Such analysis significantly improves the spatial definition of specific fishing areas within the NAFO footprint. This approach will be used for re-assessment for years for which haul by haul logbook data are available. Furthermore, the SC continues developing models and methodological approaches which assess the functional significance of VMEs and the estimation of recovery rates of different VME indicator species. This provides valuable insight to assess the level of VME connectivity between different areas. Updated analysis (including new data) has been performed on non-coral and non-sponge VME indicator species and further work is planned (NAFO, 2020b; 2021d).

Indicator species

The term "VME indicator species" refers to species that signal the occurrence of vulnerable marine ecosystem, as specified in Part VI of Annex 1.E of the NAFO CEM (Art. 15.7). The term "VME indicator element" refers to topographical, hydrophysical or geological features which potentially support VMEs, as specified in Part VII of Annex 1.E of the NAFO CEM (Art. 15.6).

A review of the current list of Vulnerable Marine Ecosystem indicator species in Annex 1.E of the NAFO Conservation and Enforcement Measures (NAFO CEM) was required to prepare for review of the VME fishery closures in 2020. The last assessment of VME species found in the NAFO Regulatory Area (NRA) occurred in 2011, where over 500 different taxa were reviewed and assessed against the FAO criteria. Since then, additional information has become available on the presence of 13 new species of large sponge, calling for a review of the list found in the NAFO CEM. At the same time the nomenclature of a few species on the NCEM list has been revised according to the taxonomic database WORMS. The addition of the three letter FAO species codes is also required to facilitate observer recording where appropriate. The SC noted that the new species of sponge were assessed against the FAO criteria for VME species, based on their fragility, vulnerability and capacity to provide structure for other organisms when aggregating. All were considered to meet the FAO criteria for VME indicator species designation (NAFO, 2020b). In 2021, the SC recommended several changes to Annex I.E, Part VI to reflect current correct taxonomic nomenclature, to correct spelling errors in previous versions and add three letter ASFIS codes where they are available (NAFO, 2021c).

Exploratory fishing protocol

According to NAFO (2021a), "Exploratory bottom fishing activities" means bottom fishing activities conducted outside of the footprint, or within the footprint with significant changes to the conduct or in the technology used in the fishery (Art. 15.2). Exploratory bottom fishing activities shall be subject to a prior exploration conducted in accordance with the exploratory protocol set out in Annex I.E of the NAFO CEM (Art. 18.1). Exploratory fisheries will be allowed only if there are adequate mitigation measures to prevent Significant Adverse Impacts to VMEs (Art. 19-21):

Article 19 – Preliminary Assessment of Proposed Exploratory Bottom Fishing Activities: Any Contracting Party proposing to participate in exploratory bottom fishing activities shall submit, in support of their proposal, a preliminary assessment of the known and anticipated impacts of the bottom fishing activity, which will be exercised by the vessels entitled to fly its flag, on VMEs.

Article 20 – Management of Exploratory Bottom Fishing Activities
The Commission shall adopt conservation and management measures to prevent significant adverse impacts of the exploratory fishing activities on VMEs, taking account of advice and recommendations provided by the Scientific Council and the Joint Commission-Scientific Council Working Group on Ecosystem Approach Framework to Fisheries Management, including data and information arising from reports pursuant to Article 22. These measures may include:

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

Article 21 – Evaluation of Exploratory Bottom Fishing Activities. According to this article, the Scientific Council will:

(a) evaluate the exploratory bottom fishing activities at its meeting immediately following the reception of the "Exploratory Bottom Fishing Trip Report" circulated in accordance with Article 18.2; and

(b) in line with the precautionary approach, provide advice to the Commission on the decision to be taken in accordance with Article 21.3, taking account the risks of significant adverse impacts on VMEs.

The Commission shall, taking account of advice and recommendations provided by the Scientific Council and the Joint Commission-Scientific Council Working Group on Ecosystem Approach Framework to Fisheries Management, either to:

(a) authorize the bottom fishing activity for part or all of the area in which exploratory bottom fishing was carried out and include this area in the footprint, or

(b) discontinue the exploratory bottom fishing activity and, if necessary, close part or all of the area where which exploratory bottom fishing was carried out, or

(c) authorize the continued conduct of exploratory bottom fishing activity, in line with Article 18 with a view to gather more information.

Modelling *is well established in NAFO for the identification of significant concentrations of VME indicators and prediction of species distribution. NAFO has applied Kernel Density Estimation (KDE) to research vessel trawl survey data to identify significant concentrations of VME indicator taxa in the NAFO Regulatory Area. KDE utilizes spatially explicit data to model the distribution of a variable of interest. It is a simple non-parametric neighbour-based smoothing function that relies on few assumptions about the structure of the observed data. It has been used in ecology to identify hotspots, that is, areas of relatively high biomass/abundance. It was first applied within NAFO to the identification of significant concentrations of sponge biomass in the NAFO Regulatory Area in 2009, followed by an application to sea pen biomass. Since then, it has been applied to all VME Indicator taxa to identify VMEs (Kenchington et al., 2019). Species distribution modelling (SDM) predicts the presence, absence or abundance/biomass of a species or habitat (the response variable) from environmental variables thought to influence it (the predictor variables). SDM for sponge grounds, black corals, large gorgonian corals and sea pen corals, the glass sponge Asconema foliata, erect bryozoans and sea squirts (Boltenia ovifera) are incorporated into the assessment of VMEs (Kenchington et al.2019 and references therein). These models are particularly valuable in areas where the survey vessels do not sample (e.g., rough bottom, cliffs, depths greater than 1500 m) and for non-aggregating taxa such as the black corals that are present in low frequency and their past occurrence (noted after removal by the trawl) may or may not reflect the presences of other colonies in the same area.*

eDNA *refers to any DNA that is collected from an environmental sample (such as water or sediments) rather than directly from an organism. eDNA originates from body cells or waste products of organisms and remains suspended in the water column or in the sediment (Ficetola et al. 2008; Taberlet et al. 2012). This technique could be used, at least in theory, to determine: a) the diversity and species composition in potential or established VMEs, and ii) the abundance and biomass of indicator species. Such an approach has been already tested to map the distribution of cold-water coral reefs in Norwegian fjords by Kutti et al. 2020. In that study, a great potential was demonstrated for eDNA measurements as a cost-efficient tool for a rapid screening of the distribution cold-water coral reefs that cannot be imaged using traditional multi-beam echo-sounders and difficult to detect using ROVs alone. newer methods such as environmental DNA (eDNA) could be tested in future surveys.*

Encounter protocols

In existing bottom fishing areas, encounters with VME indicator species above a threshold value are reported to the Executive Secretary and trigger a 2-nautical mile move on rule. In new fishing areas, such encounters also result in temporary closures of 2 nautical miles radius and require a more detailed report by the on-board observer (Art 22.2-3 of the NAFO CEM).

Article 22 (NAFO 2021a) sets out provisions in case that an encounter occurs during fishing. The master of the vessel shall report the encounter without delay to the flag State Contracting Party including the position that is provided by the vessel, either the end point of the tow or set or another position that is closest to the exact encounter location, the VME indicator species encountered, the quantity (kg) of VME indicator species encountered; and cease fishing and move away at least 2 nautical miles from the endpoint of the tow/set in the direction least likely to result in further encounters. The captain shall use his best judgment based on all available sources of information.

Regarding encounter protocols and thresholds, NAFO's SC has considered since 2012 that such measures are a very useful tool to identify VMEs in areas where there is little survey information and the fishing activity is the main source of new data. This applies especially to new fishing areas outside of the fishing footprint. However, as the locations of the benthic VMEs become increasingly well-defined in the NRA to support informed management through closed areas the need to implement encounter protocols gradually become redundant (NAFO, 2013).

Thresholds

For both existing bottom fishing areas and unfished bottom areas, an encounter with primary VME indicator species is defined as a catch per set (e.g., trawl tow, longline set, or gill net set) of more than 7 kg of sea pens and/or 60 kg of other live coral and/or 300 kg of sponges (Art 22.1 of NAFO CEM).

Ecosystem Approach to Fisheries in NAFO

The effects of fishing on other ecosystem elements is being addressed through the SAI-VME work, and other NAFO processes (e.g. COM WG-BDS) (NAFO, 2021c).

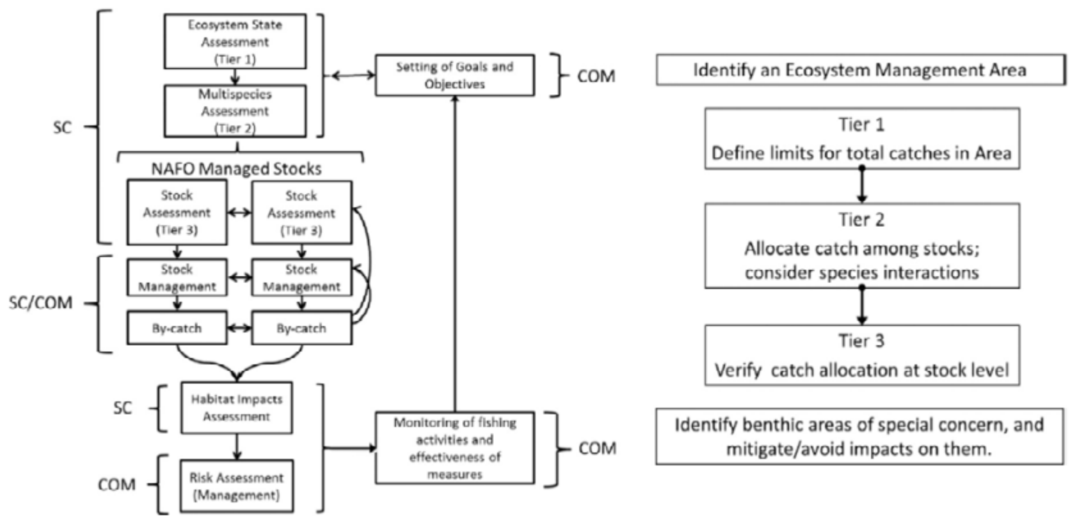

Figure 4 Current working template of the NAFO Roadmap (left), with a synoptic overview of the key steps required for using it (right). SC: Scientific Council, COM: Commission. The

labelled vertical brackets indicate the leading NAFO body for the different roadmap components (Source: Koen-Alonso et al. 2019).

Currently, the Roadmap approaches habitat impacts through an evaluation of Significant Adverse Impacts (SAIs) on VME habitats by following the FAO 2008 Guidelines. The SC's evaluation of SAIs constitutes the basis for a COM managers-led risk assessment on the need for spatial management measures to protect critical habitats (Figure 4). As the Roadmap continues developing, these habitat impacts assessments could be broadened to consider other habitats beyond VMEs (Koen-Alonso et al., 2019).
The Habitat Impacts Assessment includes:

- Identification of benthic areas/habitats of special concern (e.g. VMEs).
- Characterization of the habitat, its functionality, and its capacity to tolerate perturbations.
- Identify and define the nature of the pressures acting on the habitat.
- Evaluate impact as a combination of the features of the habitat and cumulative pressures.
- Analysis of fishing impacts on benthic ecosystems.
- Provision of advice on Significant Adverse Impacts (SAI) on habitats (e.g. VMEs) by fishing activities.

5.1.2. NORTH EAST ATLANTIC FISHERIES COMMISSION (NEAFC)

NEAFC started to implement measures to address the possible adverse impacts of bottom fisheries in the early 2000s. Measures were directed at conserving the deep-sea fish species (target resources and by-catch species), but were also aimed at addressing the impacts of bottom fisheries on other components of the marine ecosystem, in particular epifauna susceptible to lasting damage from bottom-touching fishing gear (i.e. VME taxa) (NEAFC, 2020a; FAO 2021).

The first area closures to protect VMEs were agreed in 2004, following a proposal by Norway. Over the following years, closures were seen as a primary tool to protect VMEs but then as an integrated element of a more general comprehensive approach. This approach included:

- defining the 'existing bottom fishing areas', i.e. areas that had been recently fished and where fisheries could continue relatively unrestricted, and
- ensuring that bottom fishing outside these areas (i.e. in 'new bottom fishing areas') where only exploratory fisheries subject to various restrictive conditions.

The conditions for exploratory fishing now include a pre-assessment of the proposed activities. Proposed exploratory bottom fisheries can only commence after having been assessed by the Permanent Committee on Management and Science (PECMAS) and approved by the Commission. Initially, the work accomplished in NAFO was used as a basis for formulating the general approach for NEAFC, and is provided by ICES. This involves combining VMS/logbook and VME data. VMS/logbook data is used to quantify the fishing footprint and data and is then combined with data on where VMEs are known to or are likely to occur. If ICES advice suggests that VMEs are present or likely, subareas within both the areas defined as 'existing bottom fishing areas' and 'new fishing areas' are closed to bottom fishing to prevent significant adverse impacts on VMEs. The parts of 'existing bottom fishing areas' that are not closed are subject to various measures, including reporting duties and an encounter protocol. An encounter with a VME results in a temporary closure in the relevant area. Similar encounter provisions are valid for exploratory fisheries in 'new fishing areas' and vessels have observer requirements (NEAFC, 2020a; FAO 2021).

NEAFC's work to protect VMEs began a few years before the adoption of UNGA Resolution 61/105 in 2006, and the Resolution was therefore obviously not influencing the initial development of NEAFC's measures to protect VMEs. However, the Resolution and the 2008 FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas (FAO, 2009) were important for the continued development of NEAFC's regulations. Following the initial closures agreed in 2004, and some additions in the following years, NEAFC's biggest step in adopting area closures to protect VMEs was taken in 2009 when several new closures were adopted, including very large areas on the Mid Atlantic Ridge. An extensive review of NEAFC's bottom fishing regulation was carried out in 2012. It concluded that the measures that were in place were sufficient for NEAFC to be acting consistently with the relevant UNGA Resolutions and the FAO Guidelines. However, it also suggested various further improvements to NEAFC's regime. This led to the adoption of Recommendation 19:2014, which replaced previous general measures to protect VMEs. NEAFC has now closed the areas where it has concluded, on the basis of the best available scientific information, that VMEs occur or are likely to occur. No bottom fisheries should therefore be taking place in the NEAFC Regulatory Area that will result in significant adverse impacts on VMEs. Furthermore, the provisions on 'new bottom fishing areas' ensure that bottom fisheries only expand into previously unfished areas on the basis of exploratory fisheries that are subject to various conditions, including pre-assessments and that can only commence after having been assessed by PECMAS and approved by the Commission. Additionally, several of NEAFC's closures are not based on the identification of specific individual VMEs, but rather on the likelihood of there being VMEs somewhere in the vast closed areas on the Mid Atlantic Ridge. NEAFC continues to develop its management in this context, and has a recurring request for scientific advice from ICES regarding any new information on the occurrence of VMEs in the NEAFC Regulatory Area (NEAFC, 2020a; FAO 2021)

Recommendation 19:2014 sets out measures for the protection of vulnerable marine ecosystems in the NEAFC Regulatory Area. This recommendation has been amended in three occasions, namely, by Recommendation 09:2015, Recommendation 10:2018 and Recommendation 10:2021 (NEAFC, 2021).

The objective of this Recommendation is to ensure the implementation by NEAFC of effective measures to prevent significant adverse impacts of bottom fishing on vulnerable marine ecosystems known to occur or likely to occur in the NEAFC Regulatory Area based on the best available scientific information provided or endorsed by the International Council for the Exploration of the Sea (ICES). The main measures included in Recommendation 19:2014 are detailed below.

Area closures

Area closures for the protection of VMEs in the Regulatory Area shall be based on advice by ICES and on the procedures set out in recommendations regulating fishing in the Regulatory Area. Bottom fishing shall be prohibited in the following areas, within the coordinates as defined in Annex 2 of Rec. 19-2014 (NEAFC, 2021):

a) Northern MAR Area;
b) Middle MAR Area (Charlie-Gibbs Fracture Zone and sub-Polar Frontal Region);
c) Southern MAR Area;
d) Altair Seamount;
e) Antialtair Seamount;
f) Hatton Bank 1;
g) Rockall Bank;
h) Logachev Mounds;
i) West Rockall Mounds;
j) Edora’s bank;
k) Southwest Rockall Bank;
l) Hatton-Rockall Basin; and
m) Hatton Bank 2.

If ICES advises that there are sub-areas where significant adverse impacts on VMEs are not considered likely within the areas referred to in paragraph 2 of this Article, the Recommendation may be amended by the Commission to exclude those sub-areas from the prohibition under paragraph 2.

Within closed areas and/or restricted bottom fishing areas, Contracting Parties intending to conduct scientific investigations, which shall exclude exploratory bottom fishing pursuant to Article 6, shall notify the Secretary of their intended research programmes, taking account of Article 206 of the 1982 UN Convention on the Law of the Sea. The Secretary shall forward such notifications to all Contracting Parties as well as to PECMAS. Contracting Parties shall ensure that any such proposed investigations shall be assessed to see whether they would have significant adverse impacts on VMEs.

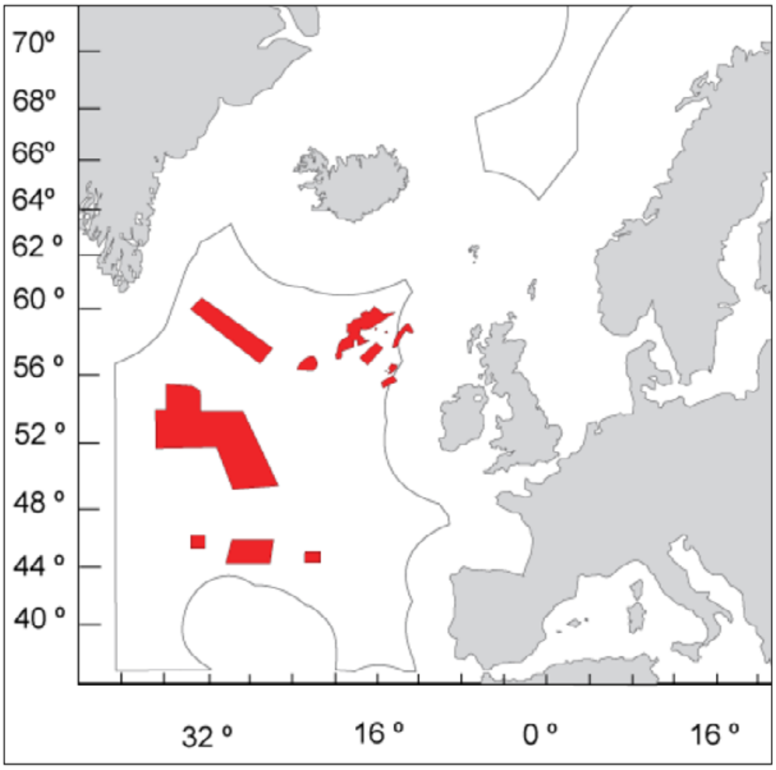

Figure 5 Map of area closures, in red, for the protection of VMEs in the NEAFC Regulatory Area. Source: NEAFC, 2021.

Apart from the annual ICES advice process, the VME Recommendation 19:2014 also includes a requirement to renew the closed areas every 5 years. The last time this occurred was in the update to the Recommendation in 2018, the closures being due to end by 31 December 2017. ICES in 2017 had advised NEAFC to renew all the closures as the need for protection of the VMEs in the areas remained valid. The 2017 Annual Meeting therefore renewed to 31 December 2022 all closures under the Recommendation. At the same time one of the areas, "Area (l) Hatton–Rockall Basin" was significantly enlarged following advice from ICES to extend it to encompass new records of deep-sea sponge aggregations found at 1200 metres (NEAFC, 2020a).

At the PECMAS 2020 Meeting (NEAFC, 2020b), ICES presented its advice on VMEs. ICES advised there were no changes needed to the existing closed areas. It explained that there had been an improvement in VMS data recently, in particular to help plot vessel speed, although the gear identification problem remained. While 15 new VME records had been submitted to its database, ICES did not advise any modifications were needed due to these. ICES also noted some fishing activity had occurred in areas outside existing fishing areas in the Mid-Atlantic Ridge and Josephine Seamount areas.

At the same meeting, ICES also presented its advice on vulnerable habitats in subareas closed for purposes other than VME protection. While no VME habitats were recorded in the Rockall Haddock Box, the proximity of these around the area, as well as 439 VME indicator records from within the Box led to the advice that the Rockall Haddock Box should remain closed to protect VMEs. However, there was a discussion as to whether the Box should be added as a VME closure to the VME Recommendation or not, and if so if current coordinates were appropriate. NEAFC requested advice from ICES on the efficacy of the Rockall haddock closure in protection of juvenile haddock. It was concluded that while the Rockall Haddock Box does coincide with areas of high juvenile and adult haddock densities, high densities are also observed outside the box to the northeast. For most years since the closure, haddock densities of age classes 1+ have been higher inside than outside the box. The overall impact of the current closure area on the Rockall haddock stock continues to be difficult to assess[1]. It was also noted that there may be potential video evidence on habitats in the area; there could also be evidence of the types of habitats and their recovery times. To this matter, PECMAS agreed that no additional request was now needed on evidence for VME habitats in the Rockall Haddock Box, but nevertheless ICES would return with this information in its recurring VME advice for 2021.

In 2013, ICES responded to a request for advice from NEAFC on the application of buffer zones to bottom fishing closure boundaries. These buffers consider the water depth and trawl warp length deployed during fishing activity, and the VME location. Two recommendations relevant here were proposed: 1) For VMEs that occur on flat or undulating seabed, a buffer zone of approximately two (> 500 m depth) or three times (< 500 m depth) the local depth is advised. 2) In some cases, the presence of geomorphological features is used to define boundaries for closures on the basis that they are considered to be VME elements, in which case the VME reflects the topographic relief of the VME element without a buffer zone. The ICES Working Group on Deep water Ecology (WGDEC) further endorsed this advice in 2017, for the use of buffers in recommendations for NEAFC fisheries closure areas for the protection of VMEs (ICES, 2020b).

Fishing areas

Recommendation 19:2014 (NEAFC, 2021) defines "existing bottom fishing areas" as the portion of the Regulatory Area where bottom fishing has historically occurred as set out in Article 4, based on information concerning bottom fishing activities in the period 1987-2007. The coordinates of the existing fishing areas can be found in Annex I of this recommendation.

Indicator species

A list of seven habitat types as well as physical elements for the NEAFC Regulatory Area, with the taxa most likely to be found in these habitats, which shall be considered as VME indicators is provided in Annex 5 of Recommendation 19:2014 (NEAFC, 2021). The list includes VME habitats such as Cold-water coral reefs, coral gardens (hard and soft-bottom), deep-sea sponge aggregations (including hard-bottom sponge gardens and glass sponge communities), sea pen fields, tube-dwelling anemone patches, mud- and sand-emergent fauna, and bryozoan patches. Physical elements include isolated seamounts, steep-slopes and peaks on mid-oceanic ridges, knolls, canyon-like features and steep flanks.

Exploratory fishing protocol

Prior to proposing to undertake exploratory bottom fishing, Contracting Parties shall gather relevant data to facilitate assessments of exploratory bottom fishing by PECMAS and ICES (Recommendation 19:2014 —NEAFC, 2021). Such data should preferably include data from sea-bed mapping programmes, i.e., data from echo-sounders, if practicable multi-beam sounders, and/or other data relevant to the preliminary assessment of the risk of significant adverse impacts on VMEs.
A Notice of Intent to undertake exploratory bottom fishing shall be submitted to the Secretary at least six months prior to the proposed start of the fishing. The Notice of Intent shall be accompanied by the following information:

[1] https://ices-library.figshare.com/articles/report/NEAFC_request_on_the_efficacy_of_the_Rockall_haddock_closure_in_protection_of_juvenile_haddock/19248983

a) harvesting plan, which outlines target species, proposed dates and areas and the type of bottom fishing gear to be used. Area and effort restrictions shall be considered to ensure that fishing occurs on a gradual basis in a limited geographical area;
b) mitigation plan, including measures to prevent significant adverse impact to VMEs that may be encountered during the fishery;
c) catch monitoring plan, including recording/reporting of all species caught;
d) a sufficient system for recording/reporting of catch, detailed to conduct an assessment of activity, if required; fine-scale data collection plan on the distribution of intended tows and sets, to the extent practicable on a tow-by-tow and set-by-set basis;
e) data collection plan to facilitate the identification of VMEs in the area fished;
f) plans for monitoring of bottom fishing using gear monitoring technology, including cameras if practicable; and
g) monitoring data obtained pursuant to paragraph 1 of this Article.

Exploratory bottom fishing shall only commence after having been assessed by PECMAS and approved by the Commission. Members of the Commission must ensure that all vessels flying their flag conducting exploratory bottom fishing have a scientific observer on board.

Encounter protocols

According to Recommendation 19:2014 (NEAFC, 2021), each Contracting Party shall ensure that fishing vessels flying its flag abide by the following rules, where, in the course of bottom fishing, evidence of VMEs is encountered:

a) fishing vessels shall quantify catch of VME indicators;
b) if the quantity of VME indicators caught in a fishing operation (such as trawl tow or set of a gillnet or longline) is beyond the thresholds defined in Article 9, the following shall apply:

i. if an encounter is discovered in connection with the hauling of a trawl gear, the fishing vessel shall cease fishing and move out of an area defined as a 2 nautical mile wide band (polygon) on both sides of the "track" of the trawl haul during which an encounter occurred. The "track" is defined as the line joining consecutive VMS positions, supplemented by more exact information, between the start and the end of the tow, extended by 2 nautical miles at both ends;
ii. if an encounter is discovered in connection with other bottom fishing gears the fishing vessel shall cease fishing and move away at least 2 nautical miles from the position that the evidence suggests is closest to the exact encounter location. The master shall use his or her best judgment based on all available sources of information; and
iii. the master shall report the incident, including the "track" or position determined under sub-paragraphs (i) and (ii), without delay to its flag state, which shall forward the information to the Secretary immediately. Contracting Parties may if they so wish also require their vessels to report the incident directly to the Secretary.

When an encounter occurs, The Secretary shall immediately inform all Contracting Parties, and ICES, and archive the information received, and shall at the same time implement a temporary closure in the areas identified in paragraph 1.b of this Article. PECMAS shall examine the temporary closure, and any relevant ICES advice, and if, on the basis of assessment by ICES, PECMAS advises that the area has or is likely to have a VME, the Secretary shall request Contracting Parties to maintain the temporary closure until such time that the Commission has acted upon the advice from PECMAS.

Encounters during exploratory fishing with VME indicators above the established thresholds are subject to the same regulations as encounters during normal operations within the existing bottom fishing areas, i.e., reporting, move-on rule and temporary closure.

Thresholds

An encounter with a possible VME is defined as:

a) for a trawl tow, and other fishing gear than longlines: the presence of more than 30 kg of live coral and/or 400 kg of live sponge of VME indicators; and
b) for a longline set: the presence of VME indicators on 10 hooks per caught per 1000 hook segment or per 1200 m section of long line, whichever is the shorter.

5.1.3. SOUTH EAST ATLANTIC FISHERIES ORGANISATION (SEAFO)

Most of the SEAFO Convention Area (CA) is deep ocean (i.e. deeper than 2000m) therefore fishing activities in the SEAFO CA are limited to seamounts or around them. Only longline and pot fisheries have been conducted since 2013. SEAFO has formulated and adopted its fishing protocols, in addition to delineating both existing and new bottom-fishing areas, establishing VME encounter thresholds and move-on rules, and exploratory fishing protocols. Several scientific surveys within the SEAFO CA area have been carried out with the aim of identifying potential VMEs. In the Walvis ridge area, three surveys from a Spanish-Namibian cooperation were carried out from 2018 to 2010 (IEO, 2008) and one survey in cooperation with FAO and Norway in 2015 with the R/V Dr. Fritdjon Nansen (IMR, 2015). In 2019 another Nansen survey was conducted to the South of the SEAFO CA in the Discovery complex (IMR,2019). Most of the seamounts visited had VME indicators (mainly corals), but there was diversity amongst the seamounts in terms of taxonomical composition and density, presumably depending on depth, shape, hydrographical setting, geological and ecological history.

Conservation Measure 30/15 on "Bottom Fishing Activities and Vulnerable Marine Ecosystems in the SEAFO Convention Area" established area closures for the protection of VMEs, the procedure to be followed when an encounter with potential VMEs occurs and the VME Data Collection Protocol among other measures. Currently 11 areas are closed to all fishing and a new area on the Valdivia to gears other than pots and longlines. Delimitation of these areas were based both on the likely occurrence of VME taxa and the intensity of the fishing. According to this CM, all 1ºx1º areas within the exploratory area that contain a VME encounter should be excluded from the proposed new fishing area. The "fishing footprint" was developed by the Scientific Committee, based on an established rule of fishing concurrence, and adopted by the Commission in 2011 (CM 22-11). The "fishing footprint" map, with a spatial resolution of 1ºx1º, was delineated using data from bottom longline and pots, and trawls (occurring during 1987 – July 2011). SEAFO explicitly defined "existing bottom-fishing areas" as the fishing footprint combined with new fishing areas. Amendments to the "existing bottom-fishing area" map can be made via the exploratory fishing protocol, which allows fisheries to start in new fishing areas subject to stringent control and review measures. Since 2012, new fishing areas for longlines only were adopted in 2014 (three 1x1 squares, CM 26-13) and 2016 (1 additional 1x1 square, CM 30-15) 1ºx1º, and added to the "existing bottom-fishing area" map, based upon exploratory fishing protocol for toothfish. The exploratory fishing areas that gave rise to these new fishing areas are shown on the FAO VME

Database map. SEAFOs most recent "existing bottom-fishing area" is provided in CM 30-15, Annex 1, p. 7-9. Bathymetry, substrate type and benthopelagic fish was mapped in 2015 in the central eastern part of the SEAFO convention area (Bergstad et al, 2019a, b).

Fishing areas

SEAFO defined bottom-fishing areas in 2008, and requested Contracting Parties to provide information on historical bottom-fishing. Subsequently SEAFO mapped existing bottom fishing areas within the Convention Area for bottom fishing activities occurring from 1996-2010, expressed as the presence and absence of fishing activity, as indicated from logbook data submitted by all CPs, in 10' x 10' cells and was used as an indicator of the level of fishing in identified seamount areas. CM 30-15 defines "existing bottom fishing areas" as the portion of the Convention Area where bottom fishing occurred in the period 1987-July 2011 and any areas added subsequently as set out in Article 4. All bottom fishing activities in new bottom fishing areas or with bottom gear not previously used are considered to be exploratory fisheries and are subject to Exploratory Bottom Fisheries Protocol and subject to scientific assessment by the SEAFO Scientific Committee, prior to approval. Existing bottom fishing and closed areas are showed in Figure 1, extracted from CM 30/15. To note that an additional area to the south of Valdivia Bank was closed to all fishing except for pots and longlines.

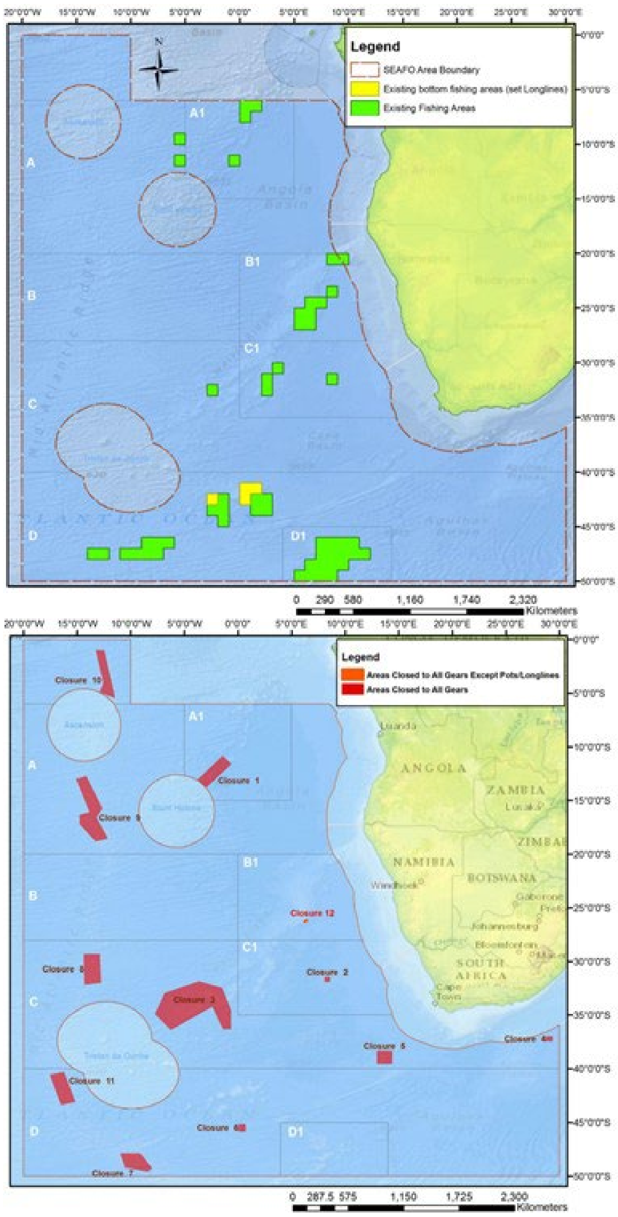

Figure 6 Existing bottom fishing (top) and closed areas (bottom); (http://www.seafo.org/Management/VME-Protection).

Indicator species

SEAFOs Scientific Committee identified, in 2010, a provisional list of benthic invertebrate VME indicator species/groups for the SEAFO CA. It includes: Gorgonacea (Order), Anthoathecatae (Family), Scleractinia (Order), Anthipatharia (Order), Zoantharia (Order), Alcyonacea (Order), Pennatulacea (Order), Bryozoa, Crinoidea (Class), Ophiuroidea (Class), Serpulidae (Family), Ascidiacea (Class). A SEAFO coral and sponge taxa guide was developed in 2009 as a simple pictorial guide to corals and sponges for use by sea-going observers in the SEAFO CA with the aim to enable observers to identify general types of corals and sponges, as it is rarely possible to identify specimens to the species level at sea (Ramos et al, 20019).to identify specimens to the species level at sea (Ramos et al, 20019).

Exploratory fishing protocol

Exploratory bottom fishing means all commercial bottom fishing activities outside area closures and existing bottom fishing areas, or fisheries within existing bottom fishing areas when a new fishing method and/or strategy are attempted to be used. Each Contracting Party proposing to undertake exploratory bottom fishing shall submit to the Executive Secretary, in addition to the Notice of Intent, a preliminary assessment of the known and anticipated impacts of the proposed bottom fishing activity as described in Annex 3 of the CM 30-15. This requires information about harvest, mitigation, catch monitoring and data collection plans to be submitted to the Executive Secretary. Exploratory bottom fishing shall only commence after the Notice of Intent has been assessed by the Scientific Committee and approved by the Commission. In the 2018 SC meeting an intersessional task team has been formed with the mandate to develop criteria for evaluation of Exploratory and research fishing plan targeting orange roughy.

Encounter protocols

Actions from encounters above threshold depend on the gear deployed: for trawlers, the vessels must cease fishing and move away at least 2 nautical miles from the end point of the trawl tow in the direction least likely to result in further encounters. This appears to be based on current practice in other RFMOs. However, although bycatch is assumed to be an indicator of *in situ* VME biomass and composition, the limited studies that have evaluated this assumption indicate that bottom-fishing gear (which is designed to catch fish) is inefficient at sampling VMEs, such that large quantities of VMEs might be destroyed on the seabed before an amount exceeding encounter thresholds is brought to the surface (Auster et al., 2010) For other gears but trawlers the fishing vessel must cease fishing and move away at least 1 nm from the position that the evidence suggests is closest to the exact encounter location, defining a buffer area with a 1 nautical mile radius. The master shall use his or her best judgment based on all available sources of information; and all encounters are to be reported to the Executive Secretary. If the encounter happened outside existing fishing areas, at the same time a temporary closure shall be implemented corresponding to the buffer area. Furthermore, to assess accurately the position and the extent of the VME encountered, sea bed mapping, preferably, should be carried out using echo-sounders, and if practicable multi-beam sounders. In order to properly implement the UNGA measures and FAO guidance, such mapping should occur before any fisheries (including exploratory fisheries) can take place. This is in addition to seabed mapping programs conducted in the assessment of the risk of significant adverse impacts on VMEs before exploratory fishing. The result of any mapping shall be submitted to the Scientific Committee for its evaluation and advice. This advice shall be forwarded to the Commission and contribute to the basis for a decision by the Commission to reopen or close such areas. The Scientific Committee shall examine the temporary closure at its next meeting or by correspondence. If the Scientific Committee advises that the area has sufficient evidence of a VME, the Executive Secretary shall request Contracting Parties to maintain the temporary closure until such time that the Commission has acted upon the advice from the Scientific Committee. If the Scientific Committee evaluation does not conclude that the temporary closed area has sufficient evidence of a VME, the Executive Secretary shall inform Contracting Parties which may re-open the area to their fishing vessels (CM 30/15, Art. 8)

5.1.4. GENERAL COMMISSION FOR FISHERIES IN THE MEDITERRANEAN (GFCM)

GFCM in 2005 prohibited the use of towed dredges and trawl nets fisheries at depths beyond 1000 m of depth (Rec. GFCM/2005/1). The next year, 2006, it prohibited the use of towed dredges and bottom trawl nets in the Nile delta area cold hydrocarbon seeps, the Eratosthemes Seamount, and Lophelia reef off Capo Santa Maria di Leuca Fisheries Restricted Areas (FRAs) (Rec. GFCM/2006/3). In 2009, a FRA Fisheries Restricted Area was established in the Gulf of Lions to protect spawning aggregations and deep-sea sensitive habitats (Rec. GFCM/33/2009/1). In this FRA, the fishing effort for demersal stocks of vessels using towed nets, bottom and mid-water longlines, bottom-set nets was limited to the level of fishing effort applied in 2008. More recently in 2018, Zone A of the Jobuko/Pomo Pit FRA area prohibited bottom fishing with the objective of contributing to the protection of VMEs (Rec. GFCM/41/2017/3).

GFCM adopted a recommendation for the "establishment of a set of measures to protect vulnerable marine ecosystems formed by cnidarian (coral) communities in the Mediterranean Sea" (Rec. GFCM/43/2019/6). This encourages (i.e. no legal requirement) CPCs to progressively implement transitional measures to prevent SAI from bottom fisheries on VMEs. This recommendation is designed to protect a list of 15 coral species that are listed in Annex II of the SPA/BD Protocol of the Barcelona Convention.

The above measure supports the protocols for the protection of VMEs in the GFCM area of application endorsed by the forty-second session of the GFCM and reported in Appendix 17 of the 42nd Commission report (pp. 128-134, GFCM, 2019). The protocol is applied to vessels above 15m LOA fishing for deep water shrimp species and vessels above 15m LOA using bottom contact gears in depths greater than 300 m. It includes an encounter protocol and an extensive list of VME indicator features, habitats and taxa. The protocol also asks for the reporting of all encounters with VME indicators and will use this information to support its GFCM Mediterranean geodatabase on VME indicator features and species (GFCM, 2019).

Fishing areas

Recommendation GFCM/2005/1 on "The management of certain fisheries exploiting demersal and deep water species" notes, in the preamble, that this recommendation is primarily aimed at protecting fish stocks from expanding fisheries when their status is unknown. It also notes in the preamble "RE-AFFIRMING the principles of the FAO Code of Conduct for Responsible Fisheries and recalling the precautionary approach to fisheries management therein and, in particular, in relation to the development of new fisheries;". The recommendation states for "deep water fisheries" that the Members of the GFCM shall prohibit the use of towed dredges and trawl nets fisheries at depths beyond 1000 m of depth. This is only a very general prohibition and does not afford protection to VME in areas less than 1000m depth.

Indicator species

The Commission endorsed the "The list of VME Indicator Features, Habitats and Taxa for the Mediterranean Sea is given in Annex 2 of GFCM/2019/6 This includes various representatives of cnidaria (anthozoa, hydrozoa), porifera (demospongiae, hexactinellida), bryozoa, echinodermata, mollusca, and certain chemosynthetic mollusca, annelida and arthropoda.

Encounter protocols

The Commission endorsed the "Recording of any VME taxa caught on form provided in Annex 2 of Res 2019/6 and reporting to the Secretariat within 30 days".

Thresholds

All encounters with VME indicator taxa are to be reported, but to date no management measures are currently applied, so that while GFCM is made aware of the destruction of VME indicator taxa during the course of fishing operations, no effective preventive measures are in place, as required under the UNGA provisions.

5.1.5. NORTH PACIFIC FISHERIES COMMISSION (NPFC)

Interim measures were initially adopted for both the Northwest and Northeast Pacific Ocean that support UNGA Res. 61/105 and the FAO DSF Guidelines. Participants have reported to the meetings on the implementation of these.

National reports on the identification of potential VMEs and assessments of impacts caused by bottom fishing activities have to be compiled and can be found at the NPFC website.

During its establishment phase (2006-2015), no closures were adopted to protect known or likely VME areas, though a closure on the south-eastern part of Koko seamount was agreed upon by Japan, Korea and Russia in 2009 and national measures were made to apply this to their flagged vessels. This closure was formalised by NPFC in 2017 though their newly adopted bottom fishing measures. The C-H seamount was initially closed in 2009 to protect aggregations of Pacific armour head, though through the new measures this closure on C-H seamount is also closed to protect possible VMEs that may occur there.

Fishing Areas

In the NW Pacific the following measures apply to the areas that can be fished west of 175 degrees W longitude (CMM 2018-05): The following seamounts have been identified as fished seamounts: Suiko, Showa, Youmei, Nintoku, Jingu, Ojin, Northern Koko, Koko, Kinmei, Yuryaku, Kammu, Colahan, and C-H. (Annex 2.4(1)). Also: 4A. Limit fishing effort in bottom fisheries on the western part of the Convention Area to the level agreed in February 2007 in terms of the number of fishing vessels and other parameters which reflect the level of fishing effort, fishing capacity or potential impacts on marine ecosystems. Regulations include:

- 4B Not allowing bottom fisheries to expand into the western part of the Convention Area where no such fishing is currently occurring, in particular, by limiting such bottom fisheries to seamounts located south of 45 degrees N latitude and refrain from bottom fisheries in other areas of the western part of the Convention Area covered by these measures and also not allow bottom fisheries to conduct fishing operation in areas deeper than 1,500m.
- 4H. C-H seamount and South eastern part of Koko seamount, specifically for the latter seamount, the area South of 34 degrees 57 minutes North, East of the 400m isobaths, East of 171 degrees 54 minutes East, North of 34 degrees 50 minutes North, are closed precautionary for potential VME conservation. Fishing in these areas requires exploratory fishery protocol (Annex 1).
- 6A. Collection of Information for purposes of defining the footprint. In implementing paragraphs 4A and 4B, the Members of the Commission shall provide for each year, the number of vessels by gear type, size of vessels

(tons), number of fishing days or days on the fishing grounds, total catch by species, and areas fished (names of seamounts) to the Secretariat. The Secretariat shall circulate the information received to the other Members consistent with the approved Interim Data Handling and Data Sharing Protocol. To support assessments of the fisheries and refinement of conservation and management measures, Members of the Commission are to provide update information on an annual basis.

In the NE Pacific, measures apply to the areas that can be fished east of 175 degrees W longitude (see CMM 2018-06).

The following seamounts have been identified as fished seamounts: Brown Bear, Cobb, Warwick, Eickelberg, Pathfinder, Miller, Murray, Cowie, Surveyor, Pratt, and Durgin. (Annex 2.4(1)). Other relevant measures are: 3i. Limit fishing effort in bottom fisheries on the Eastern part of the Convention Area to the level of a historical average based on previous fishing effort.

Indicator species

In both management areas, cold water corals include: Alcyonacea, Antipatharia, Gorgonacea, and Scleractinia, as well as any other indicator species for vulnerable marine ecosystems, as may be identified from time to time by the SC and approved by the Commission.

Exploratory fishing protocol

In the 2nd Meeting of the Small Scientific Committee on Bottom Fish Report (NPFC-2017-SSC VME02), it was agreed that each member of the Commission is to conduct assessments to establish if bottom fishing activities are likely to produce SAIs in a given seamount or other VMEs. Such an impact assessment is to address, and this requires identification, description and mapping of VMEs known or likely to occur in the fishing area.

Exceptions to the restrictions above may be provided in cases where it can be shown that any fishing activity beyond such limits or in any new areas would not have SAIs on marine species or any VME. Such fishing activity is subject to an exploratory fishery protocol outlined in Annex 1 of the report 'Exploratory fishery protocol in the north Pacific Ocean'.

Encounter protocols

In both areas encounter protocols are defined in the relevant CMM, but are the same regardless of area. If more than 50Kg of cold water corals are encountered in one gear retrieval, Members of the Commission shall require vessels flying their flag to cease bottom fishing activities in that location. In such cases, the vessel shall not resume fishing activities until it has relocated a sufficient distance, which shall be no less than 2 nautical miles, so that additional encounters with VMEs are unlikely. All such encounters, including the location and the species in question, shall be reported to the Secretariat, who shall notify the other Members of the Commission so that appropriate measures can be adopted in respect of the relevant site. However, there are no temporary measures such as closures, no requirements to collect supplementary information in the event of encounter and it is not clear who shall communicate to the Secretariat and timelines are not specified.

Thresholds

In both management areas the threshold for indicator species is set at 50Kg or more in one gear retrieval.

5.1.6. SOUTH PACIFIC REGIONAL FISHERIES MANAGEMENT ORGANISATION (SPRFMO)

In May 2007, Interim Management Measures for bottom fisheries were adopted at the 3rd International Consultations. These voluntary measures committed the Participants to not expand bottom fishing activates into new regions of the Convention Area where such fishing is not currently occurring. The Interim Benthic Assessment framework (also adopted at the 3rd International consultation) lead to the creation of a SPRFMO joint trawl footprint map. This joint trawl footprint map was defined using bottom trawl tracks, 20 minute resolution blocks and a reference period of 2002-2006. Participants in (benthic and bentho-pelagic) trawl fisheries in the SPRFMO Area agreed not to fish outside this joint trawl footprint. Australia, Chile, Korea and New Zealand all submitted bottom footprint data. The footprints are managed by the individual countries, and so SPRFMO has not yet adopted a joint bottom fishing footprint. However, flag States should provide all maps related to proposed fishing activities to the Secretariat in a compatible GIS format, for inclusion in the SPRFMO geo-spatial database. To facilitate evaluation of the relationship between proposed fishing areas, the SPRFMO Secretariat, develops and maintains electronic geospatial maps of joint bottom fishing effort and makes these maps available to participants.

SPRFMO CMM 03-2017 promotes the sustainable management of bottom fisheries including target fish stocks as well as non-target species taken as bycatch, in these fisheries, and to protect the marine ecosystems in which those resources occur, including, the prevention of significant adverse impacts on vulnerable marine ecosystems. SPRFMO CMM 08-2019 prohibits the use of all deep water gillnets in the Convention Area. An analysis of demersal fished areas using Australia-New Zealand demersal trawl data for 1990-2006 was presented at the 1st SC meeting in 2013.

Fishing areas

Exploratory and targeted commercial fishing is thought to have taken place in the area since at least the 1970s. Fisheries tend to be concentrated in areas of higher productivity where there is upwelling of nutrients, often associated with seamounts and ridges which are also the only places shallow enough to bottom fish. Although there are numerous sea-mounts and ridge systems in the South Pacific high seas, only the most prominent appear (i.e. the Lord Howe Rise, the South Tasman Rise, and the Louisville Ridge) to have been fished to any extent. Given the extent and great depth of much of the South Pacific Ocean, research into the biodiversity of the high seas of the South Pacific Ocean is still in its infancy.

The Commission has established Management Areas for a) Bottom trawl Management Area, b) Mid-water trawl Management Area, c) Bottom line Management Area. Unless a Member or CNCP is fishing in an exploratory fishery established pursuant to CMM 13-2020 (Exploratory Fisheries), bottom trawling may only occur in a bottom trawl Management Area; b) Midwater trawling shall only occur in a midwater trawl Management Area or a bottom trawl Management Area; c) Bottom lining shall only occur in a Management Area.

A complete suite of bottom fishing measures was adopted with CMM 03-2019 (extended with CMM 03-2020) that defined the areas that could be fished with bottom trawl, mid-water trawl and bottom line, known as the “management areas”. There is a “hierarchy with the bottom fishing management areas, as bottom line can fish in the bottom and mid-water trawl areas, and the mid-water trawl can fish in the bottom trawl areas. Fishing outside of a management area, or within a management area using a prohibited gear, is subject to the exploratory fishing protocol (CMMM 13-2020). Delineated areas closed to bottom fishing to protect VMEs are not currently used in SPRFMO. Rather they have very precisely defined polygons within the management areas whose status is regularly reviewed.

Under CMM 08-2019 - Conservation and Management measure for Gillnets in the SPRFMO Convention Area. Members shall require that vessels flying their flag prohibit the use of large-scale pelagic driftnets and all deep water gillnets in the Convention Area.

Indicator species

Indicator species are listed in Annex 5 of CMM 03-2020 which lists the vulnerable taxa and habitat indicators, e.g. various sponges, corals, armless stars, and sea lilies. The species used are shown in Table 5.1.6.1.

Table 5.1.6.1 List of VME Indicator Taxa (CMM 03-2020 ANNEX 5)

Taxonomic Level	Common Name	Qualifying taxa
Vulnerable taxa		
Phylum Porifera	Sponges	All taxa of the classes Demospongiae and Hexactinellidae
Phylum Cnidaria		
Class Anthozoa		
Order Scleractinia	Stony corals	All taxa within the following genera: *Solenosmilia; Goniocorella; Oculina; Enallopsammia; Madrepora; Lophelia*
Order Antipatharia	Black corals	All taxa
Order Alcyonacea	True soft corals	All taxa excluding Gorgonacea
Informal group Gorgonacea	Sea fans octocorals	All taxa within the following suborders: Holaxonia; Calaxonia; Scleraxonia
Order Pennatulacea	Sea pens	All taxa
Order Actiniaria	Anemones	All taxa
Class Hydrozoa		
Order Anthoathecatae		
Family Stylasteridae	Hydrocorals	All taxa
Habitat indicators		
Phylum Echinodermata		
Class Asteroidea		
Order Brisingida	Armless stars	All taxa
Class Crinoidea	Sea lillies	All taxa

Exploratory fishing protocol

Proposals to undertake bottom fishing: a) outside a Management Area; or b) inside a Management Area using bottom fishing methods other than bottom trawl, midwater trawl or bottom line fishing; or c) in a mid-water trawl Management Area using bottom trawl gear or in a bottom line Management Area using bottom trawl or midwater trawl gear; or d) inside a Management Area targeting species not previously targeted in the area proposed to be fished (unless the species has regularly been caught as part of an existing fishery); shall be handled in accordance with CMM 13-2020 (Exploratory Fisheries).CMM 13-2020 provides the guidance, requirements and procedures for the management of new and exploratory fishing areas according to the protocol in CMM 03-2020, including the duties of the various SPRFMO committees in the evaluation of applications for exploratory fisheries.

Encounter protocols

“Encounter” means catch of a VME indicator taxa above threshold levels as set out in CMM03-2020: "Where VME indicator taxa are encountered in any one tow at or above the threshold limits in Annex 6A, or three or more different VME indicator taxa at or above the weight limits in Annex 6B, Members and CNCPs shall require any vessel flying their flag to: a) cease bottom fishing immediately within an encounter area of one (1) nautical mile either side of the trawl track extended by one (1) nautical mile at each end; b) report the encounter immediately to the Member or CNCP whose flag the vessel is flying and the Secretariat, in accordance with the Guidelines for the preparation and submission of notifications of encounters with potential VMEs, contained in Annex 7." Where a Member or CNCP vessel triggers an encounter, the SC will review the encounter and temporary closures will remain in place until adequately reviewed. The SC will then make specific recommendations to the Commission on appropriate the management response (SC9-DW08). For example, a VME Encounter Review was conducted at the 9th SC (SC9-DW09) following an encounter by a New Zealand flagged vessel. This included details of the encounter and its consistency with habitat suitability models, and an evaluation of impacts and management actions to prevent significant adverse impacts on vulnerable marine ecosystems. It was noted that given the small scale of historical impacts and the assessment of a low likelihood of VME presence, New Zealand recommended that reopening the area to fishing was unlikely to cause further SAIs to VMEs. Based on this review it was proposed that the Scientific Committee provides advice in the future to the Commission on management actions to prevent significant adverse impacts on vulnerable marine ecosystems.

Threshold

The thresholds are given in Annex 6(A) and 6(B). Annex 6(A) of CMM 03-2020. For single VME taxa encounters (Sponges (50kg), Stony corals (80kg), Black Corals (5kg), True soft corals (60kg), Sea fan octocorals (15kg), Anemones (40kg)). Annex 6(B) is for 3 or more taxa and thresholds are either 1kg or 5kg per taxa.

5.1.7. SOUTHERN INDIAN OCEAN FISHERIES AGREEMENT (SIOFA)

The Indian Ocean is rich in ocean ridges and their associated seamounts, hydrothermal vents and trenches. However, the area has not been well mapped for benthic ecosystems, though the topography identifies many features that potentially contain VMEs. The importance of identifying and managing VMEs was recognized in preliminary discussions at the second Meeting of the Parties in 2015. Australia prepared a report on bottom fishery impact assessments in the southern Indian Ocean, and presented a proposal at the first meeting of the scientific committee where several aspects in relation to addressing impacts of bottom fisheries on VMEs were discussed. This included the constraints and opportunities of using habitat mapping and predictive modelling for the identification of VMEs, and the process that led to delineation of the designated benthic protected areas (BPAs) in the Indian Ocean. In 2016, SIOFA adopted measures to initiate the process of mapping existing fishing areas, limit bottom fishing effort, and to direct flagged States to develop their own interim measures until SIOFA have the necessary information to adopt their own full regional measures on bottom fisheries and VMEs. CPCs were asked to provide an update on Interim Bottom Fishing Measures in 2021, however some CPCs failed to do so (Mauritius). SIOFA has done little to protect VMEs in comparison to other RFMOs. For example, SIOFA has not established a bottom fishing footprint., nor adopted an RFMO-wide encounter protocol.

SIOFA provisionally designated five protected areas in 2018: Atlantis Bank, Coral, Fools Flat, Middle of What, and Walter's shoal (CMM 2020/01).

The SIOFA Scientific Committee (SC) provides advice and recommendations, to the Meeting of the Parties (MoP), on Bottom Fishing Impact Assessment (BFIA), (ref. CMM 2019/01 paragraph 7b). Work is overseen by the Protected Areas and Ecosystems Working Group (PAEWG), in accordance with the SIOFA Bottom Fishing Impact Assessment Standard (BFIAS), and takes into account all activities of bottom fishing vessels. The purpose of the BFIAS is to provide a minimum standard for assessing the potential impacts of proposed bottom fishing activities on VMEs and deep sea fish stocks. The potential impacts include consideration of past fishing activity and the cumulative effects of fishing. The standard is intended to guide SIOFA parties in preparing the required BFIA, and to guide the SC when reviewing the assessments. It is intended to constitute the standardised approach to be taken by all Contracting Parties (CCPs), Collaborating and Non-Contracting Parties (CNCPs) and Participating Fishing Entities (PFEs) when preparing risk and impact assessments for high seas, bottom fishing activities.

BFIAs[2] are conducted by contracting parties and 10 have been conducted so far. These are prepared in accordance with the FAO Guidelines (CMM 2020/01), and participants are required to prepare bottom fishery impact assessments for all proposed bottom fishing activities in the SIOFA Area, irrespective of the proposed scale, area or previous history of such fishing activities (see paragraph 21 (CMM 2020/01)). In addition, any Contracting Party, CNCP or PFE that authorises, or is seeking to authorise, any vessel flying its flag to bottom fish in the Agreement Area shall, at least 30 days prior to the commencement of the ordinary meeting of the Scientific Committee in 2018, submit to the Secretariat a Bottom Fishing Impact Assessment for its individual bottom fishing activities in the Agreement Area. This shall to the extent possible, accords with paragraph 18 (BFIA)." Any Contracting Party, CNCP and PFE that has prepared, or prepares, a BFIA prior to this CMM entering

[2] http://www.apsoi.org/bf-impact

into force is encouraged to submit this BFIA to the Scientific Committee as soon as possible.

Further information on VMEs in the Southern Indian Ocean and can be found in the BFIAs and in SIOFA CPPs (2021).

In the areas provisionally designated as protected areas in the Interim Protected Area Designation (CMM 2020/01a) CCPs shall prohibit all vessels flying their flag from engaging in bottom fishing, excluding line and trap methods; and for all other gears, CCPs shall ensure each vessel flying their flag has a scientific observer onboard at all times while fishing inside those areas (Para 36, part). The CM also establishes the threshold levels for encounters with VMEs by gear type and the extension of the fishing ban when they have been exceeded.

Fishing areas

Each Contracting Party, CNCP (Collaborating Non-Contracting Parties) and PFE (Participating Fishing Entities) shall, unless otherwise approved by the Meeting of the Parties, establish and apply specific measures to limit the level and spatial extent of the bottom fishing effort of vessels flying their flag (10(1)), and ensure that there is no significant adverse impact (SAI) on VMEs (10(1)(a)iii). Also, to submit data on spatial extent of their historical fishing effort by 2018 (20(a)). Bottom Fisheries Impact Assessments are to be submitted to the Scientific Committee by 2018 (21-26).

Mapping and description of proposed fishing areas, are provided by contracting parties for the proposed fishing areas in relation to available information on VMEs and seabed bathymetry. Where possible, the SIOFA Secretariat will make the SIOFA geospatial maps of VMEs, bathymetry, predicted VME habitat and historically fished areas available to facilitate mapping of proposed fishing activities in context with this baseline geo-spatial information. To facilitate evaluation of the relationship between proposed fishing areas, an appropriate SIOFA bottom fishing footprint and existing VME maps, participants should provide all maps related to proposed fishing activities to the Secretariat in a compatible GIS format, for inclusion in the SIOFA geo-spatial database (where possible, noting confidentiality restrictions).

Indicator species

The SIOFA Secretariat adapted the CCAMLR current taxa list for use in the SIOFA area. The SIOFA VME taxa list is almost the same as CCAMLR's. Only the Andamussium colbecki listing was removed as recommended by SC4. VME indicator taxa are listed in Annex 1. These are Chemosynthetic organisms, Cnidaria (Gorgonacea, Anthoathecatae, Stylasteridae, Scleractinia, Antipatharia, Zoantharia, Actiniaria, Alcyonacea, Pennatulacea), Porifera (Hexactinellida, Demospongiae); Ascidiacea, Bryozoans, Brachiopoda, Pterobranchia, Serpulidae, Xenophyophora, Bathylasmatidae, Stalked crinoids, Euryalida, and Cidaroida. The PAEGW noted that this list had been adapted from that of CCAMLR and agreed on the need to investigate other taxa that do not occur in the CCAMLR Area, including possible VME indicators in fishing grounds in the SIOFA Area north of 45° South.

Exploratory fishing protocol

A CCP seeking to authorise any vessel flying its flag to undertake bottom fishing in the Agreement Area in a manner at variance with the requirements of paragraph 10 to limit the bottom fishing effort of vessels flying its flag shall submit, to the Scientific Committee and at least 30 days prior to an ordinary meeting of the Scientific Committee, a proposal to undertake that activity or activities. This proposal shall include an assessment of the impact of the proposed fishing activity in accordance with the requirements for BFIAs outlined in paragraph 26, any proposed measures to mitigate that impact, and any other information as required by the Scientific Committee to undertake the assessment in paragraph 23 (21).

Encounter protocols

Each Contracting Party, CNCP and PFE shall have provisions to ensure its bottom fishing will not have significant adverse impacts on VMEs taking into account the submitted BFIA and any areas identified under paragraph 18 where VMEs are known to occur, or are likely to occur. Also, to cease bottom fishing activities within 2 nm of a bottom or mid-water trawl track, and 1 nm from longlines, traps and other gears (13). Encounters above threshold are to be included in the National Reports to the Scientific Committee using Annex 2 of the SIOFA Bottom Fishing Impact Assessment Standard. The VME taxa encounter shall be reported to the Secretariat (13) who will notify CCPs within three days that bottom fishing is suspended in the area (14). On the basis of the advice of the Scientific Committee, the MoP shall decide to confirm whether the encounter area should remain closed to all or some gears (section 17 CMM 2020/01 (Interim Management of Bottom Fishing)).

A consultancy has been awarded to conduct a bottom fishing impact assessment for trawl and longline gears in SIOFA. However, the report is not available yet.

Thresholds

Threshold levels for encounters with VMEs are established and based on best judgement, these are (a) the threshold that triggers the encounter protocol for longline gears shall be the catch/recovery of 10 or more VME-indicator units of species listed in Annex 1 in a single line segment. (b) The threshold that triggers the encounter protocol for the trawls shall be more than 60 kg of live corals and/or 300 Kg of sponges in any tow (12). The PAEWG in 2021 has been working to revise the VME encounter thresholds for trawl gears. So far, it has reviewed the VME thresholds specified in each CCP's Bottom Fishing Impact Assessments (BFIAs), as a possible basis for determining SIOFA VME encounter thresholds for trawlers.

CMM 2019/01, SIOFA adopted a threshold that triggers the encounter protocol for the trawls, of 60kg of live corals and/or 300kg of sponges in any tow, which was to be revised by the Scientific Committee in 2020. However, the SC-5 did not do so. In 2021 Regarding VME encounter thresholds, the SC NOTED that it would be worthwhile to consider the thresholds, or the processes to agree thresholds, adopted by other RFMOs, such as those described by SPRFMO in SC5-DW06. The SC recommended hiring a consultant to assist with this work. However, there has been no action on this.

5.1.8. COMMISION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES (CCAMLR)

CCAMLR has adopted a suite of conservation measures that restrict the extent of bottom fishing by closing areas to directed fishing as well as measures that have been specifically introduced to protect benthic communities including VMEs and potential VMEs in areas beyond national jurisdiction (i.e. high-seas), these are:

CM 22-04 (since 2006) – Interim prohibition of deep sea gill netting;
CM 22-05 (since 2006) – Restrictions on the use of bottom trawling gear;
CM 22-06 (since 2007) – Bottom fishing in the Convention Area;

CM 22-07 (since 2008) - Interim measure for bottom fishing activities subject to Conservation Measure 22-06 encountering potential vulnerable marine ecosystems in the Convention Area;
CM 22-08 (since 2009) - Prohibition on fishing for *Dissostichus* spp. in depths shallower than 550 m in exploratory fisheries; and,
CM 22-09 (since 2011) Protection of registered vulnerable marine ecosystems in Subareas, Divisions, small-scale research units, or management areas open to bottom fishing.

The only bottom fishing currently permitted by CCAMLR in the high-seas of its Convention Area are bottom-set longline fisheries targeting toothfish (predominantly *Dissostichus mawsoni*, and to a lesser extent *Dissostichus eleginoides)*. The use of pots (traps) for targeting toothfish is also permitted but this gear is infrequently used. Both species of toothfish have circumpolar distributions and are targeted by fisheries operating at depths of 600–1800 m.

Fishing areas

There are seven high-seas exploratory fisheries and three established fisheries targeting toothfish in the Convention Area (Table 1), these are shown in Table 2. Established fisheries for toothfish, outside of territorial seas, occur in SA 48.3 (CM 41-02) and Division 58.5.2 (CM 41-08).

Table 1 High seas fisheries within CCAMLR

CM	Subarea or Division	Classification
41-02[3]	48.3[4]	Established
41-03	48.4**Error! Bookmark not defined.**	Established
41-04	48.6	Exploratory
41-05	58.4.2	Exploratory
41-06	58.4.3a	Exploratory
41-07	58.4.3b	Exploratory
41-08	58.5.2	Established
41-09	88.1	Exploratory
41-10	88.2	Exploratory
41-11	58.4.1	Exploratory

[3] During 2121 no consensus could be obtained on a catch limit for 48.3, there was subsequently no CM in place for this Subarea during the 2022/23 season.
[4] Technically the fishable area within these two Subareas lie within territorial seas and are managed under both CCAMLR and a domestic regime.

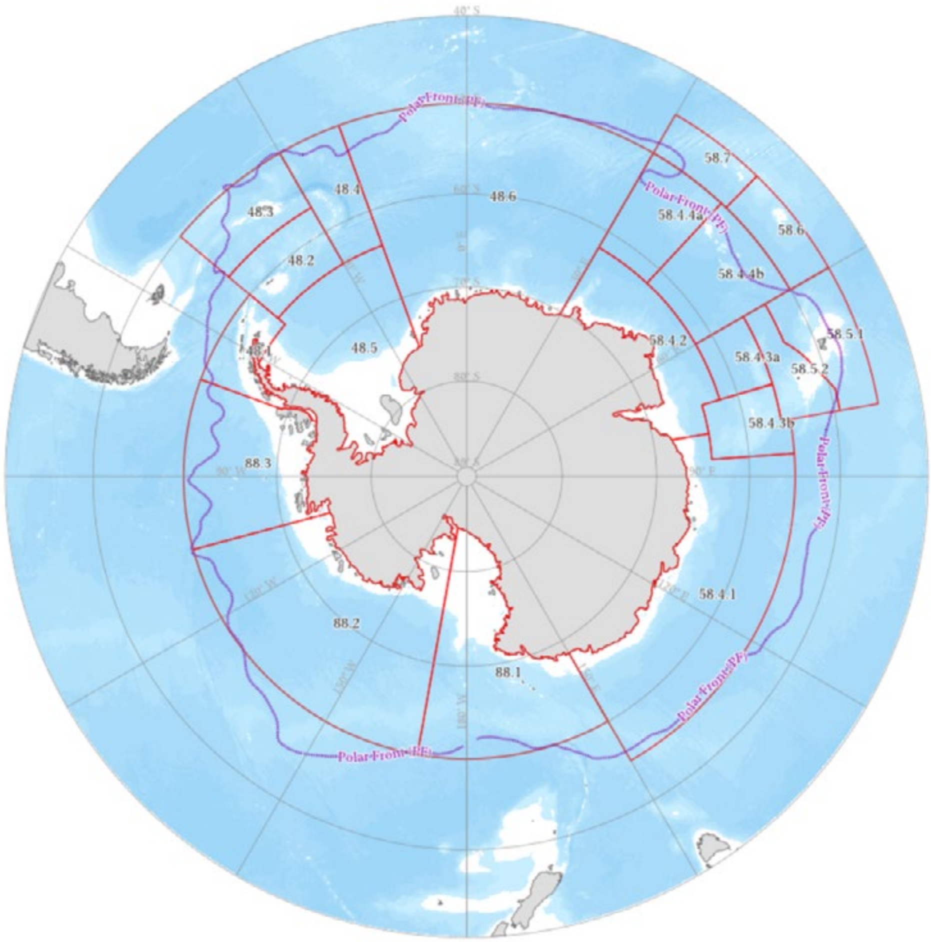

Figure 7 Map of the CCAMLR Convention Area showing the fishing areas (Subareas and Divisions)

Indicator species

VME indicator taxa are any benthic organisms listed in the CCAMLR VME Taxa Classification Guide (Para. 2ii) (CM 22-07). It divides VME taxa into 23 categories, at either class, order or phylum level. They were selected on seven criteria, based on the characteristics developed by the FAO. These included whether they were habitat forming, their longevity, speed of growth, fragility, larval dispersal potential, the lack of adult motility and whether they are rare or unique populations. Each of these criteria were evaluated for each taxonomic group based on their life history traits taken from available literature and rated as low, medium of high depending on the parameters outlined under each one. The seven criteria included in the evaluation of benthic taxa are defined below and the results summarised in Table 2.

1. Habitat-forming – One of the main characteristics of the structural species within VMEs is the degree to which they create habitat that could be used by other organisms. The relative degree to which organisms contribute to generating this habitat was classified as Low, Medium or High.

2. Longevity – Mortality of long-lived organisms can result in long recovery periods to regenerate unfished age structure. Longevity was categorised into the three levels with respect to the length of time an ecosystem takes to recover from fishing impacts and how this recovery time relates to the objectives of the Convention.

3. Slow growth – Organisms which grow slowly will take a longer time to attain a large size or reproductive maturity. Vulnerability related to growth rate was classified as Low for fast growth rates, Medium, and High for slow growth rates.

4. Fragility – The potential for damage or mortality resulting from physical disturbance from bottom fishing gear was classified as Low (organisms that are resistant due to their structure or behaviour), Medium, or High (tall, brittle, or otherwise easily damaged).

5. Larval dispersal potential – The range of dispersal by larvae and propagules influences the ability of a species to recolonise impacted areas. Taxa consisting of brooding species were scored High, broadcast spawners Low, and taxa with a mix of both strategies were scored Medium.

6. Lack of adult motility –The lack of motility does add some degree of vulnerability and decreases resilience because as adults those organisms cannot redistribute themselves in response to a direct disturbance, adjust their position if altered in some way, or move into a disturbed area to recolonise. Organisms that are completely sessile were classified as High; those with some limited potential for movement as Medium, and typically motile as Low.

7. Rare or unique populations – Vulnerable taxa containing species that create dense, isolated populations are intrinsically vulnerable because they have a more limited potential for recovery. This criterion was classified as High if populations are isolated, and Medium or Low as population patch size or frequency of occurrence increases.

Table 2 VME taxonomic groups used by CCAMLR showing the intrinsic factors contributing to their vulnerability (adapted from SC-CCAMLR-XXVIII, Annex 10).

Taxon	Habitat forming	Rare or unique	Longevity	Slow growth	Fragility	Larval dispersion	Lack of motility
Phylum Porifera							
Hexactinellida	H	L	H	H	H	M	H
Demospongiae	H	M	H	H	H	M	H
Phylum Cnidaria							
Actiniaria	L	L	H	L	L	M	M
Scleractinia	H	M	H	H	H	M	H
Antipatharia	M	L	H	H	H	L	H
Alcyonacea	M	L	M	L	M	M	H
Gorgonacea	M	L	H	H	H	M	H
Pennatulacea	L	H	H	M	H	L	M
Zoanthida	L	L			M	L	H
Hydrozoa							
Hydroidolina	L	L			L		H
Family Stylasteridae	H	L	H	M	H	H	H
Phylum Bryozoa	H	L	H	M	H	H	H
Phylum Echinodermata							
Crinoidea: Stalked crinoid orders	L	H	H		H		H
Echinoidea: Order Cidaroida	M	L	H	H	M	H	L
Ophiuroidea: Basket and snake stars	L	L			H	L	M
Phylum Chordata: Class Ascidiacea	M	L		L	L	L	H
Phylum Brachiopoda	L	H	H	L	M	M	H
Phylum Annelida: Family Serpulidae	M	L			H	L	H
Phylum Arthropoda: Infraclass Cirripedia:	L	H	H		M	L	H
Bathylasmatidae							
Phylum Mollusca: Pectinidae	L	H	H	M	M	L	M
Phylum Hemichordata: Pterobranchia	M	M			M	H	H
Phylum Xenophyophora	L	H			H		H
Chemosynthetic communities	H	H	H	H	H	L	H

The categories and assessments in Table 2 were discussed at the 2009 VME Workshop (SC-CCAMLR-XXVIII, Annex 10) and it was agreed that the table should be a living document, updated as more information becomes available. Areas in the table where no score was given would be important for identifying information gaps.

Exploratory fishing protocol

CCAMLR define an exploratory fishery as 'a fishery that was previously classified as a 'new' fishery'. It shall continue as an exploratory fishery until enough information is obtained on target and dependent species to allow appropriate catch and effort levels to be set as well as gear restrictions, if appropriate. The protocol for exploratory fisheries is outlined in CM 21-02 "Exploratory fisheries" and involves contracting parties submitting a Fishery Operational Plan for their vessels proposing to fish in the upcoming season. This includes an assessment of their impact on VMEs which was adopted in 2007, the process is outlined in CM 22-06 "Bottom fishing in the Convention Area", paragraph 7. It involves submitting a Pro forma (Annex 22-06/A) giving a description of the fishing gear, how it is expected to behave, the 'footprint index' (per km^2 of fishing effort), expected scale of fishing activity and any methods used to significant impacts to VMEs. This only applies to certain areas (any south of 60°S, the rest of the Convention Area apart from Subareas and Divisions that has had an established fishery since 2006/07 and Division 58.4.1 north of 60°S), and vessels that have previously submitted an assessment need not submit another one unless they change their fishing gear or move to another Subarea or division.

Encounter protocols

VME encounter protocols, for the areas applicable to this measure, were first adopted in 2007 and are outlined in CM 22-06 paragraphs 8-10 and in more detail 2008 under CM 22-07 paragraphs 3-7. There are two protocols in place, depending on the number of 'VME indicator units' (defined below) recovered. The most extreme consists of a move on rule, triggered once a certain threshold of indicator units are recovered from a set length of line segment. The vessel is then required to haul lines and immediately inform the Secretariat and its flag State, giving the location of the midpoint of the segment along with the number of units recovered. The area within a radius of 1 nautical mile of the midpoint will be designated as a 'Risk Area' and be closed to fishing until further review by the Scientific Committee. The Secretariat will communicate this to the relevant fleets within 24 hours of receiving the notification.

A secondary protocol, should a lesser threshold of indicator units be recovered, again involves the vessel notifying the Secretariat and its flag State. In this case the Secretariat will record the location of midpoint, should they receive five notifications from within a single fine scale rectangle (defined as an area of 0.5° latitude by 1° longitude) they will inform the fleet of the coordinates of the rectangle and indicate that there may be VMEs in the area. Vessels can continue to fish and no other action is taken.

These protocols were developed after a number of options were considered by the Scientific Committee (SC-CAMLR-XXVI, Annex 5). These included:

i. Moving to another location until a full evaluation has been undertaken.
ii. Conducting research activities, including repeat sampling and use of cameras, to gather data for further evaluation.
iii. Temporarily closing the area to all vessels until further evaluation.

The current protocol is a hybrid of (i) and (iii).

Thresholds

Threshold levels, and the actions taken when they are reached, are defined in CM 22-07. Paragraph 3 requires all vessels conducting bottom fishing using longlines or pots are required to clearly mark fishing lines into line segments and collect segment-specific data on the number of VME indicator units. A VME indicator unit is either one litre of those VME indicator organisms that can be placed in a 10-litre container, or one kilogram of those VME indicator organisms that do not fit into a 10-litre container (paragraph 2iii). The unit was defined based on advice from the Scientific Committee as it was considered easiest for vessel crews to follow, rather than for any biological reasons. A Risk Area is designated by the Secretariat where 10 or more VME indicator units are recovered within a single line segment, this triggers the encounter protocol outlined above. If five or more VME indicator units are recovered within one line segment the secondary protocol, outlined above, will be triggered.

5.2 Recommendations on existing approaches, alternatives and best practices

Based on the reviews above, here we summarise the strengths and weaknesses of the evaluation process and the effectiveness of the measures for providing a robust scientific evidence base for decision-makers, and potential modelling approaches. Then make recommendations on the clarity and efficacy of measures. Task 6, will identify gaps in research and priorities of the different scientific topics. How these can be implemented as part of an efficient and effective conservation framework will be specified in collaboration with Task 6.

In the next sections strengths and weaknesses are summarised by region.

5.2.1. NORTH ATLANTIC FISHERIES ORGANIZATION (NAFO)

Strengths

Measures are in place to protect VMEs, these are stipulated in Chapter II of the NAFO Conservation and Enforcement Measures (NCEM) (NAFO, 2021a).

Area closures, take into account a variety of VMEs base on different indicators (e.g., large-sized sponges, sea squirts, erect bryozoans, pens, black coral, NAFO, 2021a). NAFO has also been evaluating potential management options for the protection of VMEs in the NAFO Regulatory Area, by reviewing existing closures and taking into account the outcomes of the SAI assessment in evaluating possible trade-offs required to achieve conservation measures, whilst minimizing the possible consequences to ongoing bottom-contact fisheries. This evaluation has led to the proposal of ten extensions to existing closures, the creation of three new closures and modifications to Area 14.

Periodic reassessment of bottom fishing and impacts, is performed regularly as NAFO has established periodic reassessments of bottom fishing activities. The first re-assessment shall be conducted in 2021 and every 5 years thereafter, or when there is new scientific information indicating a VME in a given area, other new scientific information becomes available, or there is significant change in the fishery (Art. 23 NCEM —NAFO, 2021a). The assessment carried out this year (NAFO, 2021b) included three main parts: Part (i) Assessment of the risk of SAI from bottom fishing activities on VMEs in the NRA, Part (ii) Potential management options in relation to VME closures and Part (iii) Review of seamount closure boundaries.

Assessment of SAI, metrics for reassessment have been cross referenced against the six FAO SAI criteria (NAFO, 2021b). The latest assessment included for the first time an evaluation of the ecological functions associated with VMEs and the application of a VME fragmentation index. Based upon the outcome of the SAI analysis, NAFO's SC considered a number of options to improve VME protection, including move-on rules and buffer zones, however it was considered that these would have limited efficacy. Since move-on rules were not originally intended as stand-alone measures to protect VMEs and should be complemented with spatial closures and other measures. Consequently, an expert group was assembled to evaluate the benefits and consequences of extending existing closures, as well as considering the addition of new closures. This group included fisheries specialists as well as experts in benthic ecology. The analysis considered both VME area and biomass values, connectivity between VMEs, distribution of fishing effort and inter-year fishing stability over a ten-year period. The overall aim was to improve the protection of VMEs, while limiting the impact and/or consequences in terms of access to fishing locations and overall catches.

Available information regarding VME taxa are constantly revised and assessed against the FAO criteria. For example, Black corals were added to Annex I.E. Part VI of the NAFO CEM in 2021 (NAFO, 2021a).

Identification guide is published for coral, sponge and other VME indicators. The guide was written for fishers, fishery observers, scientific technicians and others who may not be familiar with invertebrate identification. This guide has helped to improve data collection and knowledge on the distribution of these vulnerable marine species (Kenchington et al., 2015).

Encounter protocols and thresholds, NAFO's SC has considered, since 2012, that such measures are a very useful tool to identify VMEs in areas where there is little survey information and the fishing activity is the main source of new data. This applies especially to new fishing areas outside of the fishing footprint. However, as the locations of the benthic VMEs become increasingly well-defined in the NRA to support informed management through closed areas the need to implement encounter protocols gradually become redundant. Recognising the limited efficacy of the move-on rule instead changes to current VME protection (as recommended by SC) have focussed on extensions to existing closures, the creation of new closures and modifications to Area 14 (NAFO 2021a).

Annual Compliance Reviews, are conducted where reporting obligations and apparent infringements (AIs) are examined (NAFO CEM —NAFO, 2021a). This compliance review considers compliance of vessels regarding closed areas and exploratory fisheries. Overall compliance with reporting obligations is high and has continued to improve in recent years. Contracting Parties are providing the required compliance indicators necessary to complete the compliance review process.

Existing bottom fishing area have been delineated in response to the United Nations General Assembly (UNGA Res. 61/105, paragraph 83) request for RFMOs to regulate bottom fisheries that cause a significant adverse impact on vulnerable marine ecosystems. Comprehensive information about the process used in the establishment of the footprint is contained in FC Doc. 09/20 (NAFO, 2009).

Research surveys are regularly carried out in the NAFO Regulatory Area, which allows for robust data collection on VME characteristics and distribution (i.e., the Spanish 3NO Survey, the EU Flemish Cap Survey, the Spanish 3L Survey and the DFO NL Multi-species Surveys). NAFO has been developing non-destructive sampling techniques to monitor VMEs and integrating these with existing survey trawl data. In closed areas non-destructive sampling surveys are preferred, for example camera-based surveys, but there would be trade-offs to consider in regard to obtaining adequate biological sampling. Another method being considered is whether calibration of non-destructive surveys with bottom trawl surveys was possible to enable a combined series of the data for monitoring purposes. The SC are currently exploring the feasibility of non-destructive monitoring surveys with the aim of developing objectives for future monitoring (NAFO, 216).

Weaknesses

Measures however, there is no real assessment of whether such measures beyond area closures (such as the move on rule) are truly effective to protect VME - this is a general comment applicable to all RFMO

Climate change impact to fisheries and subsequently VMEs needs to be addressed, and while NAFO is starting to incorporate climate change into stock assessments, there is little evidence of decision making for closed areas or quota decisions being influenced by climate-related factors, including ocean acidification on calcareous VMEs RFMOs should improve their assessment of climate vulnerability of targeted species, bycatch and VME indicators and develop frameworks for decision making with the goal of building further climate resilience (DSCC, 2020).

VMEs inside NAFO (and/or outside NAFO footprint) are currently protected against SAIs from commercial bottom fishing, but they are unprotected regarding potential threats from activities other than fishing (e.g., drilling activities inside VME closures in Divs. 3LM).

Research surveys and non-destructive sampling. In the past trawl bycatch surveys have been conducted, more recently underwater imagery, multibeam bathymetry, as well as box corers, benthic dredges and grab samples have been taken. NAFO has been developing non-destructive sampling techniques to monitor VMEs and integrating these with existing survey trawl data, this work should be further explored. Besides underwater imagery, that can be used to obtain information on the location and characteristics of potential VMEs, newer methods such as environmental DNA (eDNA) could be tested in the NAFO surveys.

5.2.2. NORTH EAST ATLANTIC FISHERIES COMMISSION (NEAFC)

Strengths

Measures are in place to protect VMEs from bottom fishing and are stipulated in Recommendation 19:2014. The recommendation has been amended on three occasions (Recommendation 09:2015, Recommendation10:2018 and Recommendation 10:2021, NEAFC, 2021). The main amendment was to explicitly define "restricted bottom fishing areas", i.e. areas outside closed areas and existing bottom fishing areas.

Area closures and buffer zones have implemented in 13 areas for the protection of VMEs. Designation of closed areas is based on advice by ICES and on the procedures set out in recommendations regulating fishing in the Regulatory Area. Recommendation 19:2014 also includes a requirement to renew the closed areas every 5 years, so that new information can be considered. According to this, the 2017 Annual Meeting renewed to 31 December 2022 all closures under the Recommendation. At the same time one of the areas, "Area (l) Hatton–Rockall Basin" was significantly enlarged following advice from ICES to extend it to encompass new records of deep-sea sponge aggregations found at 1200metres (NEAFC, 2020a). Buffer zones are often incorporated into closed area boundaries to protect VMEs from fishing activity that could stray across boundaries, and from the indirect effects of sediment plumes created by bottom-contact fishing gears. Area closures are based on the likelihood of VME being in that area and so the precautionary approach is followed in NEAFC.

Exploratory fisheries are regulated and procedures and standards are developed by the Permanent Committee on Management and Science (PECMAS) consideration of proposals for exploratory fishing pursuant to Rec. 19: 2014 (NEAFC, 2021). These provide detailed guidance for an assessment of an exploratory fishery with respect to vulnerable marine ecosystems to be undertaken by PECMAS and optionally with advice from ICES. The objective is to evaluate the risks of significant adverse impact on VMEs that may be encountered during the fishery in accordance with the precautionary approach and to account for cumulative effects. When developing these procedures, PECMAS considers experiences in similar regions and fisheries, and on mitigation measures to avoid SAI to VMEs. Approval is more likely if the risk of SAI to VMEs is seen to be zero or low. NEAFC had three applications for exploratory fisheries in 2015 but none received approval (even though none were believed to threat VMEs habitat).

Data collection/VME database. Over the past 10 years the joint ICES/NAFO Working Group on Deep-water Ecology (WGDEC) has been compiling data on the distribution and abundance of VMEs and organisms considered to be indicators of VMEs across the North Atlantic (ICES, 2011). A central portal for data on the distribution and abundance of Vulnerable Marine Ecosystems (VMEs), (and organisms considered to be indicators of VMEs) across the North Atlantic has been set up by the Joint ICES/NAFO Working Group on Deep-water Ecology (WGDEC). Criteria used to select habitats and indicators for inclusion in the database were those described in the FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas. The database is comprised of 'VME habitats' that are records for which there is unequivocal evidence for a VME, e.g. ROV observations of a coral reef; and 'VME indicators' which are records that suggest the presence of a VME with varying degrees of uncertainty. For VME indicators a weighting system of vulnerability and uncertainty is provided as part of the database to aid interpretation. The VME database may be used for many purposes. ICES uses it when providing scientifically-robust advice on the distribution of VMEs and recommending possible management solutions such as bottom fishing closures within NEAFC waters to protect VMEs.

Research in the NE Atlantic has been done through scientific surveys. For example, in the period 2005-2008, three research surveys were carried out within the Spanish project ECOVUL/ARPA (Durán Muñoz et al., 2012). These surveys identified areas where cold water corals are found and contributed to the closure of the Hatton Bank. There is current research regarding VMEs in the NEAFC area. For example, a recent study has presented a multi-criteria assessment (MCA) method to evaluate how likely a given area of seafloor represents a VME (Morato et al., 2020). This study also investigated the degrees of vulnerability of different types of VME. At present, the current scientific information on function, fragility and life-history of various types of VME indicator species suggest that some VMEs should be considered more vulnerable to anthropogenic impacts than others. For example, deep-sea stony corals aggregations create structural diverse habitats, are relatively long lived and slow growing and are very sensitive to bottom fishing impact. On the other hand, sea pens, while they are much less well understood, do not appear to as slow growing or long lived. This variation was accounted for when developing the methodology by devising a means of weighting the vulnerability of different types of VMEs (Morato et al., 2020 and references therein).

Modelling for identification of significant concentrations of VME indicators. Recently, ICES has started using modelling approaches to determine VME likelihood (i.e., kernel density estimation —KDE). WGDEC has been addressing the limitations in the use of KDE on datasets from the ICES VME database, to optimise its use for assessing VME likelihood. The potential use of Species Distribution Modelling (SDM) and Habitat Suitability Modelling (HSM), as a tool to identify areas where VME are likely to occur, has arisen several times over the last ten years in WGDEC. However, it has not yet been used to provide recommendations on how to incorporate such information when suggesting VME closures through draft ICES advice (ICES, 2020a).

Information on VME taxa continues to be revised based on the available information. The revision is performed by ICES who assessed the taxa against the FAO criteria. In 2020, the joint ICES/NAFO Working Group on Deep-water Ecology (WGDEC) was working to update the list of VME habitats and representative taxa. The proposed taxa have been evaluated against the FAO criteria for the prevention of significant adverse impacts on VMEs and protection of the marine biodiversity. Proposals have been drafted for hydrothermal vents and cold seeps, cold-water coral reefs, coral gardens, deep-sea sponge aggregations and sea pen fields. This list will be finalised inter-seasonality to include tube-dwelling anemone aggregations, stalked crinoid aggregations, xenophyophore aggregations and bryozoan patches (ICEs, 2020a; 2020b).

Fishing footprint has been delineated. Recommendation 19:2014 (NEAFC, 2021) defines "existing bottom fishing areas" as the portion of the Regulatory Area where bottom fishing has historically occurred as set out in Article 4, based on information concerning bottom fishing activities in the period 1987-2007. The coordinates of the existing fishing areas can be found in Annex I of this recommendation. It is a combined footprint for all gears over a wide range of effort. Subject to confidentiality agreements in NEAFC (e.g. NEAFC Rec.14–2017), there has been increasing availability of information on fishing vessel positions and gear deployment for scientific purposes and this has improved monitoring of targeted stocks, bycatch and protection of VMEs.

Weaknesses

Climate change. NEAFC is starting to incorporate climate change into stock assessments, however, there is little evidence of decision making for closed areas or quota decisions being influenced by climate-related factors. RFMOs should improve their assessment of climate vulnerability of targeted species, bycatch and VME indicators and develop frameworks for decision making with the goal of building further climate resilience (DSCC, 2020).

Advice on significant adverse impacts on VMEs by gear type and effort. Though NEAFC has made advances in this area of work, it is likely to be difficult to quantify and apply in practice. Its philosophy parallels the management of fish stocks with the difference being that we have in general a better general understanding of fish stocks and fisheries compared to VMEs where our understanding is growing but still minimal (Thomson and Fuller, 2021). The existence of long-term research surveys in the NEAFC region greatly enhances the data that is available and ability to collect more information in the future. Exploration of non-destructive survey methods for VME monitoring is in early stages. A crude estimate of the significance of bottom fishing impacts on VMEs could be made by conducting cumulative impact assessments. This would enable an index to be calculated that allows comparison across areas to be made. I.e. based on the percentage of the ground fished times the predicted range of the VME habitat. This includes a "core area with significant concentrations" likely to be closed to bottom fishing and marginal areas of lower density outside of this, likely to be in a buffer zone or an area open to bottom fishing. This assessment can be conducted by mapping available VMS data as it becomes available and overlaying with modelled VME spatial density species distributions (Thomson and Fuller, 2021). Advice is needed also for activities other than commercial fishing (e.g., drilling activities).

Exploratory fisheries Not applicable as no absolute limit reference points or thresholds are given and there is no mention of using NEAFC's encounter threshold limits.

Research surveys, future surveys in NEAFC could further explore the use of non-destructive sampling. Besides underwater imagery, that can be used to obtain information on the location and characteristics of potential VMEs,

VME indicators guides, currently, NEAFC has not published an identification guide for coral, sponge and other VME indicators, which should be developed to improve identification by observers. In 2012, NEAFC requested advice from ICES regarding the use of published identification guides from NAFO in the NEAFC area. Back then, ICES considered that the format of the NAFO guide was useful, given the positive feed-back from non-expert users. However, the difference in species composition between the NAFO and NEAFC areas are such that a separate guide will need to be prepared for the NEAFC area. ICES advised that a field identification guide for non-experts should not include all species that may occur, but focus on the common species or groups (morphological or functional) that are considered most important from a managerial point of view (ICES, 2012), and so improve identification by observers. Especially since in NEAFC VME indicators are considered by habitat type and/or at the taxonomic level of family rather than by all likely species that could be indicators of VMEs.

5.2.3. SOUTH EAST ATLANTIC FISHERIES ORGANISATION (SEAFO)

Strengths

Measures. COM 30/15 is the main regulation for Bottom Fishing Activities and Vulnerable Marine Ecosystems, and SEAFO uses the FAO Deep-sea Fisheries Guidelines (FAO, 2009) to define Vulnerable Marine Ecosystem (VME) and criteria for their identification. The objective of COM 30/15 is to ensure the implementation of effective measures to prevent significant adverse impacts of bottom fishing activities on vulnerable marine ecosystems, based on the best available scientific information, are known or likely to occur in the Convention Area. Measures are regularly updated on the best science, obtained via frequent request to ICES.

Fisheries closures currently total 11, and a new area on the Valdivia was closed to gears other than pots and longlines. These closures are for locations and features where VMEs are likely to occur; also see weaknesses below.

Observers are a mandatory requirement on board fishing vessels and so coverage is 100% and ensures transparency of fishing activities.

Exploratory fishing protocols exist and set out requirements prior to undertaking exploratory bottom fishing. Contracting Parties have to provide data prior to exploratory bottom fishing including from sea-bed mapping programmes, i.e. data from echo-sounders, if practicable multi-beam sounders, and data relevant to the risk assessment of significant adverse impacts on VMEs. They must also have a mitigation plan in place to prevent significant adverse impact to VMEs that may be encountered during the fishery.

Encounter protocols are established and are based on a move-on rule based on the type of gear. If the quantity of VME indicators caught in a fishing operation (such as trawl tow or set of a longline) is beyond the threshold then i) if an encounter is discovered by a trawl then the vessel shall cease fishing and move away at least 2 nautical miles from the end point of the trawl tow in the direction least likely to result in further encounters, defining a buffer area with a 2 nm radius. For other operations the vessel shall cease fishing and move away at least 1 nm from the position that the evidence suggests is closest to the exact encounter location, defining a buffer area with a 1 nautical mile radius.

Thresholds for VME encounters, are similar to those recommended in other RFMOs, these thresholds are precautionary.

The FAO ABNJ Deep Seas Project is providing invaluable assistance to SEAFO, as it supports the adoption of best practices, work on sponges, ecosystem approaches, and facilitating fisheries sector representation. A Cruise was conducted to perform basic mapping and identification of vulnerable marine ecosystems (VMEs) and fisheries resources on selected seamounts and seamount complexes in the SEAFO Convention Area (Hampton et al., 2022) This and used to formulate advice and recommendations, including the continuance of existing closures where VME indicators had been observed, and the preservation of existing fishing areas where no evidence of VME indicators was found. In the fishing areas where VMEs were observed, it was recommended that these should be closed to all fishing gears or that only pot fishing be permitted. The project is therefore of paramount importance for SEAFO, which has been taking good advantage of the opportunities that the project offers.

Weaknesses

Definition of Fishing areas are based on scientific evidence from observations of VME, however, the distributions at relevant spatial scales was largely lacking. Therefore, closing of specific areas is based on likelihood assessments rather than evidence of the actual presence of VMEs in the areas closed. This may mean that some areas are closed unnecessarily. While it is assumed that the correct decisions were made based on best available knowledge, the lack of direct mapping data also created the uncertainty that some areas may have been closed that do not contain VMEs, and other areas that do contain VMEs are left open to fishing. The ABNJ survey helped address these issues by identifying areas with VMEs.

Scientific information is scarce, despite the fact that some scientific research efforts were conducted in selected subareas of the SEAFO Convention Area in recent years. When the closures were first introduced scientific information was largely lacking. This is still largely the case today and prevent the SC from making full and satisfactory assessments of the appropriateness of currently adopted fishing closures. While it is likely that most seamounts have VME indicator present and many contain VMEs, it should also be recognized that seamounts are diverse features and that it cannot be universally assumed as a fact that all seamounts have VMEs or are shallow enough to be fished, and therefore require protection against bottom-touching fishing gears. The types of survey conducted under the ABNJ program should be extended to more areas. However, if SEAFO wants to implement correctly the provisions of UNGA Res 61/105, these seamounts should be closed, as they are likely to contain VMEs, and should only be opened up to bottom fishing once it has been demonstrated through the science that there are no VME present.

Indicator species, currently only species of sponges or corals are considered VME indicators. Other indicators commonly classified in other RFMOs, such as Echinodermata and Annelida, are not included risking a lack of protection and long term damage to potentially sensitive habitats.

Shortage of data on the occurrence of VMEs, is a problem, however, SEAFO has started to introduced comprehensive measures to protect VMEs from significant adverse impacts within the convention area. During the 11th Annual Meeting of the SEAFO Scientific Committee (October, 2015), the preliminary results from the research cruise were presented and used to formulate advice and recommendations to the Commission:

- The continuance of existing closures where VME indicators had been observed, and the preservation of existing fishing areas where no evidence of VME indicators was found; and

- In the fishing areas where VMEs were observed, it was recommended that these should be closed to all fishing gears or that only pot fishing be permitted.

More data are required however, and the type of survey conducted by ABNJ should be extended to more areas.

Fisheries closures are for locations and features where VMEs are thought likely to occur, and one of these closures is in an area that had previously been fished (Figure 6).

The FAO ABNJ survey found that:

i) The summit depths of several seamounts were considerably deeper than previously thought;
ii) As a consequence, many summits are deeper than the primary depths of distribution of the fish resources and potential fishing areas are smaller than originally considered by SEAFO; VME indicators (mainly corals) were present on all of the surveyed seamounts;
iii) There was diversity among the seamounts in terms of taxonomical composition and density;
iv) In general, the density of VME indicators increased towards the upper slopes of the seamount, in some cases leading to rich coral gardens present along the summit margins of seamounts.
v) SEAFO's target fisheries (alfonsino, pelagic armourhead, and deep-sea red crab) were often observed in video records;
vi) Estimation of their abundance using hydro-acoustics was difficult due to the rugged topography of the bottom and the benthopelagic distributions of the target species, making them difficult to distinguish from the seafloor in the hydroacoustic outputs. While the videos revealed lost fishing gears and trawl door skid marks in some previously fished areas (Valdivia and Vema), no evidence of adverse impacts to the surrounding benthic communities were observed. Areas with high densities of both live and dead coral that may be regarded as candidate VMEs located within subareas open to fishing (i.e. on Valdivia) also appeared intact.

5.2.4. GENERAL COMMISSION FOR FISHERIES IN THE MEDITERRANEAN (GFCM)

Strengths

Measures. The GFCM has not yet defined VMEs within its management measures. Through the application of the ecosystem approach to fisheries, the GFCM has adopted several Fisheries Restricted Areas (FRAs) as a multi-purpose area based management tool used to restrict fishing activities and protect essential fish habitats and deep-sea sensitive habitats. Unlike VMEs, FRA have been defined by the GFCM as "a geographically-defined area in which all or certain fishing activities are temporarily or permanently banned or restricted in order to improve the exploitation and conservation of harvested living aquatic resources or the protection of marine ecosystems" (GFCM, 2007). According to this definition, an FRA can be established to protect any kind of marine resource and habitat (e.g. aggregations of vulnerable sponges, Fishing is banned at depths below 1,000 meters, and three areas have been protected from deep-water dredging and trawl fishing.

Indicator species. Have been identified and a list has been agreed and covers a large number of species, Resolution GFCM/43/2019/6 6 Annex 2.

Closed Areas. Recommendation GFCM/2006/3 established areas protected from fishing with towed dredges and bottom trawls around the *Lophelia pertusa* reefs at Santa Maria de Luca, the cold seep ecosystems in the Nile Delta, and the benthic communities of the Eratosthenes Seamount. Identify and close areas where VMEs are known or likely to occur unless bottom fisheries are managed in such measures to prevent SAIs.

Mapping of VMEs. The Working Group on Marine Protected Areas (WGMPA) for the protection of VMEs has been established and has developed geo-referenced database, using data on *Isidella elongata* gardens as proof-of-concept. The geo-referenced database on sensitive benthic species and habitats, aims to support the identification of priority areas for which measures to prevent significant adverse impact (SAI) from fisheries on potential VMEs could be developed.

Weakness

Measures currently measures are limited to three FRAs and a prohibition on trawling below 1000m, therefore most VMEs in the Mediterranean are unprotected.

It is necessary to identify VMEs and determine whether bottom fishing activities would cause significant adverse impacts to them, by improving scientific research and data collection and sharing. This will allow assessments to be conducted, on the basis of the best available scientific information, whether individual bottom fishing activities would have significant adverse impacts on VMEs, and if so, manage these activities to prevent such impacts, or not authorise them to proceed. No specific measures are in place to map VMEs, or to assess impacts by bottom fisheries outside the three current FRAs. There is also no move-on rule or requirement to cease fishing if VMEs are encountered. Proposals have been formulated for the adoption of VME indicators (features, habitats and taxa) and management elements for the establishment of a VME encounter protocol, of an exploratory deep-sea bottom fishing protocol, and for the mapping of the existing deep-sea fishing areas for the Mediterranean.

The WGVME in has agreed on a process for the establishment and protection of VMEs and for determining the fishing footprint. A phased approach was endorsed by the Commission in 2018. The first phase triggers the voluntary adoption of an encounter reporting protocol while concurrently working towards the determination of the footprint of deep-sea fisheries and the identification of potential thresholds of VME indicator abundance beyond which (semi-) automatic move-on rules. While, the second phase foresees the adoption of an exploratory fishing protocol and an encounter protocol including move on rules. However, no binding decision for CPCs has been adopted yet on this matter. Work is still ongoing and is focussing on the GFCM database on sensitive benthic habitats and species and the identification of overlaps between fishing grounds and potential VMEs.

Definition of Fishing areas. Currently, protection is focused on deep-waters, but the progress of mapping the fishing footprint is still poor. GFCM working group on VMEs met in 2022 to provide advice on scientific monitoring plans in FRAs, reviewed two new FRA proposals, to identify priority areas for conservation purposes, and review the work done towards mapping the deep-sea fishing footprint including when overlapping with potential vulnerable marine ecosystems. In practice WGVME simply reiterated he importance of establishing comprehensive scientific monitoring plans to assess the effectiveness of all existing and future FRAs also considered that for any FRA, full compliance and monitoring, control and surveillance (MCS) measures, adequately implemented by the relevant party, would be the most fundamental aspects towards ensuring the effectiveness of the FRA with respect to its primary conservation objective. However, little actual progress has been made. The already started process to formulate rules guiding deep-sea fisheries and mapping their deep-sea fishing footprint should be finalized. The work already carried out in other regional fisheries management organizations with the competence over deep-sea fisheries to formulate rules guiding deep-sea fisheries and mapping their deep-sea fishing footprint could be followed.

Indicator species A review of the list could be performed on a regular basis.

Exploratory fishing protocol. The main weakness is the lack of any specific measures to ensure protection of areas outside those currently fished. There is also no legal framework addressing this topic, although the definition of this concept has been already agreed in specific WGs. Additionally, there is a list of management elements for the establishment of an exploratory deep-sea bottom fishing protocol. As this is still work in progress, further effort should be done to implement it. Progress needs to be made in the implementation of an exploratory deep-sea bottom fishing protocol.

Encounter protocols. Although it has been agreed the importance of adoption encounter and/or exploratory fishing protocols, this is still work in progress. When VMEs are encountered there is currently no mandatory move-on rule, or any requirement to cease fishing. The work already carried out in on regional fisheries management organizations should be considered, as progress needs to be made in the elaboration of encounter protocols. For example i) take immediate action to protect VMEs, from destructive fishing practices. ii) identify VMEs and determine whether bottom fishing activities would cause significant adverse impacts to them, by improving scientific research and data collection and sharing. iii) Assess, on the basis of the best available scientific information, whether individual bottom fishing activities would have significant adverse impacts on VMEs, and if so, manage these activities to prevent such impacts, or not authorise them to proceed. iv) close areas where VMEs are known to occur or are likely to occur to bottom fishing and ensure that bottom fishing does not proceed unless conservation and management measures have been established to prevent significant adverse impacts on VMEs. v) Require vessels flying their flag to cease bottom fishing activities in areas where VMEs are encountered during fishing operations, and to report encounters so that appropriate measures can be adopted.

Thresholds No specific information was available about these.

5.2.5. NORTH PACIFIC FISHERIES COMMISSION (NPFC)

Strengths

Measures Interim measures were initially adopted for both the Northwest and Northeast Pacific Ocean that support UNGA Res. 61/105 and the FAO DSF Guidelines. These include
A. Limit fishing effort in bottom fisheries on the high seas of the Northwestern Pacific Ocean to the existing level in terms of the number of fishing vessels and other parameters which reflect the level of fishing effort, fishing capacity or potential impacts on marine ecosystems.

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

These interim measures have eventually been carried through to the present time as formal CMMs of NPFC (CMM 2018-05 and 2017-06).

Participants have reported to the meetings on implementation of these. Specific measures for protection of VMEs include prohibition of expansion of bottom fisheries into the western part of the Convention area where no such fishing is currently occurring by limiting bottom fisheries to seamounts located south of 45 degrees North latitude and closing fisheries in in areas deeper than 1500 m. Closure of fisheries in C-H seamount and Southeastern part of Koko seamount areas. No direct fishing on four taxa of cold-water corals. National reports on the identification of potential VMEs and assessments of impacts caused by bottom fishing activities have to be compiled and can be found at the NFPC website.

Definition of Fishing areas. The information used to define the footprint has to be provided each year. This includes the number of vessels by gear type, size of vessels (tons), number of fishing days or days on the fishing grounds, total catch by species, and areas fished.

Indicator species are defined and other indicator species may be identified from time to time by the SC and approved by the Commission.

Exploratory fishing protocol. To support the implementation of CMMs, the SC developed a 5-year Research Plan for 2017- 2021 to address VME issues. This included a review of the encounter protocol and the exploratory fishery protocol, development of ID guides for VME indicators and a bycatch list, development of an NPFC VME map, assessment of significant adverse impact (SAI) on VMEs indicator species, and review of VME related data availability.

Weaknesses

Encounter protocols and thresholds. The NPFC has developed the elements of an encounter protocol from existing interim and voluntary measures to safeguard VMEs. The key elements of the existing NPFC encounter protocols are: a. a definition of VME indicator taxa; b. a definition of encounter thresholds; c. implementation of a move-on distance; and d. requirements to report encounters. The key elements of the existing NPFC encounter protocols are: a. a definition of VME indicator taxa; b. a definition of encounter thresholds; c. implementation of a move-on distance; and d. requirements to report encounters. The SC plans to address the following subjects to further refine encounter protocols in the Convention Area; i) Review of taxa, topographical, geographical and geological features that may indicate the presence of VMEs; ii) Taxon-specific encounter thresholds and reporting; iii) A framework for evaluating the effectiveness of encounter protocols; iv) A tiered approach with different encounter protocols associated with different thresholds; and v) Gear-specific thresholds to reflect differences in catchability.

5.2.6. SOUTH PACIFIC REGIONAL FISHERIES MANAGEMENT ORGANISATION (SPRFMO)

Strengths

Measures. Members have agreed not to expand bottom fishing activates into new regions. The Interim Benthic Assessment framework (also adopted at the 3rd International consultation) led to the creation of a joint trawl footprint map. This joint trawl footprint map was defined using bottom trawl tracks, 20-minute resolution blocks and a reference period of 2002-2006. CMM 08-2019 prohibits the use of large-scale pelagic driftnets and all deep-water gillnets in the Convention Area.

Indicator species: are defined and thresholds are given e.g. Sponges (50kg, Stony corals (80kg), Black Corals (5kg), True soft corals (60kg), Sea fan octocorals (15kg), Anemones (40kg)). These were derived from 2012-2017 catch records of New Zealand bottom trawlers fishing in the SPRFMO Convention Area by identifying the top 2-percentile catch weights for the most commonly-caught species, with data pooled across all fishing areas.

Weaknesses

Measures. The footprints are managed by the individual countries, and SPRFMO has not yet adopted a joint bottom fishing footprint.

Thresholds. The threshold set depends on the catchability of VME indicator species, the accuracy of abundance models and the fraction of total VME that is protected at a given spatial scale. To prevent SAI, the weight thresholds should be linked to the fraction of VME indicator taxa abundance protected (i.e., a lower abundance protected would warrant a lower weight threshold and vice versa). All three choices have been underpinned by some scientific understanding of VMEs, but the scientific understanding does not provide precise limits or reference levels for each of these three choices. Addressing one of these concerns, the SC recommended the commencement of a research programme to allow the determination of taxon-specific estimates of catchability for VME indicator taxa.

Encounter protocol is triggered either when VME indicator taxa are encountered in any one tow at or above threshold limits stated in one Annex, or when three or more different VME indicator taxa are encountered at or above the weight limits stated in another Annex. However, the thresholds were based on a 99th percentile, which is far from precautionary: it resulted in a weight threshold for stony corals (order Scleractinia) of 250kg (later reduced to 80kg) and for true soft corals (order Alcyonacea) a weight threshold of 60kg.

5.2.7. SOUTHERN INDIAN OCEAN FISHERIES AGREEMENT (SIOFA)

Strengths

Measures A variety of measures are in place to protect VMEs in the SIOFA area: including i) Impact assessment for fishing in exploratory areas; ii) Closures of areas to protect VMEs; iii) Encounter protocols for fishing in existing bottom fishing areas and for exploratory fishing; When the Scientific Committee is proposing a local area for VME designation, the proposal should clearly demonstrate which criteria were met. This is based on the triggering of encounter protocols from exceeding threshold levels, habitat suitability models or direct/confirmed evidence of VME presence (for example from surveys and camera deployments) (SIOFA, 2019a). There is a mandatory requirement to have 100% scientific observer coverage for fisheries targeting toothfish and inside the 5 areas provisionally designated as protected areas, but not for other targeted fisheries.

Definition of Fishing areas, SIOFA have called upon the Scientific Committee to develop a bottom fishing footprint based on historic catch and effort data from 2000–2015 provided by the Contacting Parties (CMM 2018/02) (SIOFA, 2018, 2019). Fishing is currently not restricted to a bottom footprint. Observers are required on 100% of vessels using trawl gear and 20% for any other fishing gear.

Closed areas, there are 5 areas closed for bottom trawlers since 2018. The VME Criteria used for these closures were: fragility, functional significance of the habitat and uniqueness or rarity. A number of voluntary closures, implemented by the fishing industry, are also in place. In 2006 (prior to the inauguration of SIOFA), the main deep-sea fishing operators established the Southern Indian Ocean Deepsea Fishers Association (SIODFA) and voluntarily designated eleven individual sites in deep waters as Benthic Protected Areas. Additional sites within more orthodox fishing grounds were designated as Benthic Protected Areas in 2013

Bottom Fishing Impact Assessments. Required to assess impacts of bottom fishing activities on VMEs, and to identify mitigation measures to prevent impacts. Allows review by the Scientific Committee which can then approved, prohibited or restricted to certain areas or gear types or any other restrictions imposed to prevent serious adverse impacts on VMEs (Fuller et al., 2020).

Weaknesses

Measures. A workshop was held in 2021. To develop recommendations on how to harmonise the scientific observation programmes of the CCPs. It developed a process for evaluating scientific observation programmes in order to improve data quality and to explore the prospect of an electronic monitoring system to support observations.

Indicator species have been adapted from that of CCAMLR. It is agreed that other taxa that might be present in the SIOFA CA and do not occur in the CCAMLR Area.

Exploratory fishing protocol SIOFA is working into the definition of the protocols for new/exploratory fishing. Not yet implemented.

Thresholds levels for encounters with VMEs by gear type and the extension of the fishing ban when they have been exceeded are similar to those recommended in other RFMOs and are not based on any specific studies. Currently SIOFA is reviewing the thresholds for bottom trawling.

5.2.8. CONVENTION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES (CCAMLR)

Strengths

Measures. CCAMLR has adopted a suite of conservation measures that restrict the extent of bottom fishing by closing areas to directed fishing as well as measures that have been specifically introduced to protect benthic communities including VMEs and potential VMEs. The only bottom fishing currently permitted by CCAMLR in the high-seas of its Convention Area are bottom-set longline fisheries. The use of pots (traps) for targeting toothfish is also permitted but this gear is infrequently used.

Fishing areas have been well established for bottom fisheries (longlining for toothfish). Any new fishing areas are classed as a 'New' fishery and subject to more stringent measures.

Indicator species established based on best scientific advice at the time during the CCAMLR VME workshop. The process behind this is outlined in Section 5.1.8.

Exploratory fishing and encounter protocol are established**.** All vessels conducting bottom fishing using longlines or pots are required to clearly mark fishing lines into line segments and collect segment-specific data on the number of VME indicator units (see definitions below) (Para. 3). If 10 or more VME indicator units are recovered in one line segment, the vessel must complete hauling any lines intersecting with the Risk Area without delay and not to set any further lines intersecting with the Risk Area.

Weaknesses

Indicator species. Although established based on best scientific advice at the time in 2009, it was acknowledged that there was a lack of knowledge for various species. These are shown in Table 2, where gaps in the table represent areas where little or nothing is known about the VME taxa against the criteria by which they were being assessed. In the case of Hydroidolina, for example there were gaps in knowledge about their longevity, growth rates and larval dispersion. Although research has been done in some areas the indicator species have not been updated. This is on the workplan for CCAMLR for the next five years.

Encounter Protocols. The encounter protocol developed consists of the vessel notifying the Secretariat and, depending on the threshold reached, the Secretariat either closing the area to fishing or notifying vessels that there may be VMEs present in the area. The closed area would have a radius of 1 nm from the midpoint of the line segment from which the VME were recovered. However, it is likely that benthos observed on landing may have come from an area up to 2 nm from the point where the landing occurred, making the closed area ineffective (SC-CAMLR-XXVI, Annex 5).

5.3 Area-based Management Tools

Nearly two-thirds of the ocean is in areas beyond national jurisdiction (ABNJ) which are home to unique species and ecosystems, and key to marine biodiversity. Negotiations are underway to create a new international instrument under the UN Convention on the Law of the Sea, which would help strengthen ABNJ governance.

Large changes have occurred since the adoption of UNGA Resolution 61/105 in 2006, which called on high seas fishing nations and RFMOs to take urgent action to protect vulnerable marine ecosystems (VMEs) from destructive fishing practices. As well as fishing biodiversity in ABNJ is impacted by a variety of pressures. These include noise and other pollution from ships; noise can disrupt animals' communication and displace them from breeding or feeding grounds. Marine debris entangles marine animals, causing severe injuries and death. While emerging activities such as deep-sea mining can destroy habitats, degrade water quality, contaminate seafood and wipe out species. These problems are made worse by climate change. Therefore, there is a need to place the VME work within the context of sustainable deep-sea high seas fisheries, since as well as impacts on VMEs there are also impacts on deep-sea sharks, seabirds, turtles and so deep-sea fisheries are being progressively managed according to an ecosystem approach to fisheries. The institutional arrangements to manage negative ecological impacts, particularly on biodiversity beyond national jurisdiction, need to be updated (Cespo, et al., et al., 2019).

The 2008 FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas provide guidance on management factors ranging from an appropriate regulatory framework to the components of good data collection programs and include the identification of key management considerations and measures necessary to ensure conservation of target and non-target species, as well as affected habitats. Making a joint effort towards implementation of these internationally accepted voluntary guidelines is highly necessary between regions

5.3.1. Measures available to RFMOs

Underlying the measures introduced by RFMOs is a recognition and interpretation of what the FAO Deep-sea Fisheries Guidelines refer to as SAIs. An objective is to reduce the risk of SAIs, i.e., those leading to lasting structural damage to VMEs. RFMOs have subsequently implemented various management measures to reduce SAIs by bottom fisheries, including closed areas, the move on rule, depth limitations, gear modifications, and seasonal closures. However, not all management measures are equally effective. To determine whether a measure is effective in a particular RFMO, it needs to be established if the protocols adopted for a measure contribute to avoiding SIAs. For example, in the case of the move-on rule, are the catch thresholds and move-on distances effective? Alternatively, is a closed area preventing fishing unnecessarily. The measures all have specific requirements, strengths and weaknesses, these are assessed in the following sections.

Closed Areas.

Requirements

- To quantify the known and predicted extent of VMEs and how this relates to the sustainability of deep-sea commercial fish stocks.
- Knowing how stable or representative the fishing footprint is required so to avoid closing areas that are currently heavily fished, or allowing fishing in areas which were formerly fished but that are not fished anymore. This could displace fishing activity to areas that contain VMEs

Strengths

- Closed areas have been shown to be an effective way to protect large areas from the effects of fishing or to allow areas to recover. For example, surveys conducted within the NPFC management area in the northwest Hawaiian Islands in 2015 and 2016 showed meaningful signs of recovery for areas closed to fishing for over 30 years (Baco et al. 2019).

- Compliance can be effectively monitored through the use of VMS, onboard observers and analysis of logbook data.
- Their role is normally wider in scope than just protection of VMEs and so can have the additional purpose of protecting things such as vulnerable fish species, spawning sites or larger predator colonies.

Weaknesses

- Can be disruptive to fishing. Depending on the size of the closed area and when it was implemented will displace fishing to other areas which may have adverse impacts in these locations.
- Assessing the effectiveness requires constant monitoring, using bottom trawling to sample can be destructive, using underwater videos or cameras can be expensive.
- Some fishing is normally allowed in closed areas provided an exploratory fishing plan is submitted for review by the appropriate bodies. This can allow commercial fishing in these areas under the guise of research.
- Remote and large closed areas can be expensive and impractical to monitor for IUU fishing, particularly if they lie outside the management area of an RFMO (e.g., FAO Area 41).

Move-on rules (encounter protocols)

Requirements

- Scientific establishment of thresholds
- Identify taxa

Strengths

- Allows fishing for target species.
- The rule is easy for a vessel to follow and provided the infrastructure is in place (observers, centralised VMS) and can be enforced, at least for the licensed fleet.

Weaknesses

- Rule is destructive, once triggered damage has already occurred.
- There is a degree of variation between the protocols to be followed by RFMOs, in terms of VME taxa to be included, threshold levels and the distance vessels should move on. Some RFMOs (e.g. NPFC) do not have any follow up actions in place, for example continued research, length of time the vessel must stay away, notifying other vessels in the area or closing the area until a further evaluation is undertaken. While it may not necessarily be appropriate to a single rule for all areas due to differences in species present, topography and fishing gear there should be some degree of standardisation across RFMOs.
- The issue of move on distance was highlighted recently by SPRFMO which stated that while, for trawl fisheries, a 2 nm move on rule was consistent

throughout the RFMOs (for trawls) it was applied differently, with some applying it to the length of the track, based on start and end positions, and others just to where the VME the best estimated area encounter of the VME was or just the endpoint of the trawl, based on the master's judgement (SC9-DW07).

- The initial encounter protocols (specifically move on distances) adopted by RFMOs were the result of a requirement to comply with UNGA Resolution 61/105, paragraph 83 and were hastily put in place based on limited data. They have not been updated since their first development (FAO 2016).
- Little or no follow up research has been done on the effectiveness of the measure or whether the species being recovered by the vessel represent what is on the seafloor. However, SEAFO, and NAFO and SPRFMO have been undertaking some studies into the catchability of various species which. This practice should be replicated in other RFMOs.
- Each threshold level measurement has its own limitations, for example a single sponge can have a volume of 10 litres whereas 100 Scleractinia may make up less than 1 litre. Without further research it is unknown which would better to represent a VME.
- Related to the above, moving away from the area and closing it off means that no research can be undertaken by fishing vessels in the immediate area, either through conducting research hauls or through less destructive methods such as underwater video.
- While a move on rule will protect an area of the seabed directly below the vessel, this may not reflect where the gear was actually fishing at the time. It has been estimated for example, that demersal longlines can drift up to 2nm from where they are set. This also means that vessels fishing near to the closed area may have their lines drift into it if no 'buffer' zone is set.
- The distance set for the move on distance is quite arbitrary and not necessarily based on the distributions of VME indicator taxa (Auster et al. 2011) and may lead to fishing within the same VME area or fishing in an area containing another VME, spreading the impact. Empirical data has rarely been used to establish the efficiency of the move on rule or the distance required to move on. It will be important to get a balance between reducing the impact and minimising the impact to VMEs (Dunn et al., 2014).
- When a trigger level is reached it relies on a vessel self-reporting to inform the Secretariat or flag State. While observer data can be used at a later date there is no real time independent reporting.
- A major problem in doing such evaluations is that what SIAs are, is not defined here (and elsewhere), so detecting whether SIAs are avoided is difficult. For example, in setting up fishing areas or protected areas, what fraction of VME abundance needs to be protected to avoid SIAs? Without such a threshold, it is difficult to decide if spatial management has been successful.

Depth limitations.

Requirements

- To understand how the spatial patterns of fishing activity and seabed biogenic/biodiversity 'hotspots' change with depth, e.g. going from shallow shelf sea to deep sea ecosystems.

Strengths

- A relatively easy measure to follow and manage provided the correct infrastructure is in place (observers, VMS and logbooks).
- Allows fishing at depths normally targeted by the fisheries it applies to.
- Areas can be closed off based on the characteristics of the taxa they are designed to protect and the topography rather than a detailed study of different areas.
- Most of the depth limitations were set according to the precautionary principle (i.e. it is known that species X occurs in waters shallower than 550m) and as a result will remain in place until it can be shown that they do not, or do not in significant quantities.

Weaknesses

- For remote or large areas, it can be expensive and impractical to monitor for IUU fishing, especially if not under the management measures of an RFMO (FAO Area 41).

Gear Modifications / Restrictions

Requirements

- For the range of gear types, configurations and tow durations and speeds it is required how these affect catchability of indicator taxa.

Strengths

- Allows vessels to fish while minimising the impacts to the seafloor.
- Gear requirements can be checked by observers or inspectors before, during or after the trip.

Weaknesses

- RFMOs must rely on observers or flag State inspectors to verify the gear requirements.
- Few RFMOs have gear modifications in place to prevent or reduce SAIs to VMEs, although they do for more visible species such as marine mammals and birds.

Seasonal closures

Requirements

- Benthic species are mostly sessile so there is no seasonal migration, main issue is physical impacts.

Strengths

- Seasonal closures can protect other species.

Weaknesses

- Seasonal closures are not put in place with the express purpose of protecting VMEs but to protect other species or events such as spawning aggregations. VMEs are protected as a secondary benefit, through reducing fishing pressure in general or the impact the gear may have on the seabed during rough weather.
- Impacts overall fishing effort and has limited long-term benefits on VME species.

Observers

Requirements

- Training of observers, provision of guides.

Strengths

- Observer programmes will provide an independent assessment of gear types, areas fished and VME species caught.
- If well trained, they should be able to identify VME taxa to a higher level then crew, collect and preserve samples and photograph unusual or rare species. As a result, the observer can assist the vessel with identification for their records as well as collecting their own.
- The 'observer effect' has been shown to influence the way officers and crew act and may ensure better compliance with the Conservation Measures and subsequent reporting.
- Observer data can be used as an additional source of data when conducting assessments of footprints or mapping VME areas.

Weaknesses

- Observer programmes can be expensive to recruit, train and manage and the service delivery model needs to be carefully considered to ensure transparency.
- In most cases observers are classed as 'scientific observers' are employed just to collect scientific data. They have no enforcement powers although their data may be used at a later date for compliance purposes.
- Observers may feel threatened or harassed by the vessel resulting in them being reluctant to record if, for example, a threshold level has been reached.
- Observer data are often submitted in a highly aggregated form or in formats such as
- PDFs that are difficult to transpose and analyse.
- Limiting observer coverage by overall effort (rather than requiring 100% vessel of trip coverage) can bias results if observers are only deployed on a limited number of vessels operating in a single area.
- While samples may be collected there is often no protocol in place for what to do with them, who or what body will take them and analyse them.

- There is little evidence of observer data being used for any VME assessment work

It has been raised that many of the measures described above were hastily applied to meet with the requirements set out by UNGA under Resolution 61/105 and have not been sufficiently revised since (FAO. 2016). For measures to be effective, the distribution of VMEs must be better known – this requires greater use of seabed mapping in conjunction with tools such as predictive modelling. However, in the case of some RFMOs, such as GFCM knowledge of the actual distribution of VMEs is poor. If adopted measures are to be effective, then it is necessary to reduce uncertainty. Otherwise, in line with UNGA resolution 61/105 and the precautionary approach, RFMOs should simply close areas where VME are likely to occur and not permit bottom fishing in such areas. This would have a negative economic impact. Ideally a closure should protect all potential VMEs while having a minimal impact on fishing activities.

Methods used to set threshold values should be verified by showing that there is a relationship between an ecologically significant biomass or density of VME indicator taxa on the seafloor (i.e., a VME such as coral reef or sponge garden), the catch efficiency of bottom trawl gear, and the biomass of VME indicator taxa retained as bycatch on the deck of fishing vessels. However, in most cases the data required to validate the move-on rule is absent and more research is needed in this area to progress this measure.

Geange et al., 2020 noted that the reasoning that the threshold weights and encounter protocol acts as a "backstop" to spatial management therefore requires untested assumptions regarding the level of permissible bycatch before further "real time" management action is required. The choice of whether to accept or reject those assumptions is a management decision that must consider uncertainty in the effectiveness of other management measures preventing significant adverse impacts on VMEs. Where managers are comfortable with the effectiveness of other management measures in preventing significant adverse impacts on VMEs, there is scope to select less-sensitive encounter thresholds. However, where managers are uncomfortable with the level of uncertainty in the information underpinning those management measures (including information related to the performance of spatial management measures or the relationship between the biomass of VME indicator taxa on the seabed and that landed on deck as bycatch), or the encounter protocol is the primary mechanism for preventing significant adverse impacts on VMEs, they might select more sensitive encounter thresholds to trigger a move-on rule. Where more sensitive thresholds are required, one approach would be to use a scalar to better link the biomass of VME

indicator taxa on the seafloor to bycatch landed on the deck. For example, assuming a catch efficiency of 10%, a multiplier of 0.1 could be applied to the raw data prior to analysis, resulting in down-scaled, more precautionary thresholds. Alternatively, the approach used in this paper can be modified to select thresholds lower on the cumulative distribution curve of bycatch weight. For example, the first breakpoint in the three-parameter segmented regression could be used as the ecologically relevant reference point when selecting weight thresholds, which would provide policy makers with a broader range of increasingly sensitive thresholds from which to select. Similarly, the sensitivity of the biodiversity threshold could be increased by relaxing the number of taxa required to exceed taxon-specific biodiversity thresholds before the encounter protocol is triggered.

Spatial management is increasingly informed by combining limited biological records with environmental data in habitat suitability models to predict where VMEs are likely to occur. For example, habitat suitability models have recently been used to design spatial closures to avoid significant adverse impacts on VMEs in the SPRFMO Convention Area (Georgian et al., 2019; SPRFMO CMM 03-2019). The resulting spatial management measures close the great majority of the SPRFMO Convention Area to bottom trawling, concentrating fishing in areas that contain few cells where habitat suitability models predict high conservation value for VMEs. However, predictive habitat suitability models have associated uncertainty and may generate both false positives, where VME indicator taxa are predicted to be more widespread than in actuality, potentially over-estimating the conservation value of closed areas; and false negatives, where VME indicator taxa exist at high density in areas open to fishing but are not predicted by the models, potentially exposing them to fishing impacts (Geange et al., 2020). To address this uncertainty, SPRFMO's current approach is to use move-on rules to provide for rapid responses to unexpectedly large benthic bycatch events (relative to the predicted distributions of VME indicator taxa used to underpin spatial management) in open areas while work to reassess the effectiveness of the spatial management measures in preventing significant adverse impacts continues.

Models should be validated using data, and so modelling should complement dedicated scientific surveys and the work of scientific observers. Modelling can be used to identify priorities for research, and if combined with cost-benefit analysis is more likely to result in effective management outcomes.

Even if a precautionary approach is adopted or predictive modelling used, VMEs are still likely to occur both inside and outside existing fishing footprints and thus encounter protocols are triggered by VME indicators being caught above a certain threshold level and exploratory protocols are required to identify and protect areas. However, this is a weakness since retention of VME is affected by many factors including the fragility of VME taxa. The taxonomic level of the VME indicators is not the same in all regions, nor are the threshold levels used to trigger action. The threshold levels may vary in terms of kilograms caught, or "units" that act as a proxy for weight or numbers. For longlines it may be the presence on a certain percentage of hooks. Threshold values are normally higher for sponges than for corals. The details of the response to an encounter vary among regions, an immediate temporary closure is normally applied and the vessel must cease fishing and move away some specified distance from where the VME is believed to be. This has become known as the move on rule.

The need to protect VMEs by the fisheries bodies managing the deep-sea high seas bottom fisheries has impacted both the fisheries operations and the work conducted by the RFMO. Some RFMOs are well established and well resourced, for example NAFO and NEAFC, with contracting parties who are actively undertaking surveys, requiring contracting parties to conduct impact assessments, and conducting modelling and undertaking seabed mapping to identify VME habitats. The development of the VME database of the FAO, is an attempt to share experience. The database is a compendium of information on management measures. It is intended to facilitate the work of scientists and managers by promoting transparency and accessibility. The database is linked to the data providers (RFMOs and other multi-lateral bodies) and users have access to the primary information through direct links for example to the RFMO websites. The database was developed specifically in response to a request from the UN General Assembly (61/105, paragraph 90) to create a database of information on vulnerable marine ecosystems (VMEs) in ABNJ. It has been developed within the FAO Deep-sea Fisheries Programme to promote the use of the International Guidelines for the Management of Deep-Sea Fisheries in the High Seas

In addition, the FAO ABNJ Deep Seas Project is providing assistance to the RFMOs, in order to improve deep-sea fisheries management and biodiversity conservation

through the harmonization of conservation and sustainable use following the principles of the ecosystem approach, while testing innovative and appropriate management tools. These projects are of particular value to recently established RFMOs such as SEAFO and
SIOFA.

5.3.2. Additional measures and decisions making tools

Area-based Management Tools (ABMTs), are generally understood to include tools that afford a specified area higher protection than its surroundings due to more stringent regulation of one or more or all human activities. For example, they are defined by IUCN as "regulation of human activity in a specified area to achieve conservation or sustainable resource management objectives."[5]

ABMTs may have different objectives, including (Greiber et al., 2014):

- Preservation of important ecological, biological or geomorphologic processes;
- Conservation and management of species;
- Protection of beautiful seascapes, cultural, archaeological, or historic sites;
- Recreation and public enjoyment;
- Separation of uses to prevent accidents, collisions or conflicts of use;
- Environmental monitoring and assessment; and
- Scientific research.

Sectoral ABMTs could be defined as "measures adopted by a competent international organization to achieve biodiversity conservation objectives for a specific area." As well as RFMO temporal or spatial closed areas such as VME closures examples of existing ABMTs include the IMOs Particularly Sensitive Sea Areas (PSSAs), traffic routing systems; MARPOL Special Areas; ISA's Areas of Particular Environmental Interest and Preservation Reference Zones. Sectoral ABMTs should be distinguished from MPAs: while sectoral ABMTs provide important protection, they generally are only targeted at one use, may be short term, and do not provide comprehensive protection for the full range of features in an area. Cross-sectoral ABMTs are those tools that at present require consultation, cooperation and coordination across multiple organizations and bodies, including MPAs and marine spatial planning.

5 https://www.un.org/depts/los/biodiversity/prepcom_files/area_based_management_tools.pdf

Table 3 – Examples of different types of planning tools (source UNEP-WCMC, 2018).

Single Sector Tools	Multi-Sector Tools	Supporting Tools
Tools which respond to the needs of a single sector.	*Tools which aim to address and balance the needs of a range of sectors.*	*Specific approaches (such as assessments, software, plans or descriptions) used to support the development of an area-based planning tool.*
• Areas of Particular Environmental Interest (APEI). • Fisheries management areas. Many types of closures exist including those related to the protection of Vulnerable Marine Ecosystems (VMEs). Other examples include Locally Managed Marine Areas, Territorial Use Rights for Fisheries (TURFs) and seasonal spawning closures. • Particularly Sensitive Sea Areas (PSSA). • Marine Protected Areas (MPAs)	• Marine Spatial Planning (MSP). • Integrated Coastal Zone Management (ICZM). • Marine Protected Areas (MPAs).	• Geographical Information Systems (GIS) such as Arc GIS and QGIS. • Cumulative Impact Assessments. • Identification and description processes such as Ecologically or Biologically Significant Marine Areas (EBSAs), Important Bird and Biodiversity Areas (IBAs) or Key Biodiversity Areas (KBAs). • Fishery management plans developed within the ecosystem approach to fisheries (EAF).

As well as potential impacts from the fishing sector, other sectors can also impact on the marine environment. These include anthropogenic climate change, sea-based and land-based pollution, habitat destruction, the introduction of alien species, and over-exploitation of non-renewable resources. However, these mainly commercial related aspects are not commonly considered in offshore, large-scale fisheries management (beyond dialogue among RFMO members) and may be challenging to evaluate, particularly for coastal areas, when a broader set of stakeholders needs to be considered.

Although each of the different threats requires dedicated, separate attention, there is increasingly wide support for more holistic and integrated governance approaches that take account of the spatial dimension and functioning of ecosystems, such approaches are known as "ecosystem-based management" (EBM), (Billé et al., 2017). Therefore, as well as the RFMOs, there are initiatives such as the Regional Seas programmes, supported or coordinated by the United Nations Environment Programme (UNEP); and the Large Marine Ecosystem (LME) mechanism projects supported by the Global Environment Facility (GEF).

Other Effective Area-based Conservation Measures (OECMs)

The Convention on Biological Diversity (CBD) was established at the Earth Summit in Rio de Janeiro in 1992, with the objective of promoting biological diversity, its conservation and sustainable use as part of national strategies for sustainable development. In 2010, the Aichi Biodiversity Targets were established as part of the CBD's Strategic Plan for Biodiversity. This specified that by 2020, at least 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

Other Effective Area-based Conservation Measures (OECMs), defined in 2018 by CBD Decision 14/8, and are spatial biodiversity conservation measures recognised as achieving Aichi Biodiversity Target 11. OECMs explicitly recognise that biodiversity is threatened by a range of sectors, both maritime and terrestrial, and the aims of OECMs are to identify and reinforce biodiversity conservation measures that exist or are planned, as primary or secondary objectives, by the different sectors.

Countries are now reporting on progress towards achieving the Aichi Biodiversity Targets. There is therefore a need to provide guidance on how to translate CBD Decision 14/8 into action by the RFMOs and other authorities when reporting to CBD (Rice et al., 2019). For the fishery sector, OECMs are both a challenge and an opportunity. They are a challenge because the formal identification of an OECM has implications in terms of monitoring, enforcement, and assessment of performance. While they are an opportunity to gain recognition that well managed fisheries not only maintain and build harvested stocks but also contribute to conservation of biodiversity.

The Joint ICES/IUCN-CEM FEG Workshop on Testing OECM Practices and Strategies (WKTOP, Appiott et al., 2021) investigated how to evaluate VME closures as OECMs. Case studies considered by WKTOPS included VME closures in both the NAFO and NEAFC regulatory areas. The NEAFC VME considered was the area closed to trawl fisheries to prevent bycatches of juvenile haddock, and the NAFO VME closure was the Corner Rise Seamount in the Northwest Atlantic closed to all bottom fishing and NAFO Sponge closures. It was agreed that the issue of OECM identification was of high and growing policy profile, and consistent interpretations of OECM status is important to the credibility and implementation of OECMs in contributing to global biodiversity targets and as a bridging tool between conservation biology and sectoral management.

The biodiversity issues associated with evaluating a VME closure as an OECM are complex. Biodiversity features that benefit from fisheries measures may be long-lived so that demonstrating benefits from the fishery measures, can take several decades. Alternatively for short-lived organisms' annual variability in abundance of even a ‘healthy population’ may be high making it difficult to show benefits. There may also be other benefits e.g. a reduction of bycatch of sharks and turtles, or indirect benefits via trophic pathways, or provision of habitat, even though those benefits were not initially identified and intended when the fishery measures were adopted.

WKTOPS concluded that evaluating VME closures as possible OECMs is complex and that greater clarity is needed from the CBD on interpretation of the expected permanence of biodiversity benefits. The Criteria that have to be met, how jurisdictional authority is determined for an area, and how present and possible future activities of sectors other than fisheries (e.g. oil and gas exploration and production activities and submarine cable installation) should be considered when evaluating OECM status of areas with fisheries measures such as VME closures. It was also noted that no measure, including total prohibition of activity in an area, can benefit all biodiversity, so the nature and magnitude of expected biodiversity benefits also needs clarification.

As well as the presence or absence of potential biodiversity features in the area which is a focus of VME closure evaluations, an OECM evaluation must also consider aspects of management and governance which are potentially complex in an area with multi-sectorial interests. Particularly since fisheries may be just one of several current threats to biodiversity. Regardless of how effective a management measure may be in controlling threats from the fishery sector, how other threats are managed need to be taken into account as part of any OECM evaluation. The objective of measures to protect VMEs is the delivery of biodiversity and so fit well within the OECM concept. However, other fishery measures may not have been adopted with protection of biodiversity as an objective but may produce benefits to biodiversity features other than the target species that are the subject of mitigation measures.

Traditional fishery management measures generally have much greater flexibility in the procedures for adoption and subsequent modification. Fishery measures may result in biodiversity benefits even if this was not the primary reason for their adoption. These may be limited to a specific form of biodiversity as in the case of protecting Endangered, Threatened, or Protected species. In contrast, fisheries measures such as protection of VMEs may be applied in ways that produce more general widespread benefits for biodiversity. The benefits from protecting VMEs can be intentional and comparable to establishing a marine protected area. Although the greater flexibility of fishery measures can allow management and governance to respond quickly to changing conditions, they can also be a liability if this means that there are frequent changes to the effectiveness of the measures in producing any identified biodiversity benefits.

Some aspects of Target 11 and the Annex III of CBD Decision 14/8 offer substantial breadth of interpretation when they are applied, making consistency within and across assessments hard to maintain, and sometimes making consensus in specific applications hard to achieve in expert groups where participants may have different consideration of risk. In particular, how much evidence is required to support a decision on any specific criterion? How many Criteria and Sub-criteria have to be met for an area and measure to be considered an OECM? Are there specific Criteria and Sub-criteria that, if met, make an area highly appropriate to be considered an OECM even if other Criteria and Sub-criteria are met weakly or not at all, as long as they are not actively violated, and if so, which Criteria and Sub-criteria?

As well as the IUCN-WCPA (2019) guidance document use was made of the Garcia et al. (2020). WKTOPS stressed the need to develop more specific guidance for the fisheries sector to help in the interpretation of the CBD Criteria. In particular the need to fully mirror the CBD Criteria and provide essential definitions and interpretations to the CBD-used terminology in the fisheries context; and to provide guidance on which Sub-criteria or indicators are essential for the area to meet, and guidance on how to judge when enough information is being provided.

This potential complexity of OECM evaluations highlights the value of guidance documents on OECM evaluations, and that there would be value in both the type of generic guidance provided in IUCN WCPA (2019) OECM and the more fishery-specific guidance provided in Garcia et al. (2020). Both types of guidance, when used with the CBD Decision itself, can help to both avoid some complexities through facilitating adequate preparation of appropriate information, and navigate through complexities when they cannot be avoided. Such guidance might be of even greater value when OECM evaluations are done for parts of the world's oceans which are less rich in scientific data and diversity of experts than for example the North Atlantic. WKTOPS recognised that the diversity of experts, and particularly the mix of science (and other knowledge systems) experts, managers, and policy makers was extremely valuable in the discussions, and should be encouraged in any OECM evaluation processes. However, the evaluation of OECMs will always be case specific, not just with regards to the information available but in context of the measures, the fisheries and the biodiversity of the area.

Marine Protected Areas

IUCN Resolution WCC-2016-Rec-102 Protected areas and other areas important for biodiversity in relation to environmentally damaging industrial activities and infrastructure development recognises the concept of areas being 'no-go', or off limits, to environmentally damaging industrial activities, including mining, oil & gas and agriculture, and environmentally damaging infrastructure, such as dams, roads and pipelines, is integral to conservation policy for protected areas and other sites of known importance for biodiversity and ecosystem services. And calls on governments to prohibit environmentally damaging industrial activities and infrastructure development in all IUCN categories of protected areas. Protected areas should have a primary conservation objective. Marine Protected Area (MPA) designation is based on first establishing the biodiversity value of an area. However, unlike a VME closure there is no formal requirement for measures applied inside the area to be clearly identified or in place before designation. This contrast with the identification of OECMs in that the area under consideration is delineated at the outset and the management measures inside it, typically, are already in place, with the possibility that they could be improved to strengthen the OECM case. The CBD Decision 14/8 focuses on assessment of the likely biodiversity consequences of these sectoral or cross-sectoral measures (even if the assessment does not require direct measurements) before the area is evaluated as an OECM. Of course, where States are identifying these areas, they are relatively free to interpret such guidance as they wish and can reduce the differences between OECM and MPA identification. Nevertheless, it would seem within the existing CBD frameworks that OECMs would nearly always have management structures and measures in an advanced state of implementation, whereas even after an MPA has been designated, the process of identifying and putting in place measures could stretch some years into the future. The defining criterion of an OECM is that it should deliver the effective and enduring in situ conservation of biodiversity, regardless of its objectives. In contrast an OECM is a geographically defined area other than a Protected Area, which is governed and managed in ways that achieve positive and sustained outcomes for the in-situ conservation of biodiversity, with associated ecosystem services and cultural and spiritual values

This difference in the relative roles of evidence of biodiversity features (MPAs) and evidence of biodiversity benefits from implemented measures (OECMs) has significant implications for interpreting OECM status. The difference could be interpreted as calling for a higher ‘bar for acceptance’ for the benefits from biodiversity protection measures put in place by the economic sectoral managers than for acceptance of ‘benefits’ from simply the designation of an area as an MPA. There is a contrasting concern amongst some others that loose interpretations of the OECMs definition, principles and criteria could lead to lowering conservation standards and threaten the expected benefits from progress in area-based measures coverage. The establishment of poorly designed and enforced ‘paper OECMs’ could lead to: (i) a degradation of the quality of the conservation efforts (e.g., of conservation per unit-area) in Target 11, already significantly affected by ‘paper parks’; (ii) a general risk (and a precedent) of weakening conservation standards, as socio-economic and pressures from demand for ecosystem services (including food security) increase with demography and economic globalization; and (iii) a decrease of States’ efforts towards increasing the coverage of strict MPAs (No-take-zones) in fisheries and MPAs networks. Ideally, to meaningfully achieve the overarching goals of the Aichi Biodiversity Targets, the evidentiary requirements for reporting both MPAs and OECMs against CBD targets should be consistent and equally rigorous in demonstrating accrued conservation benefit. Greater clarity of these issues of evidence and strength of management measures in place in CBD documents would increase consistency of interpretation and ease of dialogue among perspectives.

Noting the different processes behind the identification of OECMs and designations of MPAs, nevertheless Aichi Target 11 merely asked Parties to report just the total area under both OECMS and MPAs. Consequently, even if not explicitly intended, this results in reporting on Target 11 treating the value of each type of area in conserving biodiversity, when properly identified and managed, as additive and therefore interchangeable.

Areas beyond national Jurisdiction (ABNJ)

One key consideration is the implications for OECMs and MPAs in national waters compared to international waters. In national waters nation states or provinces usually has sufficient authority to integrate OECMs with measures such as MPAs across sectors, for example through marine spatial planning. Once an OECM is established the state can make decisions to protect the biological features from other human pressures in the same area. However, in international waters RFMOs are only able to formally regulate fisheries pressures but not to manage the pressures from other sectors, which have other regulatory authorities, often with overlapping but not identical member states. For example, in the Northwest Atlantic Ocean, areas closed to bottom fishing by NAFO to protect VMEs, are open to oil and gas drilling. Coordination between the oil and gas authority (Canada Newfoundland Offshore Petroleum Board) and the RFMO (NAFO) could ensure that drilling not be authorized in VME areas.

In national waters under one jurisdiction one body usually has sufficient authority to integrate OECMs with other measures such as MPAs. However, in international waters RFMOs are only able to formally regulate fisheries pressures on biodiversity but not the pressures from other sectors, which have other regulatory authorities, often with overlapping but not identical memberships of Parties. Under the 1995 United Nations Fish Stocks Agreement (UNFSA), fisheries management measures, including for biodiversity protection, can be imposed by RFMOs on all fleets operating within the sea-area falling under their jurisdiction. Some Regional Sea Conventions can regulate specified sectors under their competence for their own Parties and have designated MPAs in areas beyond national jurisdiction. However, there is no comparable agreement to UNFSA that allows conservation measures to be simultaneously imposed on all operators by all Regional Seas Organisations, many of which have no mandate in Areas Beyond National Jurisdiction, for their regional high-seas MPAs. There could therefore be added value if the policy foundations' criteria and guidance for OECMS and MPAs could enhance intersectoral cooperation and coordination in international waters.

Ecologically or Biologically Significant Marine Areas (EBSAs)

The Ecologically or Biologically Significant Marine Areas (EBSA) process is a global scientific and technical process, which although not foreseen at the time of the adoption of the Convention on Biological Diversity (CBD), finds its legal basis under CBD Articles 7 and 17-18; and facilitates the implementation of other CBD obligations (Arts. 8, 10, 12 and 14). The origins of EBSAs can be traced back to 2006, when the CBD Conference of Parties considered the targets established at the 2002 World Summit on Sustainable Development's (WSSD) Johannesburg Plan of Implementation (JPOI) on the development of approaches and tools, such as the establishment of MPA networks globally by 2012. In 2008, at the ninth meeting of the Conference of the Parties to the Convention on Biological Diversity (COP 9) adopted the following scientific criteria for identifying ecologically or biologically significant marine areas in need of protection in open-ocean waters and deep-sea habitats, 1) Uniqueness or Rarity, 2) Special importance for life history stages of species, 3) Importance for threatened, endangered or declining species and/or habitats; 4) Vulnerability, Fragility, Sensitivity, or Slow recovery; 5) Biological Productivity; 6) Biological Diversity; and 7) Naturalness.

The EBSA process has resulted in around 300 being created. An example of an EBSA that overlaps with NAFO VME closures is the Sargasso Sea. Although there is no regional environment agreement equivalent to the OSPAR in the North East Atlantic region, the Sargasso Sea Commission (SCC) has taken on a stewardship role for a high seas ecosystem and has committed to work with the existing international organisations with jurisdictional competences over a range of high seas activities and sectors (Freestone, 2021). There is no regional fisheries regime covering its core area equivalent to NAFO or NEAFC. The only international bodies with regulatory powers are ICCAT (for tuna and tuna-like species), the International Maritime Organization (IMO, 1958) for vessel movement and pollution control and the International Seabed Authority (ISA) to regulate deep sea mineral exploration and exploitation).

The SSC achieved recognition of the Sargasso Sea as an EBSA at the 11th Session of the Conference of the Parties (COP11) in 2011 (CBD, 2011). The SSC has continued to leverage this description in other fora (Freestone and Morrison, 2013). Defining the Sargasso Sea as an EBSA has achieved the objective of bringing international attention to the importance of this unique high seas' ecosystem, however, it has had limited success to date in implementing conservation measures. Despite the early success of having it described as an EBSA in 2012, only one legally binding measure has resulted from its efforts—that related to the 2016 NAFO restrictions on mid-water trawling.

5.4 Summary

This document has discussed the variety management measures RFMOs have implemented to reduce SAIs by bottom fisheries. The following section begins by summarising and comparing these methods namely closed areas, move-on rules, depth limitations, gear modifications and seasonal limitations in Summary of **measures in place.**
Table 4. These are also outlined in more detail in Appendix A. It goes on to summarise the strengths and weaknesses of each, although in many cases the studies and data to available to conduct any validation of the measure is absent or incomplete. Finally, it goes onto give some conclusions drawn from the report.
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Summary of measures in place.

Table 4 Summary of the main management measures regarding SAIs and conservation of VMEs.

RFMOs	Closed Areas	Encounter protocols (threshold and distance moved)	Depth limitations	Gear restrictions/modifications	Seasonal closures	Observers
NAFO	27 (2,707,895) 17 temporary closures also in place	60kg live coral, 300kg sponge, 7kg sea pens - 2nm	None	None	None	100%. VME data collected.
NEAFC	22 (375,606[1])	30kg live coral, 400kg live sponge – 2nm, 10 hooks / 1,000 – 2nm	None	No gillnets >200m	None	100% for exploratory fisheries. VME data collected.
SEAFO	12 (16%)	60kg live coral, 600kg live sponges – 2nm 10 units of VME taxa – 2nm	None, but only 2% - 3% < 2000m	Division 1B closed to all gears except pots and longlines	None	100%. VME data collected.
GFCM	3 (15,659)	N/A	>1000m, <50m[4]	Dredges and trawls >1000m, trawls <50m[4]	None	~25%, varies by contacting party
NPFC	2 (546 (2.1%))	50kg live coral – 2nm	>1,500m	Distance between gillnet and seafloor >70cm	Closures introduced for fish species but can also reduce SAIs on VMEs	100% for vessels bottom fishing. VME data collected.
SPRFMO	N/A[2]	60kg stony coral, 5kg black coral, 15kg sea fans, 35kg anemones, 10kg hexacorals – 1nm	None	Type of gear limited to management area	Only for Protected, Endangered and Threatened (PET) species.	100% bottom trawl, 10% longline (observed hooks) 100% exploratory fisheries. VME data collected.
SIOFA	12 (504,922 (3.2%))	60kg live coral and / or 300kg live sponges – 2nm either side of trawl track plus 2nm each end for trawls 10 units of taxa in the VME indicator taxa list in a single line segment (1,000 hooks or 1,200m of line) – 1nm from midpoint of segment for longline or traps.	Demersal longlines prohibited <500m and encouraged to set >1,000m[5]	All bottom gear types, with the exception of lines and traps, excluded from interim protected and recently fished areas.	None	Longline vessels targeting toothfish - at least one observer per vessel covering 25% of hooks. Trawl gear – 100% coverage. Other bottom fishing gear – 20%.
CCAMLR	86[3] (1,647,092)	10 units of VME taxa – 1nm	<550m[6]	Ban on bottom trawling and gillnets. Use of integrated weights on longlines.	Yes, but for seabirds.	100%. VME data collected on at least 30% of line segments

[1]Fishing only permitted in historical fishing grounds, representing 2% of the area. [2]337 areas defined for permitted bottom fishing. [3]Includes 4 permanent closures, 82 temporary closures and MPAs.[4] Primarily to protect fish stocks and shark species but benthic communities also cited. [5]1,000m recommendation is in place to reduce potential for depredation.[6]Unless otherwise stated in a Conservation Measure.

As Summary of **measures in place.**

Table 4 shows, there is some variety between the RFMOs, not least with the encounter protocols and move on rules. Move-on rules were not originally intended as stand-alone measures to protect VMEs from SAI. For example, NAFO's Scientific Council, in June 2013, stated that:

" … management through the closing of areas with significant concentrations of VME indicator species is the most effective measure for protecting VMEs in the NRA [NAFO Regulatory Area] and that the need to implement encounter protocols gradually becomes redundant as the locations of the benthic VMEs becomes increasingly well-defined. This avoids issues associated with the implementation of complex move-on rules"

NAFO is helped by the available sources of information, and the relatively small areas of the existing fishing footprint, this means that it is reasonable to assert that the distribution of key VME indicator species is relatively well understood. While in GFCM, where fishing is not restricted to the existing footprint, there is no move-on rule although encounters have been reported since 2019.

In NEAFC the encounter protocol appears to be the least important of the measures adopted, given that effective protection measures, i.e., closures, are in place and no reports of encounters above the threshold levels have been made, although there is a lack of observer coverage onboard vessels to verify this.

No thresholds have been specified by the GFCM. The Working Group on VMEs is in the process of defining them for corals and sponges (Cryer & Soeffker, 2019). The encounter protocol established by GFCM/43/2019/6 requires vessels to report encounters, but no associated move-on rule is in place. The programme of work for the period 2019-2021 includes: i. Identify priority areas for the collection of data on VMEs; ii. Compile information on the distribution and abundance of VME indicators; and iii. Analyse data, identify VMEs and reflect on additional measures.

The SPRFMO Scientific Committee recognised that move-on rules should only be used to complement well-designed spatial closures. They concluded that move-on rules should act as a rapid response mechanism to unexpectedly high bycatch events outside of closed areas, therefore, threshold levels were set high (SPRFMO, 2017). Although SPRFMO have implemented these "high" threshold levels to complement their spatial management strategy, the thresholds are lower than most of those used by other RFMOs. Catchability of VMEs within the SPRFMO Convention Area was assessed by Geange et al. (2019). SPRFMO is planning to review the move-on distances for potential VME encounters, based on the size and spatial clustering of VME indicator taxa distribution (SPRFMO, 2021c).

Unlike other RFMOs which have a broad set of encounter thresholds, NPFC have listed a range of VME indicator taxa but only apply the move-on protocol for cold-water corals. Unlike other RFMOs, NPFC currently has no designated post-encounter treatment except reporting.

For the move-on rule there is an implicit assumption that the threshold weights used to trigger the rule are related to the presence of a VME. However, studies linking the in-situ density or biomass of VME indicator taxa to the bycatch in individual trawl events may be a poor indicator of the composition and density of VME indicator taxa on the seabed (Freese et al., 1999; Auster et al., 2010; Watling and Auster, 2017). For example, CCAMLR's Scientific Committee have found that in certain locations there was insufficient evidence of indicator taxa in catches to trigger the 10kg threshold rule subsequent video transects provided ample evidence of the presence of a VME.

Methods used to set threshold values should be verified by showing that there is a relationship between an ecologically significant biomass or density of VME indicator taxa on the seafloor (i.e., a VME such as coral reef or sponge garden), the catch efficiency of bottom trawl gear, and the biomass of VME indicator taxa retained as bycatch on the deck of fishing vessels. However, in most cases the data required to validate the move-on rule is absent and more research is needed.

Geange et al., 2020 noted that the reasoning that the threshold weights and encounter protocol acts as a "backstop" to spatial management therefore requires untested assumptions regarding the level of permissible bycatch before further "real time" management action is required. The choice of whether to accept or reject those assumptions is a management decision that must consider uncertainty in the effectiveness of other management measures preventing significant adverse impacts on VMEs. Where managers are comfortable with the effectiveness of other management measures in preventing significant adverse impacts on VMEs, there is scope to select less-sensitive encounter thresholds. However, where managers are uncomfortable with the level of uncertainty in the information underpinning those management measures (including information related to the performance of spatial management measures or the relationship between the biomass of VME indicator taxa on the seabed and that landed on deck as bycatch), or the encounter protocol is the primary mechanism for preventing significant adverse impacts on VMEs, they might select more sensitive encounter thresholds to trigger a move-on rule. Where more sensitive thresholds are required, one approach would be to use a scalar to better link the biomass of VME indicator taxa on the seafloor to bycatch landed on the deck. For example, assuming a catch efficiency of 10%, a multiplier of 0.1 could be applied to the raw data prior to analysis, resulting in down-scaled, more precautionary thresholds. Alternatively, the approach used in this paper can be modified to select thresholds lower on the cumulative distribution curve of bycatch weight. For example, the first breakpoint in the three-parameter segmented regression could be used as the ecologically relevant reference point when selecting weight thresholds, which would provide policy makers with a broader range of increasingly sensitive thresholds from which to select. Similarly, the sensitivity of the biodiversity threshold could be increased by relaxing the number of taxa required to exceed taxon-specific biodiversity thresholds before the encounter protocol is triggered.

Spatial closures are in place in all RFMOs but SIOFA. The spatial management measures currently used by SPRFMO (SPRFMO CMM 03-2019) are based on habitat suitability models (Georgian et al., 2019) and only areas containing no or few cells with high conservation value for VME indictor taxa are open to bottom trawling (Delegation of New Zealand, 2019). However, to mitigate risks caused by uncertainty in these models, a data-informed approach is used for selecting taxon-specific encounter thresholds for a move-on rule to cease fishing in areas where trigger levels are reached. This approach sets thresholds for triggering a move-on event relatively high, indicating that habitat suitability models underpinning the spatial closures might be highly inaccurate. When encounter protocols are triggered, SPRFMO CMM 03-2019 requires that: an area around the relevant trawl tow is immediately closed to fishing; the encounter must be reviewed by the Scientific Committee; and the Commission must determine if the closure should stay in effect or be lifted. The review process must consider, amongst other things, previous VME encounters within the vicinity of the new encounter (and all information on benthic bycatch), habitat suitability model predictions of VME indicator taxa, details of relevant fishing activity, and any other information the Scientific Committee considers relevant.

A review by NEAFC in 2019 concluded that Recommendation 19:2014 was effective in its aim to protect VMEs as well as areas outside defined fishing areas from bottom fisheries. It found that NEAFC has been advised effectively on area closures to protect VMEs, and has closed most of the areas advised. Compliance with the closed areas was found to have been effective (NEAFC, 2020). The restriction of bottom fishing to limited areas (2% of the Regulatory Area) in which bottom fishing has historically operated, combined with closures to protect known or likely VMEs, and additional encounter protocols, provides effective protection of VMEs.

Conclusions

- Many of the measures enacted were hastily applied to meet the requirements set out by UNGA under Resolution 61/105 and have not been sufficiently revised since. A reason for this is because identifying VMEs is problematic, therefore in some regions a precautionary approach is still being used, where VMEs are identified through encounter protocols, i.e. during commercial fishing operations. A concern therefore is "are fishing vessels reporting accurately?" Or are encounters actually unlikely as there are few VMEs in the fishing areas? This can only be verified during fishing operations where there are scientific observers are on board, ideally having 100% observer coverage during all fishing operations. To a limited extent this can be done through electronic monitoring systems (EMS), specifically having cameras monitor fishing operations. However, this would identify presence or absence of benthos rather than species.
- Habitat modelling combined with electronic monitoring systems, i.e. having cameras on gears, will help improve data collection, and will potentially help to validate habitat models. However, electronic monitoring systems are not as effective as having scientific observers onboard.
- For measures to be effective, the distribution of VMEs must be better known this requires greater use of seabed mapping in conjunction with tools such as predictive modelling. Predictive modelling has already been done to identify such areas suitable for the species and habitats under future climate change scenarios.
- Predictive modelling can also help to include the impact of climate change into area-based management decisions such as those aimed to preserve VMEs. Since climate change may affect the distribution of fished stocks and hence the fishery. Therefore, fishing footprints need to be dynamic, but without the temptation to simply expand them without knowing if VMEs occur in the new fishing areas. RFMOS should identify current and future areas where deep-water species and VME habitats are likely to better survive the impacts of climate change (e.g. acidification, deoxygenation, reduced food availability, temperature changes) and ensure that these areas are set off-limits to bottom contact fisheries to establish refugia and build resilience.
- If measures are to be effective, then it is necessary to reduce uncertainty. Otherwise, in line with UNGA resolution 61/105, and the precautionary approach areas where VMEs are likely to occur bottom fishing should be banned. An ideal closure scenario protects all potential VMEs while having a minimal impact on fishing activities. Providing an incentive to fish responsibly by providing positive feedback to follow regulations.
- Although most RFMOS have developed thresholds, only a few RFMOs have developed thresholds based on historical catch records from either the fisheries for which the threshold is required, or from similar fisheries. Encounter thresholds, which are usually expressed as the quantity of a VME indicator taxon retained by the fishing gear, should ideally be specific to area, gear type

and taxon, and based on historic bycatch levels and catchability estimates. Although, while scientifically validated thresholds are preferable thresholds are often very high and difficult to quantify the corresponding impact on a VME.

- The definitions of what constitutes a VME, based on the DSF Guidelines, should be reviewed, i.e. where does the current definition cause a problem e.g. the Mediterranean, although the actual definition and resulting taxa will vary between regions.
- There is a tendency to want to survey the whole area first and then pick out the best VMEs. This is not in line with the relevant UNGA provisions, as should there be no significant adverse impact allowed on VMEs, it is not just about conserving the best ones.

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Appendix A. Summary of measures in place by Organisation

Closed Areas

RFMO	Measures in place	Number in place	Area covered
NAFO	Areas were closed to bottom fishing in 2007 when four seamounts were closed to bottom trawling as a precautionary measure. Closed areas were then created following research surveys to develop VME indicator groups and species, and analysis to identify significant concentrations of VME species. VME closed areas are divided into two categories, seamount closures, and sponge, coral, and sea pen closures (Article 17 of the NAFO CEM)	Within its Convention Area, NAFO has identified 27 areas as being vulnerable to bottom contact gears and subsequently closed these areas to bottom fishing (Article 17 of the NAFO CEM).	NAFO management divisions only apply to the areas straddling, as well as outside the EEZs (Exclusive Economic Zones). Known as NAFO's Regulatory Area (NRA) — 2,707,895 km^2.
NEAFC	Closures of areas to protect VMEs have been progressively implemented starting in 2005 with five closures. NEAFC follows scientific advice provided by ICES and has now closed the areas where the best available scientific information indicates that VMEs occur or are likely to occur.	In 2005 there were five closures (Altair Seamount, Antialtair Seamount, Hecate Seamount, Faraday Seamount and Reykjanes Ridge), and now there are 22 closures covering areas both within and outside existing bottom fishing areas and including large areas on the mid-Atlantic ridge.	Bottom fishing is only permitted in areas where it has historically operated, and is limited to 2% of the Regulatory Area. Within the Regulatory Area as a whole the 22 closures represent around 375,606 km^2.
SEAFO	All fishing gear is prohibited in closed areas except for on the South Valdivia Bank where pots and longlines are permitted.	There are 12 precautionary VME closures in the SEAFO Convention Area.	16% of the fishable area
GFCM	"Fisheries restricted area" (FRA) to protect deep-sea ecosystems.	Three. These include Capo Santa Maria di Leuca, Eratosthenes Seamount and the Nile Delta.	NA
NPFC	Yes, in the Northwestern Pacific, areas around the C-H seamounts and the south-eastern part of the Koko seamount. Closed to bottom fishing with the exception of exploratory fishing. There is a prohibition on the expansion of bottom fisheries into the western part of the area. Measure put in place in 2006 (prior to the Convention entering into force)	Two, one around the C-H seamounts and the south-eastern part of the Koko seamount	580 km^2 (2.1%)
SRFMO	There are no designated closed areas, however there are designated Management Areas defined for bottom trawling and bottom lines which limits fishing to these areas. Bottom fishing outside these areas must be done through the exploratory fishery protocol.	N/A. There are around 337 areas defined for permitted bottom fishing (158 for trawl and 179 for longline).	N/A
SIOFA	Yes. Ten of the 13 identified, fishable seamounts closed between 2007 and 2010. Revised by SC in 2010 after which one was reopened, boundaries were changed for six other ones and five new areas along the mid-Atlantic Ridge were also closed. Finally, in 2016, a new VME was established on the Valdiva Bank (based on scientific research cruises).	Currently 12 closed areas.	504,922 km^2 (3.2%)
CCAMLR	Yes. Areas closed permanently (2012) and temporarily (ongoing since 2008) to protect VMEs. Two MPAs also in place in the Ross Sea (2017) and South Orkney Islands (2009). MPA closures not exclusively to protect VMEs. Other areas in CCAMLR, south of 60°, require Members to submit an exploratory fisheries proposal.	Four permanent VME closures, 82 temporary VME closures, two MPAs)	Permanent – 2,190 km^2 Temporary – 902 km^2 MPAs – 1,644,000 km^2 Total – 1,647,096 km^2 (4.6%)

Move-on rule (encounter protocol)

RFMO	Gear	Threshold	Move-on distance

NAFO	Catch per set (e.g., trawl tow, long-line set or gill net set)	60 kg of live coral 300 kg of sponges 7 kg of sea pens	2 nm from endpoint of tow in direct least likely to result in further encounters
NEAFC	Trawl tow, other gears	Corals: 30 kg live; Sponges: 400 kg live Rec. 19/2014	2 nm wide band on both sides of the bottom trawl tracks, extended by 2 nm at both ends, or 2 nm from the position that is closest to the exact encounter location for other fishing methods
	Longline set	Presence on 10 hooks per 1000 hooks or per 1200 m line, whichever is shorter	
SEAFO	Trawl (per trawl tow)	60 kg live coral 600 kg live sponges	2 nm from the end point of a trawl tow in the direction least likely to result in further encounters and define a buffer of 2 nm radius
		60 kg live coral 400 kg live sponges	
	Longline (per line segment of 1000 hooks or 1,200 m length)	10 units of taxa (1 unit = 1 kg or 1 litre of live coral or sponge)	
	Existing or exploratory area	10 units of taxa (1 unit = 1 kg or 1 litre of live coral or sponge)	
GFCM	The encounter protocol established by GFCM/43/2019/6 requires vessels to report encounters, but no associated move-on rule is in place.	Thresholds have not yet been established, and an 'encounter' is defined as any catch of VME indicator taxa by any deep-sea fishery.	No encounter protocol adopted
NPFC	Trawl (per trawl tow)	50 kg of live cold-water coral (Alcyonacea, Antipatharia, Gorgoneia, Scleractinia)	2 nm
SRFMO	Single species limits	25 kg sponges 60 kg stony coral 5 kg black coral 15 kg sea fans 35 kg anemones 10 kg hexacorals	1 nm either side of the trawl track extended by 1 nm at each end
	Biodiversity (any 3 taxa above thresholds)	5 kg sponges 5 kg stony corals 5 kg anemones 1 kg black corals 1 kg soft corals 1 kg sea pens 1 kg hydrocorals 1 kg armless stars 1 kg sea lilies	
SIOFA	Trawl (per trawl tow)	60 kg live coral 300 kg live sponges	2 nm either side of a trawl track extended by 2 nautical miles at each end
	Longline (per line segment of 1000 hooks or 1,200 m length)	10 units of taxa in the VME indicator taxa list (1 unit = 1 kg or 1 litre of VME indicator organisms)	1 nm from midpoint of line segment
CCAMLR	Longline (per line segment of 1000 hooks or 1,200 m length)	>=5 VME Units triggers notification to Secretariat. >= 10 VME units triggers 'Risk Area' and move on rule. Units are collected per 1,200m of line or 1,000 hooks. VME unit is 1 litre of VME taxa, or 1kg where specimen cannot fit in a 10-litre container.	1 nm from centre point of line segment where >10 VME units are recovered. Area is closed until further assessments are undertaken.

Depth Limitations

RFMO	Gear type	Limitations in place
NAFO	NONE	N/A
NEAFC	NONE	N/A
SEAFO	NONE	The Convention Area of SEAFO are not rich in fisheries resources with about 2-3 % of the whole area being shallower than 2000m of depth.
GFCM	Towed dredges and trawl nets, and trawling.	The deep water Fishing Restricted Area (FRA) prohibits the use of towed dredges and trawl nets at depths greater than 1,000 m throughout the GFCM area (Recommendation GFCM/29/2005/1). Whilst implemented mainly for the precautionary protection of fish stocks, it also makes reference to 'the presence both of unmapped sensitive habitats (deep water coral banks, sea vents, sea mounts, etc.)'. It encompasses around 59% of the GFCM area (FAO, 2016). In addition, trawling is prohibited within 3 nm of the coast (Recommendation GFCM/36/2012/3) within the 50 m isobath, in order to protect coastal sharks and coastal benthic communities.
NPFC	All bottom gear types that operate in the area (trawl, gillnet, longline hook and trap gear)	Maximum depth 1,500 m
SRFMO	None	N/A
SIOFA	Demersal longlines	Prohibited above 500m. Encouraged to set below 1,000m (to reduce depredation).
CCAMLR	Bottom longline.	Minimum depth of 550m, unless otherwise stated.

Gear Modifications / Restrictions

RFMO	Gear type	Modifications / restrictions made
NAFO	None	NAFO consider that the management through the closing of areas with significant concentrations of VME indicator species is the most effective measure for protecting VMEs, and no need for additional measures.
NEAFC	Gillnets, entangling nets and trammel nets	There is a prohibition on the use of gillnets, entangling nets and trammel nets in waters greater than 200 m depth, which also serves to protect VME habitats from potential impacts from net fishing, as these habitats usually occur in deeper waters.
SEAFO	None	N/A
GFCM	towed dredges and trawl nets, trawls	The deep-water Fishing Restricted Area (FRA) prohibits the use of at depths greater than 1,000 m throughout the GFCM area (Recommendation GFCM/29/2005/1). Whilst implemented mainly for the precautionary protection of fish stocks, it also makes reference to 'the presence both of unmapped sensitive habitats (deep water coral banks, sea vents, sea mounts, etc.)'. It encompasses around 59% of the GFCM area (FAO, 2016). In addition, trawling is prohibited within 3 nm of the coast (Recommendation GFCM/36/2012/3) within the 50 m isobath, in order to protect coastal sharks and coastal benthic communities.
NPFC	Gillnets	Distance between gillnet and seafloor must be greater that 70cm to limit contact.
SRFMO	All bottom fishing gear types	Type of gear limited to particular fishery management areas. Gear outside of these areas subject to exploratory fishing protocol.
SIOFA	All bottom gear types	With the exception of lines and traps excluded from interim protected and recently fished areas.
CCAMLR	Bottom set grill nets Bottom trawling	Banned since 2010 Banned since 2008

Observers

RFMO	Level of coverage	VME data recorded	Observer data triggers encounter rule
NAFO	100%	Yes. The quantity of all catch by species, including discards and VMEs. VME species are outlined in the CMMs	No. It is the duty of the vessel master to report it to the flag State.
NEAFC	100% for exploratory fisheries	Yes. Data are collected for the identification and mapping of VMEs and to contribute towards the assessment of SAIs.	No. It is the vessel's responsibility to notify the flag State and Secretariat.
SEAFO	100%	Yes. Observers are required to record all locations where VME indicator species are caught.	No. It is the vessel's responsibility, although a threshold trigger level has never been reached.
GFCM	~25%, varies by contracting party	No	No
NPFC	100% for all vessels undertaking bottom fishing. No guidance for effort levels to monitored but details on VME species should be taken for every haul.	Yes, identified according to recently developed guide. Information collected on species on VME taxa, quantity (in weight or volume), total quantity of all invertebrate species. Collection of samples and photos also encouraged.	No. It is the vessel's responsibility to notify the flag State and Secretariat.
SRFMO	Bottom trawl – 100% coverage Longline – 10% effort coverage (number of hooks).	Yes. For all gear types, quantity to the nearest 0.1 kg, method of weight estimation and sample collection.	No. It is the vessel's responsibility to notify the flag State and Secretariat.
SIOFA	Longline vessels targeting toothfish - at least one observer per vessel covering 25% of hooks. Trawl gear – 100% coverage. Other bottom fishing gear – 20%.	Yes. Observers record quantity (weight or volume) and collect samples.	No. It is the vessels responsibility to report to its flag State, the flag State to report to the SC annually in its National Report.
CCAMLR	100% of all vessel deployments. Up to 50% of effort (hooks hauled). At least 30% of line segments for VME specific data. Two observers required for exploratory fisheries	Yes, identified according to the CCAMLR VME taxa guide. Number of different taxa, the identification and count of each species and volume or weight depending on the size.	No. It is the vessel's responsibility to notify the flag State and Secretariat. Observer will record the data and report at the end of the trip to CCAMLR and these data can be used to verify the vessel data and if necessary for compliance purposes (although this has not happened to date).

Other

RFMO	Gear type	Rule enacted	Frequency
NAFO	N/A	N/A	N/A
NEAFC	N/A	N/A	N/A
SEAFO	N/A	N/A	N/A
GFCM	N/A	N/A	N/A
NPFC	All bottom gear types that operate in the area (trawl, gillnet, longline hook and trap gear)	No direct fishing on four taxa of cold-water corals (Alcyonacea, Antipatharia, Gorgonacea, and Scleractinia).	N/A
SRFMO	N/A	N/A	N/A
SIOFA	N/A	N/A	N/A
CCAMLR	Bottom longline	VME Fine Scale Rectangle (VME FSR). Set in place when a trigger level is reached (between 5 and 10 units), the vessel must notify the Secretariat. When 5 are more vessels the area the area is declared a VME FSR and vessels in the area are informed they may encounter VMEs within it.	Ten VME FSRs have been notified.

Seasonal closures

RFMO	Gear type	Closure
NAFO	None	N/A
NEAFC	None	N/A
SEAFO	None	N/A
GFCM	None	Temporal restrictions to those already established may be designated.
NPFC	All bottom gear types that operate in the area (trawl, gillnet, longline hook and trap gear).	Although seasonal closures were not introduced for VME protection, the introduction of them to protect certain fish stocks coincided with the season for bad weather. This had the effect of reducing bottom set gear movement on the seabed and reducing SAIs on VMEs. The closures are between November and December.
SRFMO	None	Only potentially set for PET species.
SIOFA	None	N/A
CCAMLR	None	Seasonal closures are in place but their primary purpose is to protect vulnerable bird colonies.

Template for Observer Programmes for RFMOs

Using examples from RFMOs the framework for an observer programme can therefore be developed for data collection from different bottom fishing gear types to assess their impact on VMEs and the effectiveness of mitigation measures. This is only a template, based on examples from the RFMOs that have a programme in place, variations between RFMOs in terms of terrain, fishing gear used and used and potential VME indicator species encountered will require there to be some adaptation. This will look at the two main bottom gear types, demersal longlining and trawl.

Identifying specific VME species, producing clear picorial guides, developing a metric for what constitutes a VME and categorising bentic species into different levels of vulnerability.

While the ecology of deep water systems globally is broadly similar and contain similar indicator taxa (CCAMLR, SPRFMO, and SIOFA all use the same guides for example), there will be variations in the individual species potentially being impacted by the fishing gear. All available VME guides are available as a resource on the FAO site[1].

Developing a protocol for the implementation of mitigation measures in line with the need to prevent impacts on VMEs from contact with bottom fishing gear.

Throughout the RFMOs current mitigation measures consist of restricting fishing to current footprints, developing impact assessments for any exploratory fisheries, closed areas, depth and gear restrictions and encounter protocols. Of these the observer will most likely to directly monitor encounter protools although it is the vessel’s reponisbility to ensure the relevant authorities are notified if thesholds are reached.

As discussed, encounter protocols mostly take the form of move on rules when a particular threshold of VME taxa is reached. This varies between RFMOs with some including the same threshold for all VME taxa, others (SPRFMO, NAFO) varying it according to the vulneability, or catchability, of a particular species group. Figure and Figure give examples on how these may work in practice, using examples from longlines (from CCAMLR) and trawls (from NAFO).

[1] https://www.fao.org/in-action/vulnerable-marine-ecosystems/background/vme-tools/ar/

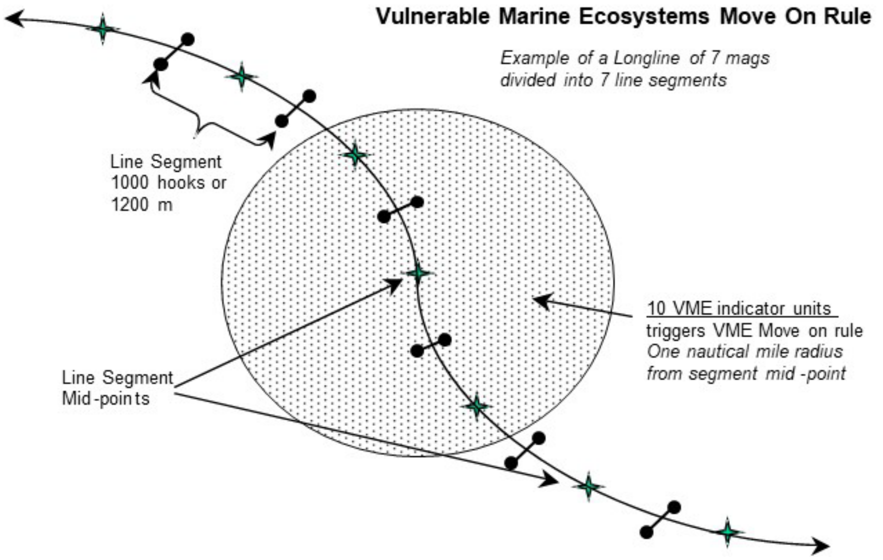


Figure 1 Encounter rule - Longline

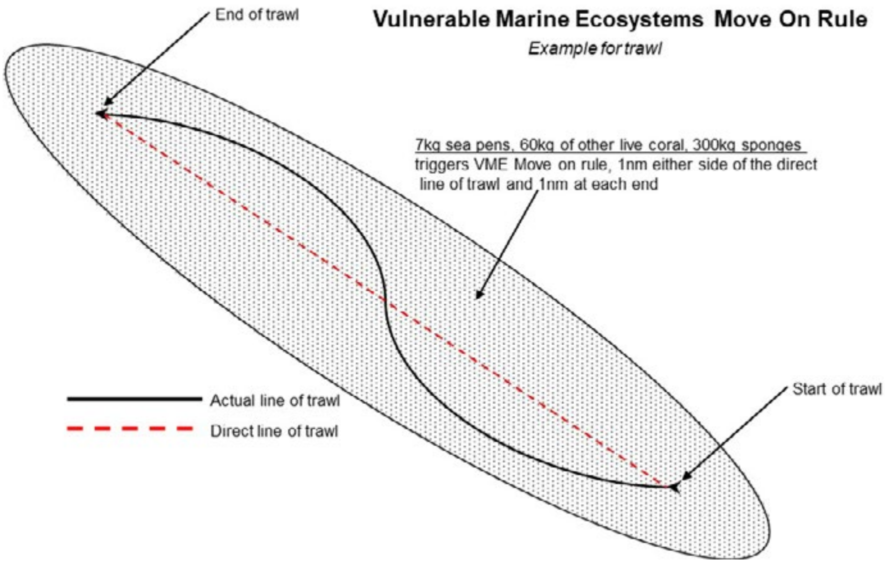


Figure 2 Encounter rule - Trawl

Developing a data collection protocol for observers.

When collecting data from longlines (Figure) there will be certain amount of cooperation required from the crew, both in regards to setting up the lines (set universally at 1,000 hooks or 1,200m sections) and in collecting benthos samples as it will not be possible for observer to monitor the whole line. Current protocols use both random sampling of 30% of the line segments, and directed sampling where five or more units are collected (by weight or volume). This is summarised below

- Observers are to record benthos taxa hauled that come up to the surface and drop off or are hauled on board. Retained benthos must be sampled according to the following protocol and identified to the lowest taxonomic level possible using the relevant VME guide.
- The vessel will be required to retain all benthos that come onboard in 10lt buckets, one bucket per line segment, (1000 hooks or 1200 meters whichever is shortest).

The observers must follow two sampling strategies:

1) sample randomly about **30%** of the line segments; and
2) sample every line segment that collects 5 or more VME-indicator units of VME-indicator organisms.

A sample data recording form is given in Figure 33 and includes midpoint of the line section, number of VME Units in the section and type of sample (Random or Directed). Meta data, such as date, time and depth, are recoded separately and linked by the haul number.

For trawls (Figure), data are collected at the end of the haul, a sample data form is given in Figure.

Collecting information on mitigation devices incorporated into fishing gear.

With the exception of NPFC, there are no modifications to fishing gear currently in place. For other mitigation devices (e.g. Tori lines, seal exclusion devices) observers will confirm they are being deployed and that they meet the requirements laid out by the RFMO or match the plans submitted by the vessel.

Developing procedures for the continual assessment and improvement of observer protocols.

This is done during the debriefing process, through direct interviews with the observers themselves. Reviews of data quality and coverage can also be undertaken by the RFMO scientific body, the Member State or the Commission.

VME Taxa Recording (Longline) Vessel name:________________

Haul Number	VME Segment Number	Observed Bucket VME Unit(s)	Sample Type (Random, Directed)	Segment Midpoint				Complete these columns for each species found in sample bucket		
				Latitude degrees (-DD)	Latitude minutes (MM.mm)	Longitude degrees (DDD)	Longitude minutes (MM.mm)	VME Species Code	Volume (litres)	Weight (kg)

Figure 3 VME Taxa Recording (longline)

VME Taxa Recording (Trawl)

Vessel name:________________

Trawl Number	Observed VME (Kg) total	Live corals (Kg) in haul	Live sponges (Kg) in haul	**Trawl Details**				**Complete these columns for each species found in trawl**	
				Start Latitude	Start longitude	End Latitude	End Longitude	VME Species Code	Weight (kg)

Figure 4 VME taxa recording (trawl)

ANNEX 10

Data Requirements related to Council Regulation (EC) No 734/2008

<table>
<tr><th>Requirement under Reg.</th><th>Comments</th></tr>
<tr><td colspan="2">Article 4 – Issuance of Permit</td></tr>
<tr><td>Detailed fishing plan
Location
Target species
Type of gear and depth
Bathymetric profile of area to be fished.</td><td>EU vessels planning to fish with bottom gears in the high seas are required to apply for special fishing permit for which they must submit a detailed fishing plan. This is equivalent to submitting a research or impact assessment for new and exploratory fisheries in most RFMOs or fishing in areas outside the current footprint.
The information required in the plan is common to most RFMOs with the exception of the bathymetric profile, although this is only required if not familiar to the Flag State concerned.
Additional data collected include proposed dates, fishing effort (number of hooks/hauls/sets), proposed modifications to fishing gear or methods to reduce impacts to VMEs, biology and ecology of target and by-catch species and the overall potential impact footprint of the proposed fishing operations (e.g. CCAMLR, NAFO, SPRFMO).
Some organisations (CCAMLR) have developed a pro forma (currently under revision) to ensure all the information is captured and can be assessed. This includes a preliminary assessment of the impact of planned activities on VMEs for vessels entering the fishery for the first time or who have altered their fishing gear (CCAMLR CM 22-06/Annex A).</td></tr>
</table>

Requirement under Reg.	Comments
Review of plan • Use of best scientific data on VMEs in proposed fishing area. • Assessment of SAIs • Assessment of Risk • Precautionary Principal • Amendments to plan	• Applications to fish in new or exploratory fisheries are reviewed by the scientific body responsible within each organisation on an annual basis, prior to the start of each season. No time scale included, i.e. research plan must be submitted at least three months prior to commencement of fishing and review of plan completed at least one month prior to fishing to allow amendments to be made. • The procedure followed is basically as described here, no additional changes suggested to the review process itself.
Article 5 – Validity	
• Notification of change of plan. • Assessment of change.	• What constitutes a change of plan should be specified (gear, dates, fishing effort etc.) along with time scale, i.e. does this refer to prior to fishing or once operations have started?
Article 6 – Unassessed Areas	
• Assessment shows no risk to VME	• No change suggested.
Article 7 – Encounters with VME	

• Action taken by vessel
  ○ Cease fishing
  ○ Move at least 5nm
• Assess alternative site
• Report encounter.
	• No definition of what constitutes a VME or the threshold levels that will trigger the required action. This needs to defined by gear type and VME taxa according to previous research and best available science.
	
	• 5nm is greater than other move on rules as they stand, consider reviewing. ICES have advised that move on rules can be ineffective in previously unfished areas and cause damage due to fishing taking place in pristine VME areas. They recommend areas are surveyed first to review extent of VME.
	
	• Current requirement is report VME encounter 'without delay' can be open to interpretation. A time limit should be put in place (e.g. within 24 hrs).

Requirement under Reg.	Comments
	• Follow up actions are unclear, is the area closed to fishing under Article 8 ad what is the extent of the closed area for different gear types. Does Article 8 just refer to closed areas in general or closed areas as a result of data obtained through Article 7.
Article 8 – Area Closure	
• Based on best scientific advice • Circulated to Members	• More clarity on if this refers to closed areas in general or those proposed due to the actions triggered under Article 7.
Article 9 - VMS	
• VMS failure protocol • Action on returning to port	• No change suggested.
Article 11 - Observers	

• 100% coverage for all vessels with permit
• Observer tasks
    ○ Record catch information
    ○ Alteration of fishing plan
    ○ Encounters with VMEs
    ○ Depths
• Submit report with 20 days to competent authorities
• Submit report within 30 days to Commission, upon request.
• Conditions of observer
	• Data collection protocols should be harmonised between Member States (see previous).
	• Encounters with VMEs should be harmonised between Member States (see previous).

Article 12 - Information	
• Submission of reports to Member States • Submission of Impact assessments	• No change suggested.

ANNEX 11

Summary of "Key concepts" used across RFMOs and Council Regulation (EC) No 734/2008

Definitions	Council Regulation (EC) No 734/2008	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
		NAFO[1]	NEAFC[2]	SEAFO[3]	GFCM[4,5]	NPFC	SPRFMO	SIOFA	CCAMLR
Marine Ecosystem	A dynamic complex of plant, animal and microorganism communities and their nonliving environment interacting as a functional unit	n.a.	n.a.	n.a.	n.a.				
Significant Adverse Impacts (SAI)	Impacts (evaluated individually, in combination or cumulatively) which compromise ecosystem integrity in a manner that impairs the ability of affected populations to replace themselves and that degrades the long-term natural productivity of habitats, or causes on more than a temporary basis significant loss of species richness, habitat or community types	It Refers to paragraphs 17 to 20 of the *FAO DSF Guidelines* [6]	Has the same meaning and characteristics as those described in paragraphs 17-20 of the *FAO DSF Guidelines*	Has the same meaning and characteristics as those described in paragraphs 17-20 of the *FAO DSF Guidelines*	Has the same meaning and characteristics as those described in paragraph 17 of the *FAO DSF Guidelines*	Has the same meaning and characteristics as those described in paragraphs 17-20 of the *FAO DSF Guidelines*	Has the same meaning and characteristics as those described in paragraphs 17-20 of the *FAO DSF Guidelines*	Has the same meaning and characteristics as those described in paragraphs 17-20 of the *FAO DSF Guidelines*	n.a
Vulnerable Marine Ecosystem (VME)	Any marine ecosystem whose integrity (i.e. ecosystem structure or function) is, according to the best scientific information available and to the principle of precaution, threatened by significant adverse impacts resulting from physical contact with bottom gears in the normal course of fishing operations, including, inter alia, reefs, seamounts, hydrothermal vents, cold water corals or cold water sponge beds. The most vulnerable ecosystems are those that are easily disturbed and in addition are very slow to recover, or may never recover	It refers to paragraphs 42 and 43 of the *FAO DSF Guidelines*	Has the same meaning and characteristics as those contained in paragraphs 42 and 43 of the *FAO DSF Guidelines*	Has the same meaning and characteristics as those contained in paragraph 42 with its Annex and paragraph 43 of the *FAO DSF Guidelines*	"It refers to paragraphs 42 and 43 of *FAO DSF Guidelines*	Each member of the Commission, using the best information available, is to decide which species or areas are to be categorized as VMEs, identify areas where VMEs are known or likely to occur, and assess whether individual bottom fishing activities would have SAIs on such VMEs or marine species.	CMM 03-2021: "vulnerable marine ecosystem" (VME) means a marine ecosystem that has the characteristics referred to in paragraph 42 of, and elaborated in the Annex to, the *FAO Deepsea Fisheries Guidelines*.	CMM 2021-01: Vulnerable marine ecosystem' (VME) means a marine ecosystem identified using the criteria outlined in paragraph 42 of the *FAO Deepsea Fisheries Guidelines*	CM 22-06: Benthic ecosystems containing species or communities that are considered at risk of disturbance due to fishing or other human activities. The most vulnerable ecosystems are those that are both easily disturbed and very slow to recover, or

[1] NAFO Conservation and Enforcement Measures (CEM) 2021
[2] NEAFC Recommendation 10:2021. Recommendation to amend Recommendation 19:2014 on the Protection of Vulnerable Marine Ecosystems in the NEAFC Regulatory Area, as amended.
[3] Conservation Measure 30/15 on Bottom Fishing Activities and Vulnerable Marine Ecosystems in the SEAFO Convention Area (Adopted 03/12/2015)
[4] Resolution GFCM/43/2019/6
[5] (GFCM-WGVME , 2017)
[6] FAO International Guidelines for the Management of Deep Sea Fisheries in the High Seas (FAO, 2009)

Definitions	Council Regulation (EC) No 734/2008	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
		NAFO[1]	NEAFC[2]	SEAFO[3]	GFCM[4,5]	NPFC	SPRFMO	SIOFA	CCAMLR
						A marine ecosystem is to be classified as vulnerable based on its characteristics. The following list of characteristics is used as criteria in the identification of VMEs. (a) Uniqueness or rarity screte areas; (b) Functional significance of the hábitat; (c) Fragility; (d) Life-history traits of component species that make recovery difficult; (e) Structural complexity.			may never recover. These include ecosystems associated with seamounts, hydrothermal vents, deep-sea trenches and submarine canyons, as well as oceanic ridges.
VME indicator element	n.a.	Topographical, hydrophysical or geological features which potentially support VMEs (NAFO CEM, Part VII of Annex I.E): Five features.	"VME indicators" are those included in Annex 5: Five features.	n.a.	The WGVME (2017) agreed on a first list of Mediterranean "VME indicator features, habitats and taxa" (corals, sponges and other vulnerable groups that could signal the occurrence of VMEs) for the Mediterranean Sea: Appendix E, Annex I, Six features	n.a	n.a	n.a	n.a
VME indicator species	n.a.	Species that signal the occurrence of VME (NAFO CEM, Part VI of Annex I.E): List of species/taxa.	"VME indicators" are those included in Annex 5: Seven habitat types with the correspondant list of species/taxa	"VME indicators" are those species (live sponges and/or live corals) and indicator units (see threshold section) included in Annex 6. In 2010, SEAFOs Scientific Committee identified a provisional list of benthic invertebrate VME indicator species/groups for the SEAFO Convention Area (list of taxa)	"VME indicator taxa" refers to the species or group of species used as signal of VME occurrence. The list of Mediterranean VME indicator taxa is defined in Annex 1 of Appendix 17 of report of the forty-second session of the GFCM	Although Paragraph 83 of UNGA Resolution 61/105 refers to seamounts, hydrothermal vents and cold-water corals as examples of VMEs, there is no definitive list of specific species or areas that are to be regarded as VMEs.	CMM 03-2021: "VME indicator taxa" means any benthic organism listed in Annex 5.		CM 22-07: Para. 2ii. VME indicator organism' means any benthic organism listed in the CCAMLR VME Taxa Classification Guide

Definitions	Council Regulation (EC) No 734/2008	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
		NAFO[1]	NEAFC[2]	SEAFO[3]	GFCM[4,5]	NPFC	SPRFMO	SIOFA	CCAMLR
						Examples of potential vulnerable species groups, communities and habitats as well as features that potentially support them are given in Annex 2.1 of CMM 2021-05			
Encounter with VME	n.a.	Catch of a VME indicator species above threshold levels (NAFO CEM, Article 22.1). Any encounter with a VME indicator species or merely detecting its presence is not sufficient to identify a VME. That identification should be made on a case-by-case basis through assessment by relevant bodies	Catch of VME indicator species above threshold levels (Article 9)	"Encounter" means an incidental catch of a VME indicator species above threshold levels as set out in Annex 6. (Any encounter with a VME indicator species or merely detecting its presence is not sufficient to identify a VME. That identification should be made on a case-by-case basis through assessment by the Scientific Committee)	There is no definition for "encounter with VME". Nevertheless, an "encounter with VME Indicator Taxa" is defined as any catch of VME Indicator Taxa obtained by any DSF.	If cold water corals more than 50Kg are encountered in one gear retrieval, Members of the Commission shall require vessels flying their flag to cease bottom fishing activities in that location. In such cases, the vessel shall not resume fishing activities until it has relocated a sufficient distance, which shall be no less than 2 nautical miles, so that additional encounters with VMEs are unlikely. All such encounters, including the location, gear type, date, time and name and weight of the VME indicator species, shall be reported to the Secretariat, through the	CMM 03-2021: "Encounter" means catch of a VME indicator taxa above threshold levels as set out in paragraph 27.	CMM 2020-01: As an encounter may be considered evidence of a potential presence of a VME.	CM 22-06: Annex 22-06/B provides guidelines specifying categories of information to be included in the notification to be submitted to the Secretariat by Contracting Parties when evidence of VMEs has been encountered, and has not otherwise been reported under Conservation Measure 22-07. CM 22-07: Report encounter. Move 1 nmile. Temp closure. Review by SC. Report when >=5 units

Definitions	Council Regulation (EC) No 734/2008	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
		NAFO[1]	NEAFC[2]	SEAFO[3]	GFCM[4,5]	NPFC	SPRFMO	SIOFA	CCAMLR
						Member, within one business day, who shall immediately notify the other Members of the Commission so that appropriate measures can be adopted in respect of the relevant site. It is agreed that the cold water corals include: *Alcyonacea, Antipatharia, Gorgonacea, and Scleractinia*.			encountered-report
Thresholds defining an encounter with VME indicator species	n.a.	Catch per set (e.g. trawl tow, longline set, or gill net set) of more than 7 kg of sea pens and/or 60 kg of other live coral and/or 300 kg of sponges.	(a) For a trawl tow, and other fishing gear than longlines: the presence of more than 30 kg of live coral and/or 400 kg of live sponge of VME indicators; (b) for a longline set: the presence of VME indicators on 10 hooks per caught per 1000 hook segment or per 1200 m section of long line, whichever is the shorter.	(a) For a trawl tow: more than 600 kg of live sponges and/or 60 kg of live coral in existing fishing areas and more than 400 kg of live sponges and/or 60 kg of live coral in new fishing areas. (b) For a longline set: at least 10 VME-indicator units (1 unit = 1kg or 1 litre of live coral and/or live sponge) in one 1200m section of line or 1000 hooks, whichever is the shorter, in both existing and new fishing areas; (c) For a pot set: at least 10 VME-indicator units (1 unit = 1kg or 1 litre of live coral and/or live sponge) in one 1200m section of line in both existing and new fishing areas. The definition of VME indicator units for bottom longlines and pots is as follows: The quantity of VME-indicator organisms (i.e. live corals and/or live sponges) recovered during hauling should be reported for each 1200m section of the longline or potline (in	n.a.	>50Kg (cold water corals: *Alcyonacea, Antipatharia, Gorgonacea, and Scleractinia*)	CMM 03-2021: Range of weights for different taxa from 1kg to 60kg. - Annex 6A: Weight Threshold for Triggering VME Encounter Protocol in Any One Tow for a Single VME Indicator Taxa: Sponges: 25 kg; Stony corals: 60 kg; Black corals: 5 kg; Seafan octocorals: 15 kg; Anemones: 35 kg and Hexacorals: 10kg - Annex 6B: Weight Threshold for Triggering VME Encounter Protocol in Any One Tow for Three or More	CMM 2020-01: threshold levels for encounters with VMEs: a. the threshold that triggers the encounter protocol for longline gears shall be the catch/recovery of 10 or more VME-indicator units of species listed in Annex 1 in a single line segment. b. the threshold that	CM 22-07: 10 units per line segment (Longlines: 1000-hook section or 1200m; Pots: 1200m

Definitions	Council Regulation (EC) No 734/2008	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
		NAFO[1]	NEAFC[2]	SEAFO[3]	GFCM[4,5]	NPFC	SPRFMO	SIOFA	CCAMLR
				the case of longlines - or 1000 hooks whichever is the shorter) as: (a) Volume (litre) for VME-indicator organisms which fit into 10-litre container; (b) Weight (kg) for VME-indicator organisms which do not fit 10-litre container (e.g. branching species); and (c) VME-indicator units which is the combined total of volume of VME-indicator organisms which fit into 10-litre and weight of VME-indicator organisms which do not fit into containers of 10-litre (i.e. unit = volume + weight).			Different VME Indicator Taxa: Sponges: 5 kg; Stony corals: 5 kg; Black corals: 1 kg; True soft corals: 1 kg; Seafan octocorals: 1 kg; Sea pens: 1 kg; Anemones: 5 kg; Hexacorals: 1kg; Hydrozoans: 1 kg ; Hydrocorals: 1 kg; Bryozoans: 1 kg; Armless stars: 1 kg and Sea lillies: 1 kg	triggers the encounter protocol for the trawls shall be more than 60 kg of live corals and/or 300 Kg of sponges in any tow. The threshold that triggers the encounter protocol for the trawl as defined is paragraph 12b shall be reviewed by the Scientific Committee in 2020.	
Move-on rule	There are no indications about VME indicators quantification. Where, in the course of fishing operations, a fishing vessel encounters a VME, it shall immediately cease fishing, or refrain from engaging in fishing in the site concerned. It shall resume operations only when it has reached an alternative site at a minimum distance of five nautical miles from the site of the encounter within the area foreseen in its fishing plan	Catch of VME indicators shall be quantified. If the quantity of VME indicator species caught in a fishing operation is beyond the threshold: (i) Report the encounter and (ii) cease fishing and move away at least 2 nautical miles from the endpoint of the tow/set in the direction least likely to result in further encounters.	Catch of VME indicators shall be quantified. If the quantity of VME indicators caught in a fishing operation is beyond the thresholds: (i) Trawl gears: the fishing vessel shall cease fishing and move out of an area defined as a 2 nautical mile wide band (polygon) on both sides of the "track" of the trawl haul during which an encounter occurred. The "track" is defined as the line joining consecutive VMS positions, supplemented by more exact information,	Catch of VME indicators shall be quantified. If the quantity of VME indicators caught in a fishing operation is beyond the thresholds: (i) Trawl gears: the vessel master shall cease fishing and move away at least 2 nautical miles from the end point of the trawl tow in the direction least likely to result in further encounters, defining a buffer area with a 2 nautical mile radius; (ii) Other bottom fishing gears: the fishing vessel shall cease fishing and move away at least 1 nautical miles from the position that the evidence suggests is	There are no indications about move-on rules Nevertheless there is an "encounter rule" (WGVME, 2017): Following an encounter with VME Indicator Taxa during DSF, the vessel captain shall immediately report the encounter to the flag State, on the form provided in Annex II, including the following information: (i) the position of the vessel, either by the start and end point of the tow or set, or by another position that is closest to the exact encounter location;(ii) the fishing characteristics of the	The move-on rule has never been triggered. Moreover, the rule only applies to bycatch of the four orders of coral species designated by NPFC as VME indicators	CMM-03-2021: Where VME indicator taxa are encountered in any one tow at or above the threshold limits in Annex 6A, or three or more different VME indicator taxa at or above the weight limits in Annex 6B, Members and CNCPs shall require any vessel flying	2 nm either side of a trawl track extended by 2 nautical miles at each end	N/A - no bottom trawling allowed

Definitions	Council Regulation (EC) No 734/2008	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
		NAFO[1]	NEAFC[2]	SEAFO[3]	GFCM[4,5]	NPFC	SPRFMO	SIOFA	CCAMLR
			between the start and the end of the tow, extended by 2 nautical miles at both ends; (ii) Other bottom fishing gears: the fishing vessel shall cease fishing and move away at least 2 nautical miles from the position that the evidence suggests is closest to the exact encounter location; (iii) The master shall report the incident, including the "track" or position.	closest to the exact encounter location, defining a buffer area with a 1 nautical mile radius. (iii) the master shall report the incident, including the track of the trawl or position.	vessel;(iii) the groups of the VME Indicator Taxa encountered and the best estimates of their live weight (kg).		their flag to: a) cease bottom fishing immediately within an encounter area of one (1) nautical mile either side of the trawl track extended by one (1) nautical mile at each end; b) report the encounter immediately to the Member or CNCP whose flag the vessel is flying and the Secretariat, in accordance with the Guidelines for the preparation and submission of notifications of encounters with potential VMEs, contained in Annex 7.		
Bottom gears/ Bottom fishing activities	"Bottom gears" means gears deployed in the normal course of fishing operations in contact with the seabed	"Bottom fishing activities" means bottom fishing activities where the fishing gear is likely to contact the seafloor during the normal course of fishing operations	"Bottom fishing" means the use of fishing gear that is likely to contact the seafloor during the normal course of fishing operations.	"Bottom fishing activities" means fishing activities where the fishing gear is likely to contact the seafloor during the normal course of fishing operations.	n.a.	"Bottom fishing" means fishing activities where the fishing gear is likely to contact the seafloor during the normal course of fishing operations	CMM 03-2021: "bottom fishing" is defined as fishing using any gear type likely to come in contact with the seafloor or benthic organisms during the normal course of operations, and includes: a) "Bottom trawl" which is	CMM 2020-01: 'bottom fishing' means fishing using any gear type likely to come in contact with the seafloor or benthic organisms during the normal	CM 22-06: 'bottom fishing activities' includes the use of any gear that interacts with the bottom.

Definitions	Council Regulation (EC) No 734/2008	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
		NAFO[1]	NEAFC[2]	SEAFO[3]	GFCM[4,5]	NPFC	SPRFMO	SIOFA	CCAMLR
							defined as fishing using a trawl net that is designed to be pulled through the water and to come into contact with the seabed; b) "Mid-water trawl" which is defined as fishing for bentho-pelagic species using a trawl net that is designed to be pulled through the water near the seabed and designed not to come into extended contact with the seabed; c) "Bottom line" which is defined as fishing using a line to which a hook or hooks (whether baited or not) are attached and rigged to sink and fish on or near the seabed. This includes, but is not limited to, longlines, hand lines, drop lines, trot lines, and dahn lines.	course of operations .	
Unassessed areas	Areas where no proper scientific assessment (regarding risk of SAI on VMEs) has been carried out and made available (in such areas, the use of bottom gears shall be	n.a.	n.a.	n.a.	n.a.				

Definitions	Council Regulation (EC) No 734/2008	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
		NAFO[1]	NEAFC[2]	SEAFO[3]	GFCM[4,5]	NPFC	SPRFMO	SIOFA	CCAMLR
	prohibited, subject to the review of this Regulation, Article 13).								
Closed areas/Areas closures	Areas that shall be closed to fishing with bottom gears, based on the best scientific information available on the occurrence or on the likelihood of occurrence of VMEs. Member States shall identify and implement these closures	Only defined in terms of the areas that are closed to bottom fishing (spatial location)	Areas closed to bottom fishing (Article 5)	Areas closed to all fishing activities (Annex 2), except the area closure to the south of Valdivia Bank (No12), explicitly identified as being closed to all fishing except for pots and set longlines (Annex 2B)	n.a.				CCAMLR has prohibited directed fishing on various taxa in some subareas and divisions (refer Conservation Measure 32-02). These regions are generally referred to as 'closed areas' and afford protection and conservation to target and by-catch species.
Restricted bottom fishing areas	n.a.	n.a.	Areas outside closed areas and existing bottom fishing areas	n.a.	n.a.				
Fishery restricted area (FRA)	n.a.	n.a.	n.a.	n.a.	A geographically defined area in which all or certain fishing activities are temporarily or permanently banned or restricted in order to improve the exploitation and conservation of harvested living aquatic resources or the protection of marine ecosystems (FAO, 2008)[7].				
Fishing activities	n.a.	Harvesting or processing fishery resources, landing or transhipping of fishery resources or products derived from fishery resources, or any other activity in preparation	There is no definition in Rec 10:2021. Nevertheless, in the *NEAFC Scheme*[8], "fishing activities" means fishing, including joint fishing operations, fish processing operations,	There is no definition in CM30/15. Nevertheless, in the *SEAFO System*[9] context, "fishing related activities" means any operation in support of, or in preparation for fishing, including the landing, packaging,	In the context of the GFCM Agreement,"fishing" means searching for, attracting, locating, catching, taking or harvesting of living marine resources or any activity which can reasonably be expected to result in	(i) the actual or attempted searching for, catching, taking or harvesting of fisheriesresource s;	(i) the actual or attempted searching for, catching, taking or harvesting of fishery resources; (ii)		

[7] http://www.fao.org/3/a1579b/a1579b00.pdf
[8] NEAFC scheme of control and enforcement (2021)
[9] SEAFO System of observation, inspection, compliance and enforcement (2019)

Definitions	Council Regulation (EC) No 734/2008	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
		NAFO[1]	NEAFC[2]	SEAFO[3]	GFCM[4,5]	NPFC	SPRFMO	SIOFA	CCAMLR
		for, in support of, or related to the harvesting of fisheries resources in the Regulatory Area	the transhipment or landing of fisheries resources or products thereof and any other commercial activity in preparation for, or related to, fishing; including *inter alia*, packaging, transporting, refuelling or re-supplying	processing, transhipping or transporting of fishery resources that have not been previously landed at a port, as well as the provisioning of personnel, fuel, gear and other supplies at sea	attracting, locating, catching, taking or harvesting of living marine resources; Moreover,"fishing related activities" means any operation in support of, or in preparation for fishing activities, including landing, packaging, processing, transshipping or transporting of fish, as well as provisioning of personnel, fuel, gear and other supplies	(ii) engaging in any activity that can reasonably be expected to result in locating, catching, taking or harvesting of these resources for any purpose; (iii) the processing of these resources at sea and the transshipping of these resources at sea or in port; and (iv) any operation at sea in direct support of, or in preparation for, any activity described in subparagraphs(i)to(iii) above, except for any operation related to emergencies involving the health and safety of crew members or the safety of fishing vessels;	engaging in any activity which can reasonably be expected to result in the locating, catching, taking or harvesting of fishery resources for any purpose; (iii) transhipment and any operation at sea in support of, or in preparation for, any activity described in this definition; and (iv) the use of any vessel, vehicle, aircraft or hovercraft, in relation to any activity described in this definition;		
Exploratory bottom fishing	n.a.	Bottom fishing activities conducted outside the footprint, or within the footprint with significant changes to the conduct or in the technology used in the fishery	All commercial bottom fishing within restricted bottom fishing areas, or if there are significant changes to the conduct and technology of bottom fishing within existing bottom fishing areas	All commercial bottom fishing activities outside area closures and existing bottom fishing areas, or fisheries within existing bottom fishing areas when a new fishing method and/or strategy are attempted to be used	"Exploratory (or new) deep-sea bottom fishing" (WGVME, 2017) occurs during the initial development phase of a DSF when the DSF operates in areas that have not been previously fished or in fished areas following significant changes in the gear or effort, as described in paragraphs 23, 55, 61 and 65 of the *FAO DSF Guidelines*	Annex 1 of 2021-05 and 2019-06 Conservation Management Measures describes Exporatory Fisheries as "all bottom fishing activities in new fishing areas and areas where fishing is prohibited in a precautionary manner or with bottom gear not	CMM 13-2021 (Exploratory Fisheries) both "new and exploratory fisheries" are referred as "exploratory fisheries" (SPRFMO, 2021a). For the purposes of this CMM, a fishery is defined as an "exploratory fishery": (i) if it	The term "new fishery" encompas ses both "new" and "explorato ry" fisheries. A fishery shall be considere d as a "new fishery" for a species	An exploratory fishery (CM 21-02) is defined as a fishery that was previously classified as a 'new fishery'. An exploratory fishery will continue to be classified as such until sufficient

Definitions	Council Regulation (EC) No 734/2008	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
		NAFO[1]	NEAFC[2]	SEAFO[3]	GFCM[4,5]	NPFC	SPRFMO	SIOFA	CCAMLR
						previously used in the existing fishing areas".	has not been subject to fishing in the previous ten years; or (ii) for the purposes of fishing with a particular gear type or technique, if it has not been subject to fishing by that particular gear type or technique in the previous ten years; or (iii) if fishing in that fishery has been undertaken in the previous ten years pursuant to this CMM, and a decision has not yet been taken in accordance with paragraph 25or 26 of this CMM to either close or manage the fishery as an established fishery; or (iv) if it is of a kind listed in paragraph 15 of CMM 03-2021 (Bottom Fishing) (SPRFMO, 2021b), that is, any proposals to undertake bottom fishing: (i) outside a SPRFMO Management	using a particular fishing method when one or more of the following conditions is/are met: i. information on fishing activity (catch, effort, distribution) using a given fishing method in the proposed activity area has not previously been submitted to SIOFA; or ii. catch and effort data from the two most recent years in which fishing activities occurred have not been submitted to SIOFA; or iii. the proposed combination of fishing area and gear falls outside	information is available: (a) to evaluate the distribution, abundance and demography of the target species, leading to an estimate of the fishery's potential yield (b) to review the fishery's potential impacts on dependent and related species (c) to allow the Scientific Committee to formulate and provide advice to the Commission on appropriate harvest catch levels, as well as effort levels and fishing gear, where appropriate.

Definitions	Council Regulation (EC) No 734/2008	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
		NAFO[1]	NEAFC[2]	SEAFO[3]	GFCM[4,5]	NPFC	SPRFMO	SIOFA	CCAMLR
							Area; or (ii) inside a Management Area using bottom fishing methods other than bottom trawl, midwater trawl or bottom line fishing; or (iii) in a mid-water trawl Management Area using bottom trawl gear or in a bottom line Management Area using bottom trawl or mid-water trawl gear; or (iv) inside a Management Area targeting species not previously targeted in the area proposed to be fished (unless the species has regularly been caught as part of an existing fishery).	the defined fishing footprints for the correspon ding gear ("benthic/ demersal trawl" and "gears other than benthic/d emersal trawl").	
Fishing vessel	n.a.	Any vessel equipped for, intended for, or engaged in fishing activities, including fish processing, transhipment or any other activity in preparation for or related to fishing activities, including experimental or exploratory fishing activities	There is no definition in Rec 10:2021. Nevertheless, in the *NEAFC Scheme* "fishing vessel" means any vessel used or intended for use for the purposes of the commercial exploitation of fisheries resources, including fish processing vessels and vessels engaged in transhipment.	There is no definition in CM30/15 Nevertheless, in the *SEAFO System*, context "vessel" means fishing vessel and fishing research vessel	In the context of the GFCM Agreement, "vessel" means any vessel, ship of another type or boat used for, equipped to be used for, or intended to be used for fishing or fishing related activities	"Fishing vessel" means any vessel used or intended for use for the purpose of engaging in fishing activities, including fish processing vessels, support ships, carrier vessels and any other vessel directly engaged in such fishing activities	'fishing vessel' means any vessel used or intended for fishing, including fish processing vessels, support ships, carrier vessels and any other vessel directly engaged in fishing operations		Any vessel of any size used for, equipped to be used for, or intended for use for the purposes of fishing or fishing related activities, including support ships, fish processing

Definitions	Council Regulation (EC) No 734/2008	Atlantic Ocean and adjacent waters				Pacific Ocean		Indian Ocean	Southern Ocean
		NAFO[1]	NEAFC[2]	SEAFO[3]	GFCM[4,5]	NPFC	SPRFMO	SIOFA	CCAMLR
									vessels, vessels engaged in transhipment and carrier vessels equipped for the transportation of fishery products except container vessels and excluding Members' marine science research vessels.
Research vessel	n.a.	A vessel permanently used for research or a vessel normally used for fishing activities or fisheries support activity that is for the time being used for fisheries research	n.a.	There is no definition in CM30/15. Nevertheless, in the *SEAFO System* context, "vessel" means fishing vessel and fishing research vessel	n.a.				

Overview of the concept "fishing footprint/existing bottom fishing areas" in the RFMOs

Atlantic Ocean and adjacent waters	NAFO[10]	*"Footprint"*, otherwise known as *"Existing bottom fishing areas"*, means that portion of the Regulatory Area where bottom fishing has historically occurred (based on information concerning the period 1987-2007)[11], and is defined by the coordinates shown in Table 4 and illustrated in Figure 2 of NAFO CEM.
	NEAFC[12]	*"Existing bottom fishing areas"* means the portion of the Regulatory Area where bottom fishing has historically occurred, based on information concerning the period 1987-2007 (Article 4). Areas where the NEAFC Commission decides to authorise new bottom fishing based upon the exploratory fisheries conducted in the previous two years are also defined as "existing bottom fishing areas".
	SEAFO[13]	*"Existing bottom fishing areas"* means the portion of the Convention Area where bottom fishing occurred in the period 1987-July 2011. Areas where new bottom fishing activities are authorised shall be defined as "existing bottom fishing areas" pursuant to Article 4.
	GFCM[14]	*"Existing deep-sea bottom fishing areas"*, means that portion of the GFCM area of application where deep-sea bottom fishing has occurred up to and including 2019.
Pacific Ocean	NPFC[15]	Under CMM 2021-05 and CMM 2019-06, members are required to submit to the Scientific Committee (SC) an estimate of their impacts on VMEs and the footprint is assessed according to the standards laid out in the Annex 2 *'Science-based Standards and Criteria for Identification of VMEs and Assessment of Significant Adverse Impacts on VMEs and Marine Species'*. Member states submit the required data the on an annual basis which are reviewed by the Scientific Committee.
	SPRFMO[16]	Area of the sea floor potentially contacted by bottom fishing gear. It was constructed from reported demersal and midwater trawling, and bottom longlining fishing effort records from 1989 to 2019[17].
Indian Ocean	SIOFA[18]	*"SIOFA bottom fishing footprint"* means a map of the spatial extent of historical bottom fishing in the Agreement Area, for all vessels flagged to all Contracting Parties, Cooperating Non-contracting Party (CNCPs) and Participating fishing entities (PFEs) over a period to be defined by the Meeting of the Parties. The SC agreed that the maps will include all grid squares in which fishing effort has been recorded between 2000 and 2015[19].
Southern Ocean	CCAMLR[20]	*"Fishing footprint"* is the area of the seafloor within which fishing gear interacts with benthic organisms. Fishing footprint may be expressed per unit of fishing effort for a particular gear configuration (e.g. for longlines, km^2 seabed contacted per km of longline deployed), or as a cumulative footprint when calculated and summed for all fishing gear deployments in a defined period and area. This areal measure does not incorporate the level of impact within the footprint. This defines both the fishing footprint from an individual fishing event and the cumulative footprint.

[10] NAFO Conservation and Enforcement Measures (CEM) 2021.
[11] NAFO Secretariat (2009) https://www.nafo.int/Portals/0/PDFs/fc/2009/fcdoc09-20.pdf
[12] NEAFC Recommendation 10:2021. Recommendation to amend Recommendation 19:2014 on the Protection of Vulnerable Marine Ecosystems in the NEAFC Regulatory Area, as amended.
[13] SEAFO Conservation Measure 30/15 on Bottom Fishing Activities and Vulnerable Marine Ecosystems in the SEAFO Convention Area (Adopted 03/12/2015).
[14] GFCM-WGVME (2017) Scientific Advisory Committee on Fisheries (SAC). Report of the first meeting of the Working Group on Vulnerable Marine Ecosystems. Malaga, Spain, 3-5 April 2017.
[15] NPFC (2021) Sustainable use and conservation handbook.
[16] SPRFMO CMM 2.03. (2014) Conservation and Management Measure for the Management of Bottom Fishing in the SPRFMO Convention Area. Paragraphs 6 & 8(d). For the purpose of this measure, the term *'bottom fishing footprint'* means a map of the spatial extent and distribution of historical bottom fishing in the Convention Area of all vessels flagged to a particular Member or CNCP over the period 1 January 2002 to 31 December 2006. CMM 2.03 is superseded/expired and since 2019, the definition of *'bottom fishing footprint'* is missing in the SPRFMO CMMs for the Management of Bottom Fishing (CMM 03-2019, CMM 03-2020, CMM 03-2021).
[17] SC8-DW07 rev 1 Cumulative Bottom Fishery Impact Assessment for Australian and New Zealand bottom fisheries in the SPRFMO Convention Area, 2020.
[18] SIOFA Conservation and Management Measure for the interim management of bottom fishing in the Agreement Area (interim management of bottom fishing) CMM 2020-01.
[19] SIOFA (2019) Report of the Fourth Meeting of the Scientific Committee of the Southern Indian Ocean Fisheries Agreement (SIOFA) Yokohama, Japan 25 – 29 March 2019.
[20] Sharp and Parker (2010) An updated glossary of terms relevant to the management of Vulnerable Marine Ecosystems (VMEs) in the CCAMLR Area (WG-FSA-10/28) https://www.ccamlr.org/en/wg-fsa-10/28.

ANNEX 12

Deliverable 5:

TASK 8 – SUPPORT THE EVALUATION OF COUNCIL REGULATION (EC) No 734/2008

CONTENTS

1. Introduction

1.1 Background

In June 2008, the Council of the European Union adopted Regulation (EC) No 734/2008 (the Regulation) on the protection of vulnerable marine ecosystems (VMEs) in the high seas from the adverse impacts of bottom fishing gears. Its purpose was to transpose the measures contained in the United Nations General Assembly (UNGA) Resolution 61/105 into Union law for vessels flying flags of its Member States, for those areas of the high seas where no Regional Fisheries Management Organization (RFMO) or arrangement with competence to regulate fishing activities had been established or where no process for establishment of a RFMO is under way and where no interim measures were put in place during negotiations for the establishment of an RFMO.

The Regulation establishes that the competent authorities of an EU Member State can only issue special fishing permits for the use of bottom fishing gears on the high seas if specific conditions are met. Member States are obliged to carry out an assessment of the potential impacts of the vessels' intended fishing activities and can only issue a special fishing permit after concluding that such activities were not likely to have significant adverse impacts (SAIs) on VMEs. The use of bottom gears is prohibited in areas where no proper scientific assessment has been carried out and made available. The Regulation also contains provisions on unforeseen encounters with VMEs, area closures and an observer scheme for all vessels which have been issued with a special fishing permit.

The European Commission (EC) is considering whether it is necessary to review and update the Regulation to ensure it is still relevant given the current needs and reflects the most recent scientific advice and best practices. Considering the EU's involvement in various RFMOs managing deep sea fisheries (DSFs) and in view of the possibility to update the Regulation, there is need to evaluate the Regulation and provide recommendations to guide future actions. Amongst others, recommendations are needed based on improvements in scientific knowledge and corresponding best practice, and on reinforcing RFMOs action for the protection of VMEs. Further, various countries and RFMOs have adopted a range of approaches on the protection of VMEs and this raises the need to promote and ensure there is an appropriate level of consistency between the Regulation and the approaches used by RFMOs.

1.2 Geographical scope

The Regulation applies to the areas of the high seas used by vessels flying flags of EU Member States where no RFMO has been established or where no interim measures were put in place during negotiations for the establishment of an RFMO. The two main areas where the Regulation applies therefore are the Central Atlantic and Southwest Atlantic Ocean. Given the limited extent of deep-sea fisheries on the high seas of Central Atlantic, this area is of low interest. However, the Southwest Atlantic Ocean (FAO Area 41) has no RFMO or other multilateral interim measures that have been established to regulate the high seas bottom fisheries, nor are any negotiations currently underway to establish an RFMO in the region. Area 41 is therefore the main focus of the Regulation and this stakeholder consultation.

1.3 Main fleets in FAO Area 41

According to the FarFish project (Mikkelsen 2020), the European fleet in Area 41 takes part in the mixed fisheries using demersal trawlers mainly in 41.3.1 and 41.3.2 between 44° and 48°S within areas without evidence of seamounts or VMEs (Figure 1). The other important non-EU fleets fishing in Area 41 are from China, Taiwan and Korea. The main fishing areas are at the part of Patagonian shelf and southern slope between 110 and 250 m depth (Figure 1). The EU fleet operating in this area is almost exclusively represented by Spanish trawlers over 40 m consisting of around 19 vessels ranging from 696 to 1,819 GT. This fleet is usually based in Galician ports, mainly in Vigo. The target species are mainly Argentine Hake (*Merluccius hubbsi),* Argentine shortfin squid (*Illex argentinus*), Patagonian squid (*Loligo gahi*), Antarctic rockcod (Nototheniidae), Longtail southern cod (*Patagonotothen ramsayi*) and southern blue whiting (*Micromesistius australis*).

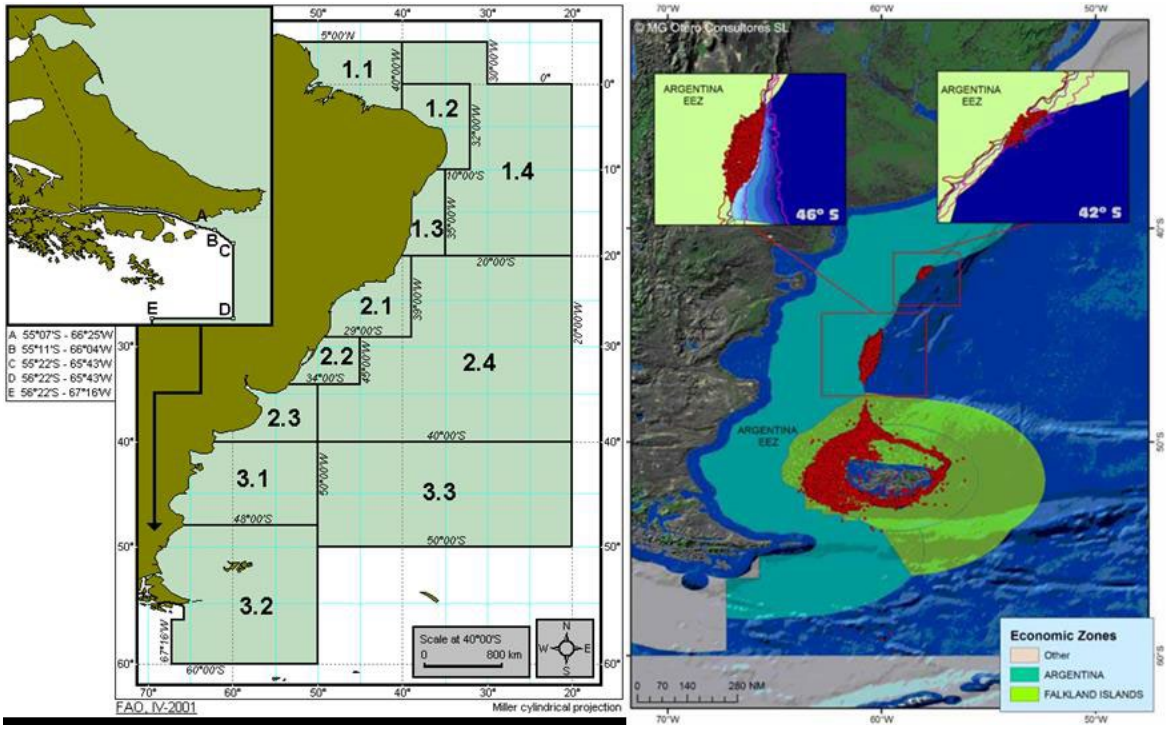


Figure 1: FAO Fishing Area 41 and its subareas including the locations of Spanish fishing effort (subareas 41.3.1 and 41.3.2) in Southwest Atlantic. Source: FarFish project (Mikkelsen 2020).

The Spanish fleet's fishing strategy was analysed by Vilela et al. (2018), and based on on-board observer data collected from 1989 to 2015, three main fishing seasons were identified: (i) mainly targeting Argentinean squid from January to March, (ii) another targeting hake from April to August, and (iii) a third season from September to December showing an opportunistic and heterogeneous behaviour.

According to ANAMER (Asociación Nacional Armadores Buques Congeladores Pesca Merluza), the annual number of vessels fishing in Area 41 reached its peak in 1990 with 79 vessels, although estimates from IEO (Spanish Institute of Oceanography) place the real number of Spanish fishing vessels that year at 100 (Portela, 2009). After 1990, the number of fishing vessels decreased until its minimum in 2001 (18 vessels), and thereafter remained stable at around 23–26 fishing vessels.

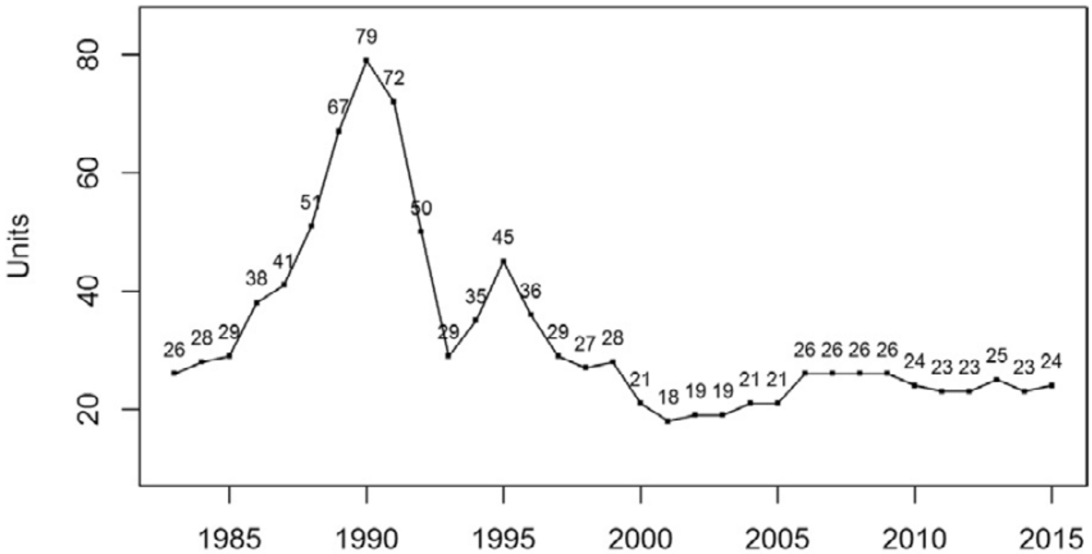


Figure 2: Number of vessels fishing in FAO Area 41 between 1983 and 2015 (Source: Vilela et al., 2018).

1.4 Objectives

The overall objective of Task 8 is to support the evaluation of Council Regulation (EC) No 734/2008 on the protection of VMEs from the impacts of bottom fishing gears. Specifically, we aim to

- Support the evaluation of Council Regulation (EC) No 734/2008 on the protection of vulnerable marine ecosystems from the impacts of bottom fishing gears
- Analyse the extent to which the Regulation is effective, efficient, still relevant given the current needs, coherent and complementary to other interventions (such as the best practices by RFMOs) and has achieved EU added value.
- Identify where the Regulation needs to be updated to reflect best practices, particularly within RFMOs, best available science, as well as providing recommendations on how the Regulation can be updated (if needed) to reflect the findings.

1.5 Institutes and researchers involved

- Task Leader: MRAG EU (Stephen Mangi Chai)
- Participating Institutes/Researchers: MRAG EU (Stephen Mangi Chai; Laurence Kell; James Clark; Imogen Hamer), IEO (Pablo Durán Muñoz; Mar Sacau), IPMA (Ricardo Alpoim), CSIC (Francisco Saborido, Rebeca Rodriguez).

1.6 Sub-tasks

The following sub-tasks were used to deliver the evaluation:

Sub-task 8.1 – Describe the current situation
Sub-task 8.2 – Assess the effectiveness, efficiency, relevance, coherence and added value
Sub-task 8.3 – Stakeholder consultation
Sub-task 8.4 – Conclusions and recommendations

2. Approach and methods

2.1 Approach

Our approach involved collation of the measures adopted for the protection of VMEs by each of the RFMOs which manage bottom fishing activities from Tasks 2-5, and gathering views from key stakeholders to understand the extent to which the Regulation is effective, efficient, currently relevant, coherent and has achieved EU added-value. Three key activities were undertaken: Desk-based synthesis of information from the other tasks in this project, development of a questionnaire and setting it up as an online survey, and conducting the survey including analysing the responses. The desk-based review involved a comparative analysis of the Regulation with other relevant rules, such as the measures adopted by RFMOs with a competence to regulate bottom fishing. The survey aimed to gather the specific viewpoints and needs of the different actors that are directly affected by implementation of the Regulation, including authorities in the Member States, the fishing sector, NGOs and scientists. It also covered various aspects including the different impacts that measures for the protection of VMEs from the impacts of bottom fishing has on the stakeholders.

2.2 Methodology

We extracted the measures contained in the Regulation and appraised them with those of the RFMOs. To achieve this, we used information already synthesised in the reports of Tasks 2-5. We did not collect details of for example, how many special fishing permits have been issued, for which areas, for what Member States under the Regulation or RFMOs. Instead, we focused on providing an overview of the different measures under the Regulation and cross-checking to what extent these are applied by the different RFMOs. We stated where we could not find this information.

A questionnaire was designed to explore the views of stakeholders regarding Regulation No 734/2008 and to obtain feedback on (i) the extent to which the Regulation is effective, efficient, still relevant, coherent and has achieved EU added value, and (ii) measures in the Regulation that might need updating to reflect current knowledge and best practices.
The questionnaire comprised of statement-based questions using Likert scale answer categories (e.g. to a very great extent; to a great extent; to some extent; to a small extent; and not at all) for the stakeholder to choose from. It also included open-ended questions to capture stakeholder opinions on e.g. the most likely consequences of stopping applying the Regulation, and what needs improving/updating under Regulation 734/2008.

The questions were grouped into eight broad categories to encapsulate the key issues under study. These included:

(i) Respondent information. The first section required basic information from the respondent, including their name, institution and the type of stakeholder category they belonged to.

(ii) Application of Regulation 734/2008. The second section of the questionnaire focused on how the Regulation was being applied. Stakeholders were asked to provide their opinions on the extent to which various aspects of the Regulation were applied e.g. the extent to which Member States issue special fishing permits for the use of bottom fishing gears on the high seas under the scope of the Regulation.

(iii) Effectiveness of Regulation 734/2008. The third section of the questionnaire explored stakeholders' views on the effectiveness of the Regulation with questions requiring stakeholders to describe the contribution of Regulation 734/2008 towards different actions in areas of the high seas where no RFMO has been established or where no interim measures are in place.

(iv) Efficiency in applying Regulation 734/2008. The fourth section of the questionnaire focused on efficiency of the process of applying the Regulation and explored stakeholders' satisfaction with different elements of the Regulation. Stakeholders were asked to state how satisfied they were with the timeliness for reporting, appropriateness of compliance and enforcement, and appropriateness of the administrative burden to apply the Regulation.

(v) Relevance of Regulation 734/2008. This section of the questionnaire focused on the relevance of the Regulation towards the protection of VMEs from the adverse impacts of bottom fishing gear.

(vi) Coherence of Regulation 734/2008 with other interventions. This section of the questionnaire focused on how coherent measures for the protection of VMEs under Regulation 734/2008 are with those undertaken by the best performing RFMOs and those under Chapter 4 of the Sustainable Management of External Fishing Fleets (SMEFF).

(vii) EU added value of Regulation 734/2008. The final section of the questionnaire focused on the added value of Regulation 734/2008 and was mainly comprised of open-ended questions. Stakeholders were asked to indicate what would be the most likely consequences of stopping applying Regulation 734/2008, what needs improving/updating under the Regulation, what they would you do to improve the effectiveness and applicability of the Regulation, and whether there is anything else they would like to say about the Regulation.

In addition, we analysed whether the VME Regulation is coherent with and serves the needs of the implementation of the UN Resolutions 64/72, 66/68 and 71/123.

2.3 Online survey

The questionnaire (in English) was translated into all 23 EU languages and set up as an online survey. A cross section of stakeholders from national authorities, representatives of the fisheries sector in Member States including the Long-Distance Advisory Council, NGOs interested in marine biological resources, in particular the Deep-Sea Conservation Coalition (DSCC), and scientists were selected and entered onto a list of potential participants. The stakeholders were identified based on project team experiences of scientists and other interest groups that work on deep sea fisheries including VMEs. The list included a total of 64 potential participants (Table 1).

Table 1 List of potential participants that were asked to take part in the study showing the stakeholder category and number of people invited.

	Stakeholder	**Number**
1	ARVI	1
2	Cefas	1
3	CEPESCA	1
4	CETMAR	1
5	Deep-Sea Conservation Coalition	2
6	Europeche	1
7	FAO	1
8	Fisheries attaches	32
9	GFCM	3
10	ICES	1
11	IEO-CSIC	1
12	IFREMER	2
13	INTECMAR	1
14	ISPRA	2
15	IUCN	1
16	Long Distance Fisheries Advisory Council (LDAC)	1
17	NFFO	1
18	NIOZ	2
19	Pesquerias Georgia SL	1
20	Polytechnic University of Marche (UNIVPM)	1
21	Scottish Fishermen's Federation	1
22	Scottish Whitefish Producers Association	1
23	SEAFO EU-representative	1
24	Secretaría de Pesca	1
25	University of A Coruña	1
26	University of Santiago de Compostela	1
27	Wageningen Marine Research (WUR)	1
	Total	64

Once the online survey had been set up, links (one for each of the 24 languages) were circulated to all 64 potential participants on the list through emails asking them to take part. The listed stakeholders were also asked to forward the links to others that they think should take part including all members of the DSCC. The online survey was carried out from 10th May to 10th June 2022. Half way through the survey (25th May 2022), email reminders were sent to everyone on the list asking/encouraging them to ensure they fill it in before the deadline.

Once the survey period had ended and responses collected, it was evident that very few stakeholders had taken part. At this point, there were only three fully completed responses. A targeted stakeholder consultation was therefore initiated by sending emails to a shortlist of 26 stakeholders whom the project team understood were aware of the implementation of the Regulation. During an Interim meeting with CINEA/DG MARE, the project team was informed that the key stakeholders with experience of the Regulation would mainly come from three main organisations: i) Spanish administration; ii) Spanish fishing sector (particularly through the LDAC); and iii) NGOs and civil society (particularly members of the DSCC). A cross check found that the 26 stakeholders invited for the targeted consultation included representatives from these three organisations.

Stakeholders in this targeted consultation were requested to indicate their availability for an oral interview (via zoom/Teams) with the project team. Out of the 26 invitations sent, only seven people responded, four of them positive indicating that they would like to be interviewed. Three people declined to take part stating that they did not see themselves as stakeholders. An interview was conducted with one of the four people that had accepted to be interviewed while the other three refused to provide a date when they would be available despite several reminders (Table 2).

Table 2 Number of stakeholders invited for the targeted consultation showing the proportion that accepted/declined to take part.

Action		Number of people
Invitations for stakeholder interview		26
Responses to email		7
Positive responses (total):		4
	Interviews	1
	Could not confirm date and time	3
Negative responses (total):		3
	Don’t deem self as stakeholder	3

The quantitative data on the responses to the Likert scale questions were converted to scores for the different stakeholder categories and plotted for each of the questions under study. For the open-ended questions and the comments provided towards the closed-ended ones, a summary was made on the responses provided.

3. RESULTS AND DISCUSSION

3.1 Sub-task 8.1 – Current situation

In line with UNCLOS, it is the responsibility of flag States to cooperate in the management of high seas fisheries, including to establish sub regional or regional fisheries organizations (LOS Convention, Article 118). Further, under international law, vessels fishing in the high seas are subject to regulation by their respective flag States. Given that there have been updates to the UN sustainable fisheries resolutions regarding deep sea fisheries since 2006, e.g., in UN Resolutions 64/72, 66/68 and 71/123, and the FAO guidelines were adopted after the VME Regulation, the question then is whether the VME Regulation is still coherent and sufficiently in line and provides the basis for the implementation of the UNGA Resolutions on sustainable fisheries. It is worth noting that these more recent UN resolutions (59/25 and 61/105) which are binding for contracting parties to implement, have had challenges when it comes to enforcement. The FAO international guidelines for the management of deep-sea fisheries in the high seas are non-binding and therefore non-enforceable on their own, the Resolutions can only ‘call’ on States to introduce them.

Since the introduction of resolution 61/105 there have been a number of developments to strengthen it, e.g. via adoption by UNGA of resolutions 64/72, 66/68 and 71/123. These have been brought in following reviews which have recognised that the implementation of the requirements under 61/105 has been uneven amongst regional fisheries management organisations or arrangements and States. They emphasise the importance of implementing the FAO guidelines, improving the collection of scientific data to provide informed management decisions and assessments, to make the results of these assessments more publicly available and to generally improve compliance with the measures.

This is in contrast to Regulation 734/2008 which has remained unchanged since its adoption. It will be important to establish if the regulation is therefore still relevant or whether the requirements are in fact surpassed by the measures put in by the RFMOs and the increased measures brought in by the more recent UN resolutions.

The Instituto Español de Oceanografía (IEO), conducted a series of research surveys between 2007 and 2010 and identified VMEs on the high seas in this area where Spanish vessels had historically operated. They prepared an assessment regarding the potential impact of Spain’s bottom trawl fisheries in the region (IEO, 2011). Based on this assessment, most of the seabed below 300-400 meters depth is now closed to bottom fishing by Spanish vessels (9 closures amounting to approximately 41 300 km^2) because of the likely presence of VMEs (Durán Muñoz et al., 2012, Portela et al., 2010, 2015; Del Río et al., 2012). The closure proposal was made public in April 2011 at an international meeting and where representatives from the EC, FAO, NGOs and the fishing industry were present. While the EU fishing fleets operating in the area accepted these conditions, other fishing fleets mainly Asian countries (China, Taiwan and South Korea) have not adopted any equivalent conservation measures. This means that fishing in the international waters of the Southwest Atlantic is not a level playing field, and importantly the main objectives of these area closures (to prevent significant adverse impacts on VMEs, as required in the UNGA Resolution), are not being achieved.

An opinion piece by the Deep Sea Conservation Coalition (DSCC) indicated that apart from the measures adopted by the EU fleet through the VME Regulation, the other flag States whose vessels engage in bottom fisheries in the Southwest Atlantic region have not adopted any measurers (Fuller et al 2020, Tingley et al., 2016). Further, no impact assessments have been conducted or published for any high seas bottom fisheries by other countries whose vessels conduct bottom fisheries in the region. Similarly, the FarFish project identified several challenges for Area 41 including lack of level playing field, data paucity and insufficient control and monitoring. This implies that through the VME Regulation, the EU is the only one that has largely implemented the UNGA resolutions in the Southwest Atlantic. The VME Regulation has enabled the EU to gather data including use of the observer programme and setting up of the footprint.

3.2 Sub-task 8.2 – Assess the effectiveness, efficiency, relevance, coherence and added value

Findings show that the measures in the Regulation are being applied to some extent by the different RFMOs. NAFO and NEAFC are especially applying most of the measures to a great extent (Table 3).

Table 3 Comparison of measurers under the Regulation with the most recent management measures in place by the different RFMOs

Application: To what extent Member States apply…		
Measure	**Evidence from RFMOs**	**Explanation**
Issuance of special fishing permits for the use of bottom fishing gears on the high seas under the scope of the Regulation	NAFO	For exploratory fishing outside of areas where bottom fishing takes place, only strictly regulated exploratory bottom fishing can be authorised – need to undergo an EIA and be agreed by NEAFC before going ahead – in practice this has not occurred.
Issuance of the special fishing permits after having carried out an assessment on the potential impacts of the vessel's intended fishing activities including whether the activities are not likely to have significant adverse impacts on VMEs		No information
Use of information on the potential risk to VMEs by asking applicants to amend fishing plans to avoid them		No information
Prohibition of the use of bottom gears because there has been no proper scientific assessment carried out and made available on VMEs		No information
Vessels cease fishing immediately or refrain from engaging in fishing in a site where they have encountered VMEs	NEAFC NAFO Score: To a great extent	If quantity of VME indicator caught is greater than the thresholds defined in Article 9, fishing shall cease and move at least 2 nautical miles - little information on compliance with rules. In existing bottom fishing areas, encounters with VME indicator species above a threshold value are reported to the Executive Secretary and trigger a 2-nautical mile move on rule. In new fishing areas, such encounters also result in temporary closures of 2 nautical miles radius and require a more detailed report by the on-board observer- little information on compliance with rules.
Fishing vessels report each encounter with VMEs to the competent authorities,	NEAFC	Under recommendation 19:2014 – the captain/master must report the incident, including the position determined immediately to their flag

providing precise information on the nature, location, time and any other relevant circumstances of the encounter	NAFO Score: To a great extent/some extent	state who will then report it to the Secretary. Contracting parties can report directly to the secretary. Secretary then immediately informs all contracting parties, and ICES. Little information on compliance with rules.
		The master of the vessel shall report the encounter without delay to the flag State Contracting Party including the position that is provided by the vessel, either the end point of the tow or set or another position that is closest to the exact encounter location, the VME indicator species encountered, the quantity (kg) of VME indicator species encountered; and cease fishing and move away at least 2 nautical miles from the endpoint of the tow/set in the direction least likely to result in further encounters. The captain shall use his best judgment based on all available sources of information. Little information on compliance with rules.
	NPFC Score: To some extent	If over 50 kg of VME species retrieved, must report to Secretariat via the Member state within 1 working day
VMEs reporting by the vessel is similar when there is an observer onboard and when there is no observer		No information
Fishing vessels comply with the move on rule		No information
MS have identified areas that are to be closed to fishing with bottom gears due to the occurrence or likelihood of occurrence of VMEs in the region where their fishing vessels operate	NEAFC Score: To some extent	Closures seen as primary tool to protect VMEs – occurred since 2004 This approach included: i. defining the 'existing bottom fishing areas', i.e. areas that had been recently fished and where fisheries could continue relatively unrestricted, and ii. ensuring that bottom fishing outside these areas (i.e. in 'new bottom fishing areas') where only exploratory fisheries subject to various restrictive conditions. Renew closed areas every 5 years – Recommendation 19:2014

		Closed 22 areas – where fishing is only permitted to occur in historical fishing grounds representing only 2% of the area.
	NAFO Score: To some extent	Areas have been identified and closed by the Scientific Council – mostly seamount closures in their jurisdiction. These were re-assessed in 2021 and subsequently every 5-years. Has identified 20 areas as being vulnerable to bottom contact gears and these have subsequently been closed Understand that the need for encounter protocols becomes redundant as the area and extent of VMEs becomes well defined. Closed 26 areas – 2,707,895 km^2
	SEAFO Score: To some extent	12 closed areas – 16%
	GFCM Score: To some extent	3 closed areas – (15.659 km^2)
	NPFC Score: To some extent	2 closed areas – 2.1% Seasonal closures introduced for fish species but can reduce SAIs on VMEs
	SPRFMO Score: Not at all	Have 337 areas defined for permitted bottom fishing but no closed areas Seasonal closures for protected, endangered and threatened (PET) species
	SIOFA Score: To some extent	12 closed areas – 3.2%
	CCAMLR Score: To a great extent	86 closed areas – 1647092 km^2 Seasonal closures for seabirds
Fisheries observers taken on-board vessels to which a special fishing permit has been issued	NAFO Score: To some extent	Article 30 - Observer Program - The purpose of the Observer Program is to collect reliable information and data on activities in the NAFO Regulatory Area. The information and data collected through the Observer Program shall be made available to any NAFO body requesting

		it. Observers assigned to their vessels shall record for each haul/set, in the format indicated in Annex II.M, hereafter referred to as the observer trip report: the quantity of all catch, by species, including for discards and VMEs indicators as referred to in Annex I.E.VI.
The actual Regulation, as formulated, is clear and straightforward for MS to apply		No information
Effectiveness – How would you describe RFMO measures towards ...		
Identification and protection of VMEs in fishing areas by MS	NAFO Score: Very effective	Areas identified to contain VME indicator species have been closed. Article 23 of the NAFO Conservation and Enforcement Measures (NAFO CEM —NAFO, 2021a) states that the Scientific Council, at request of the Commission, shall conduct a reassessment of bottom fishing activities. This reassessment shall: (a) identify VMEs, on the basis of best available scientific information and with the co-operation of Contracting Parties; (b) map sites where these VMEs are known to occur or likely to occur; and (c) provide such data and information to the Executive Secretary for circulation to all Contracting Parties.
	NEAFC Score: Very effective	Have measures that limit bottom fishing to areas where bottom fisheries took place in a specific reference period, and which have not been closed due to VMEs occurring or being likely to occur.
Promotion of scientific research on VMEs by MS		No information
Data collection programmes	NAFO Score: Effective	VMS and logbook data for mapping footprint
	NEAFC Score: Very effective	Detailed list of data that needs to be recorded by each vessel. Adopted FLUX, a system that allows detailed information to be collected on fishing trips and activity within a trip – haul by haul info, catches and discards, and transhipment including the occurrence of VME indicator species
	FAO Area 41 Score: Non-existent	There is very little information on fishing effort in the high seas of the Patagonian Shelf apart from the Spanish fleet as this fleet has an observer programme onboard some vessels

	NPFC Score: Effective	All members must submit information related to fleet size, gear types, areas fished, number of days, total catch etc. As well as specific information for each bottom fishing vessel – Catch and effort data and time, location, depth, temp etc. Have observer programs
	SPRFMO Score: Effective	All fishing pursuant to CMM03-2020 (bottom fishing) and CMM03a-2020 (deep-water species) requires flag States to provide detailed information on the time and location of each fishing event, the catch of target and non-target species of fish, interactions with marine mammals, seabirds, reptiles and other species of concern, and benthic invertebrates, including VME indicator taxa. There is also a requirement to carry observers, with coverage specified as 100% for trawling and at least 10% for bottom line methods for each fishing year Vessel monitoring system (VMS) position reports are reported by each of their vessels: a) at least once every hour if fishing is using benthic or bentho-pelagic trawling, bottom long-line gear or potting or if operating within 20 nm of an EEZ boundary; b) at least once every four hours in other circumstances
	SIOFA	Conservation measure 2019/10 states what data needs to be submitted by each Contracting Party, cooperating non-Contracting Party and participating fishing entity (CCP), the format it should submitted in the deadlines for submission (VMS & logbooks). CCPs are encouraged to share VMS data.
Assessment of risk of significant adverse impacts (SAIs) from bottom fishing	SIOFA	A bottom fishing impact assessment method was developed for trawl and longline gears in the SIOFA Area in 2021. Due to the spatial aggregation of a large proportion of these data, the assessment was carried out at a 1°resolution for trawl gear and 20’ resolution for longline gear. The proportion of each cell within fishable depths, defined as shallower than 2000m depth, was accounted for. The mapped trawl footprint over time (cells of 1 degree) indicates that the footprint is still expanding. The mapped longline footprint over time (cells of 20’) indicates that the footprint is still expanding but at a slower rate than the trawl footprint.
	NAFO	Part of the 2021 assessment –

		Assessment of the risk of SAI from bottom fishing activities on VMEs. The assessment was based on estimates of the biomass distribution of VMEs, the distribution of fishing effort (VMS data), and a set of assessment metrics that considers ecosystem function and fragmentation
Assessment and submission of fishing plans alongside potential impacts to VMEs	NAFO	Any Contracting Party proposing to participate in exploratory bottom fishing activities shall submit a preliminary assessment of the known and anticipated impacts on VMEs of the proposed bottom fishing activity
	NEAFC	Each Contracting Party proposing to undertake exploratory bottom fishing shall submit, in addition to the Notice of Intent, a preliminary assessment of the known and anticipated impacts of the proposed bottom fishing
	SEAFO	Each Contracting Party proposing to undertake exploratory bottom fishing shall submit, in addition to the Notice of Intent, a preliminary assessment of the known and anticipated impacts of the proposed bottom fishing
	GFCM	No preliminary assessment required
	NPFC	Members of the NPFC are required to provide the following information of each conservation and management measure before exploratory fishing commences: Harvesting plan; Mitigation plan; Catch monitoring plan and Data collection plan
	SPRFMO	This Bottom Fishery Impact Assessment Standard (BFIAS) goes beyond the issue of VMEs. Assessments shall follow procedures outlined in Conservation and Management Measure (CMM) 03-2021. Content of BFIAS in line with FAO Guidelines. CPs shall submit: (i) description of fishing activities; (ii) mapping and description of fishing areas; (iii) risk and impact assessment framework. Appendix D identify exceptions in the content of BFIA.
	SIOFA	SC considers all BFIAs received and provides advice about impacts of bottom fishing activity. BFIAs shall: (i) follow FAO guidelines; (ii) meet the standards; (iii) take into account areas with VMEs; (iv) take into account relevant information provided in paragraphs 20, 18. 21 and 22; (v) be updated; (vi)assess historical and cumulative impact and (vii) be made available on SIOFA website.

	CCAMLR	Required under CM 22-6 (paragraph 7). The assessment must include info on the fishing activity, as well as mitigation measures to prevent impacts. Must be submitted to the SC and the Commission by 1 June prior to the season in which it intends to fish.
Assessment and submission of potential impacts when applying to undertake bottom fishing		No information
Identification and establishment of area closures	NAFO Score: Effective	
Precautionary closing of areas for VME protection		No information
Establishment of bottom fishing footprint	NAFO Score: Effective	The total area subjected to bottom fishing by all gears combined from 1987–2007 were plotted from data submitted by Contracting Parties (these data did not distinguish between mobile and static fishing gears) and used to delineate a perimeter around the existing fishing areas by fishery. Information on effort was included only in some submissions, and the VMS data used to support the submissions had only been collected since 2003. In the final analysis made by the Secretariat, it was generally possible to filter the supplied information to "areas that had been fished twice" but the spatial resolution to do this was somewhat arbitrarily selected, and this affected the extent of the delineated areas (NAFO Secretariat, 2009). Final composite map for all gears was adopted in 2010 and has not been revised to date. NEREIDA EU Programme was crucial to conduct an update on the classification of fisheries distribution effort, particularly the description of demersal fisheries (footprint, fleet characteristics, etc.), based on the logbook and VMS data for the period 2016-2019. Combining haul by haul logbook data with VMS data – but relies on the correct submission of logbooks and fully functioning VMS

		Spatial resolution of 5nm x 5nm
	NEAFC Score: Very Effective	Uses the FLUX system to obtain the data needed to define fishing footprint, as well as VMS data.
	SEAFO Score: Effective	2009 – commission agreed to develop a fishing footprint for reporting to the Secretariat on the bases of digital catch position data for individual hauls sets.
	FAO Area 41	Can create footprints and spatial information on fishing effort from observer data. Have a 5 x 10 nm footprint from the IEO Scientific observers programme (1989 to 2007) and fishing effort per square km using the Kernel Density tool in ArcGIS
	Deliverable 3 NPFC Score: Effective	Currently the annual footprint reports summarize the general footprints from all member States due to fishing for both bottom and pelagic fisheries and gives the activity by seamount by country. In the case of the bottom fishing footprint summary, extra data is given with a more detailed breakdown by area fished (seamount). There are more details on the vessels (in accordance with CMMs 21-05 and 21-06) involved including gear, Gross Tonnage (GT), power, and overall length as well as a summary of the of the number of days each vessel has been fishing. This is used to assess the overall footprint in terms of fishing pressure on different seamounts rather than an actual spatial calculation. There is currently, or historically, no accounting of the type of gear used when establishing the footprint, just a summary of fishing catch and effort by gear and vessel type on different seamounts so to establish which areas have the greatest fishing pressure and therefore risk to VMEs.
	SIOFA Score: Effective	'SIOFA bottom fishing footprint' means a map of the spatial extent of historical bottom fishing in the Agreement Area, for all vessels flagged to all Contracting Parties, Cooperating Non-contracting Party (CNCPs) and Participating fishing entities (PFEs) over a period to be defined by the Meeting of the Parties.

		Historical fishing footprint from every bottom gear at 20 minutes resolution were presented at PAE-03-05 as well as all gears merged. - The biggest challenge would be to obtain data at an appropriate scale to be used to define a reliable bottom fishing footprint.
	CCAMLR Score: Very-effective	Well defined, footprint calculated each year - The footprint is currently calculated to the nearest meter, using the length of the line and the potential area impacted by each meter. However, there is a proposed revision of this resolution, in that rather than using a linear system from start to end point (km of line/Km2) using a grid system (km2/km2) based on a 10km2 grid. Difficulties in footprints for longline – lines drift, vessels not moving in straight line.
Use of exploratory fishing protocols	General information	Mandatory in most RFMOs to have an observer on board when undergoing exploratory fishing (not GFCM) For full details of these protocols see table 1 on page 4 of
	CCAMLR Score: Very effective	CCAMLR is the most prominent regulator of exploratory fisheries
	GFCM Score: Non-existent	No specific legal framework for exploratory fishing
	NAFO Score: Effective	Existent but been amended several times
	NEAFC Score: Existent	Outside the areas where bottom fisheries took place in a specific reference period, only strictly regulated exploratory bottom fishing can be authorised. These need to undergo an environmental impact assessment and be explicitly agreed to by NEAFC before being authorised, and in practice no such exploratory bottom fishing has taken place.
	SEAFO Score: Existent	It is required to have exploratory fishing data within a specified area without reaching the VME threshold to open that area for fishing: (i) two years of data within 5-year period for an area (<2000m) adjacent to an existing fishing area, (ii) and three-years of data within 5 years for areas (<2000m) not adjacent to an existing fishing area, (ii) Existing fishing records/data that contain VME data may be counted as a first-year data set.

		All 1x1° areas within the exploratory area that contain a VME encounter should be excluded from the proposed new fishing area. Exploratory data stations should be set in such a way that it covers the exploratory area representatively above the 2000m depth isobath. In case VME encounters are reported to the Executive Secretary after opening an area, the SC should re-evaluate the status of the newly opened fishing area.
	GFCM Score: Non-existent	According to endorsed protocols, contracting parties and cooperating non-contracting parties (CPCs) with vessels involved in deep-sea bottom fisheries are required to submit comprehensive maps of existing deep-sea bottom fishing areas (exploited at least within a five-year period prior to present) to the GFCM Secretariat, who will, in turn, produce composite maps, preferably by gear type, of the existing deep-sea bottom fishing areas within the GFCM area of application. Priority is given to bottom trawl fisheries at depths below 300 m. There is not any specific definition of spatial footprint. There are not agreed methodologies for the establishment of fishing footprint at GFCM level.
Use of encounter protocols	NAFO	60kg live coral, 300kg sponge, 7kg sea pens - 2nm
	NEAFC	30kg live coral, 400kg live sponge – 2nm, 10 hooks / 1,000 – 2nm
	SEAFO	60kg live coral, 600kg live sponge – 2nm 10 units of VME taxa – 2nm
	GFCM Score: Non-existent	N/A – discussions about the need to implement
	NPFC	50kg live coral – 2nm
	SPRFMO	60kg stony coral, 5kg black coral, 15kg sea fans, 35kg anemones, 10kg hexacorals – 1nm
	SIOFA	60kg live coral, 300kg live sponges – 1nm
	CCAMLR	10 units of VME taxa – 1nm
Identification and use of thresholds based on gear types and indicator species	NEAFC Score: Effective	Areas where VMEs occur or are likely to occur are closed to bottom fishing, but as a precautionary measure, encounters with VME indicator species above a specific threshold result in a temporary bottom fishing closure for all vessels.

Implementation of conservation and management measures that establish monitoring, control and surveillance (MCS) for compliance and enforcement		No information
Implementation of measures relating to illegal, unregulated and unreported (IUU) fishing		No information
Use of fisheries observers in vessels engaged in bottom fishing	NAFO– Final D4_Task 5	100% observer coverage – VME data collected
	NEAFC	100% observer coverage for exploratory fisheries – VME data collected
	SEAFO	100%observer coverage = VME data collected
	GFCM	~25% observer coverage varies depending on the contracting party
	NPFC	100% coverage for vessels who are bottom fishing – VME data collected
	SPRFMO Score: Very effective	There is also a requirement to carry observers, with coverage specified as 100% for trawling and at least 10% for bottom line methods for each fishing year
	SIOFA	50% observer coverage – VME data collected
	CCAMLR	100% observer data collected – VME data collected on at least 30% of line segments

Table 4 summarises the level of consistency between the Regulation and the approaches used by various RFMOs. Findings show that in general, the measures contained in the VME Regulation match closely to those of most RFMOs. Apart from the GFCM and SIOFA, where there are differences in the application of the measures, the rest of the RFMOs are applying the same measures to a great extent. These include protocols for defining VMEs, thresholds, encounter protocols and move on rules. This review shows that the approaches for the protection of VMEs most implemented by the RFMOs include (i) establishing the existing fishing footprint, and any bottom fishing taking place outside of this area must be assessed and approved, and is subject to strict controls (e.g. observer coverage to record encounters with VME indicator species); and (ii) area closures where bottom fishing is prohibited to protect VMEs. Most of the RFMOs are using the FAO criteria to compile lists of indicator species or taxa. The RFMOs make the decision on whether a particular site or ecosystem constitutes a VME, however, the methods and approaches to identify these differ between RFMOs. In line with earlier reviews on the measures adopted to manage deep-water fisheries and a particular focus upon measures to limit deleterious impacts upon sensitive benthic ecosystems that found NEAFC, NAFO and CCAMLR as the best performing RFMOs (EASME, 2018), the current review shows consistency with this scoring. It further indicates SPRFMO, SEAFO and NPFC have recently implemented the measures contained in the Regulation to a great extent.

Table 4 A comparison of RFMO vulnerable marine ecosystem conservation measures with the Regulation (EC) No 734/2008

	Regulation (EC) No 734/2008	NAFO	NEAFC	SEAFO	GFCM	NPFC	SPRFMO	SIOFA	CCAMLR
Do they clearly define a VME data collection protocol?	✓	✓	✓	✓	✕	✕	✓	✕	✓
Do they have an exploratory fishing protocol?	✓	✓	✓	✓	✕	✓	✓	✕	✓
Do they have encounter protocols & move-on rules?	✓	✓	✓	✓	✕	✓	✓	✕[1]	✓
Have they defined VME encounter thresholds?	✓	✓	✓	✓	✓	✓	✓	✓	✓
Do they have area closures?	✓	✓	✓	✓	✕[2]	✓	✓	✓	✓
Are fisheries observers required onboard vessels?	✓	✓	✓[3]	✓	✕[4]	✓	✓[5]	✓[6]	✓
Do observers record VME data?	✓	✓	✓	✓	✕	✓	✓	✓	✓
Have they identified & frozen the fishing footprint?	✓	✓	✓	✓	✕	✓	✓	✓	✓
Have they defined the key concepts?	✓	✓	✓	✓	✕	✓	✓	✕	✓

[1] only for trawling not for longline vessels; [2] fisheries restricted areas not closed areas; [3]for exploratory fisheries only; [4] ~25% depending on the contracting party; [5]100% for bottom trawling, 10% for bottom longline; [6]50% coverage;

Table 5 examines in more detail how the requirements under (EC) 734/2008 compare to the requirements developed under the various organisations in the study on an Article-by-Article basis, this is based on the findings from the other sections of the project. For the purpose of the table the following colours were used to indicate areas where the Regulation could be changed or altered:

	No change required; current regulation is in line with requirements under RFMOs and remain unchanged from when the resolution was originally developed.
	Requires some revision; while most of the requirements are in line with those developed by the RFMOs there are changes that could be made to improve it.
	Falls behind all the RFMOs and the original requirements under UNGA 61/105 (or more recently 71/123), some of the requirements can be taken from the current RFMO requirements.

The main issues would appear to the actions taken when a VME is encountered, the current protocol is to move a distance of 5nm but there is nothing currently in place as to what the threshold levels should be or the long term affects this in terms of follow up research and establishing a closed area. There is also no current definition as to what the defined VME species are when developing the threshold levels, although this will, in reality, only apply to Area 41. The key to this this lies within effective observer programmes and their ability to recognise and report on VME species being recovered and vessels being required to report and act on this when it occurs, developing a clear mechanism for Member States to act (under Article 8, where necessary) and an effective reporting mechanism (under Article 12) to communicate this to other Members.

Table 5 Comparison of how the RFMO/As used in the case studies compare against the requirements of Council Regulation (EC) No 734/2008

Measure	NAFO	NEAFC	SEAFO	GFCM	NPFC	SPRFMO	SIOFA	CCAMLR	Regulation 734/2008
Article 2 – Definitions									
Marine Ecosystem	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	A dynamic complex of plant, animal and microorganism communities and their nonliving environment interacting as a functional unit
Vulnerable Marine Ecosystem	Refers to paragraphs 42 and 43 of the *FAO DSF Guidelines*	Has the same meaning and characteristics as those contained in paragraphs 42 and 43 of the *FAO DSF Guidelines*	Has the same meaning and characteristics as those contained in paragraphs 42 and 43 of the *FAO DSF Guidelines*	Refers to paragraphs 42 and 43 of *FAO DSF Guidelines*	Each member of the Commission, using the best information available, is to decide which species or areas are to be categorized as VMEs, identify areas where VMEs are known or likely to occur, and assess whether individual bottom fishing activities would have SAIs on such VMEs or marine species.	'…a marine ecosystem that has the characteristics referred to in paragraph 42 of, and elaborated in the Annex to, the *FAO Deepsea Fisheries Guidelines*.'	'…a marine ecosystem that has the characteristics referred to in paragraph 42 of, and elaborated in the Annex to, the *FAO Deepsea Fisheries Guidelines*.'	Ecosystems containing species or communities that are considered at risk of disturbance due to fishing or other human activities. The most vulnerable ecosystems are those that are both easily disturbed and very slow to recover, or may never recover. These include ecosystems associated with seamounts, hydrothermal vents, deep-sea trenches and submarine canyons, as well as oceanic ridges.	Any marine ecosystem whose integrity (i.e. ecosystem structure or function) is, according to the best scientific information available and to the principle of precaution, threatened by significant adverse impacts resulting from physical contact with bottom gears in the normal course of fishing operations, including, inter alia, reefs, seamounts, hydrothermal vents, cold water corals or cold water sponge beds. The most vulnerable ecosystems are those that are easily disturbed and in addition are very slow to recover, or may never recover
Significant Adverse Impact	Refers to paragraphs 17 to 20 of the *FAO DSF Guidelines*	Has the same meaning and characteristics as those described in paragraphs 17-20 of the *FAO DSF Guidelines*	Has the same meaning and characteristics as those described in paragraphs 17-20 of the *FAO DSF Guidelines*	"…are those that compromise ecosystem integrity ; i) impairs the ability of affected populations to replace themselves; ii) degrades the long-term natural productivity of habitats; iii) causes a significant loss of species	Has the same meaning and characteristics as those described in paragraphs 17-20 of the *FAO DSF Guidelines*.	Has the same meaning and characteristics as those described in paragraphs 17-20 of the *FAO DSF Guidelines*	Has the same meaning and characteristics as those described in paragraphs 17-20 of the *FAO DSF Guidelines*	References UNGA Resolution 61/105. Article II (c) of Convention mentions '…changes to the marine ecosystem not reversable over two or three decades…'	Impacts (evaluated individually, in combination or cumulatively) which compromise ecosystem integrity in a manner that impairs the ability of affected populations to replace themselves and that degrades the long-term natural productivity of habitats, or causes on more than a temporary basis significant loss of species richness, habitat or community types

Measure	NAFO	NEAFC	SEAFO	GFCM	NPFC	SPRFMO	SIOFA	CCAMLR	Regulation 734/2008
				richness, habitat or community types"					
Bottom Gears	"Bottom fishing activities" means bottom fishing activities where the fishing gear is likely to contact the seafloor during the normal course of fishing operations	"Bottom fishing activities" means bottom fishing activities where the fishing gear is likely to contact the seafloor during the normal course of fishing operations	"Bottom fishing" means the use of fishing gear that is likely to contact the seafloor during the normal course of fishing operations.	N/A	"Bottom fishing activities" means fishing activities where the fishing gear is likely to contact the seafloor during the normal course of fishing operations.	"…fishing using any gear type likely to come in contact with the seafloor or benthic organisms during the normal course of operations, and includes	'…bottom fishing' means fishing using any gear type likely to come in contact with the seafloor or benthic organisms during the normal course of operations.	'…bottom fishing activities' includes the use of any gear that interacts with the bottom.	"… gears deployed in the normal course of fishing operations in contact with the seabed.
Article 3 – Special fishing permit									
Community vessels bottom fishing in high seas areas shall have a special fishing permit.	Fishing plan required and assessed prior to any fishing activity.	Fishing plan required and assessed prior to any fishing activity.	Fishing plan required and assessed prior to any fishing activity.	N/A	Fishing plan required and assessed prior to any fishing activity.	Fishing plan required and assessed prior to any fishing activity.	Fishing plan required and assessed prior to any fishing activity.	Fishing plan required and assessed prior to any fishing activity.	Not referred to specifically as fishing but requirement for a permit following the application of a detailed fishing plan is in line with RFMOs.
Article 4 – Issuance of permits									
Detailed fishing plan. • Location • Target species • Type of gear and depth • Bathymentric pro-file of area to be fished **Review of plan** • Use of best scien-tific data on VMEs in proposed fish-ing area. • Assessment of SAIs • Assessment of Risk • Precautionary Principal • Amendments to plan	Exploratory fishing outside of areas where bottom fishing takes place needs to undergo an EIA before going ahead, although in practice this has not occurred. Additional data collected include proposed dates, fishing effort (number of hooks/hauls/set s), proposed modifications to fishing gear or methods to reduce impacts to VMEs, biology and ecology of target and by-catch species and the overall potential impact footprint of the	Contracting party to submit notice to of intent to undertake exploratory fishing at least six months prior to proposed start of the fishery. Includes: Target species, proposed dates and areas, type of fishing gear. Mitigation plan to include measures to prevent SIAs to VMEs Catch monitoring plan to include monitoring and reporting of all species caught.	Contacting party to submit a 'Notice of Intent', 60 days prior to start of fishing. Includes: Dates, target species, areas and gear used. Mitigation plan to prevent SAIs on VMEs Methods of monitoring and reporting catch. Plans for monitoring of effects bottom fishing activities.	N/A	Contacting parties to distribute prior to commencement of fishing the following information to reviewed by the Commission: Catch and effort limits. Precautionary measures including those against SAIs on VMEs. Monitoring of fishing effort and captures. Data on target species, gear used, effort, dates and areas and depths. Contracting parties shall ensure that the distance between	Additional data collected include proposed dates, fishing effort (number of hooks/hauls/sets), proposed modifications to fishing gear or methods to reduce impacts to VMEs, biology and ecology of target and by-catch species and the overall potential impact footprint of the proposed fishing operations	CCP shall submit, at least 30 days prior to the SC meeting a proposal that includes its assessment of the impact of its proposed activities on the benthic environment.	A pro forma (currently under revision) exists to ensure all the information is captured and can be assessed. Must be submitted before 1 June. Additional data collected include proposed dates, fishing effort (number of hooks/hauls/sets), proposed modifications to fishing gear or methods to reduce impacts to VMEs, biology and ecology of target and by-catch species and the overall potential impact footprint of the proposed fishing operations	The fishing plan is equivalent to submitting a research or impact assessment for new and exploratory fisheries or area outside current footprint in most RFMOs In addition, Article 4 includes information on the bathymetric profile (over and above RFMOs). Applications to fish in new or exploratory fisheries are reviewed by the scientific body responsible within each organisation on an annual basis, prior to the start of each season. No time scale included, i.e. research plan must be submitted at least three months prior to commencement of fishing and review of plan completed at least one month prior to fishing to

Measure	NAFO	NEAFC	SEAFO	GFCM	NPFC	SPRFMO	SIOFA	CCAMLR	Regulation 734/2008
	proposed fishing operations	Reviewed by PECMAS.			the footrope of the gear net and seafloor is > 70cm.				allow amendments to be made.
Article 5 – Conditions for validity									
• Notification of change of plan. • Assessment of change.	N/A	N/A	N/A	N/A	N/A	N/A	Change of gear type requires new assessment.	N/A	What constitutes a change of plan should be specified (gear, dates, fishing effort etc).
Article 6 – Unassessed areas									
• Assessment shows no risk to VME	Vessel is granted permit / permission to fish.	Vessel is granted permit / permission to fish.	Vessel is granted permit / permission to fish.	N/A	Vessel is granted permit / permission to fish.	Vessel is granted permit / permission to fish.	Vessel is granted permit / permission to fish.	Vessel is granted permit / permission to fish.	No change suggested.
Article 7 – Unforeseen encounters with vulnerable marine ecosystems									
• Action taken by vessel ○ Cease fishing ○ Move at least 5nm • Assess alternative site • Report encounter.	Threshold: 60kg live coral, 300kg sponge, 7kg sea pens. Action: The master of the vessel shall report the encounter without delay to their flag State Contracting Party including the position that is provided and cease fishing and move away at least the required distance from the endpoint of the tow/set in the direction least likely to result in further encounters. The captain shall use his best judgment based on all available sources of information.	Threshold: 30kg live coral, 400kg live sponge on 10 hooks / 1,000 Action: Master must report the incident, including the position determined immediately to their flag state who will then report it to the Secretary. Move 2mn. Contracting parties can report directly to the secretary. Secretary then immediately informs all contracting parties, and ICES.	Threshold: 60kg live coral, 600kg live sponge – 2nm 10 units of VME taxa – 2nm	Threshold: N/A – discussions underway about the need to implement	Threshold: over 50 kg of VME species. Action: Master must report to Secretariat via the Member state within 1 working day	60kg stony coral, 5kg black coral, 15kg sea fans, 35kg anemones, 10kg hexacorals – 1nm	60kg live coral, 300kg live sponges – 1nm	10 units of VME taxa – 1nm	Currently no definition of what constitutes a VME or trigger levels. This needs to defined by gear type and VME taxa according to previous research and best available science, although research is still underway into these parameters. 5nm is greater than other move on rules and should consider being reviewed. ICES have advised that move on rules can be ineffective in previously unfished areas and cause damage due to fishing taking place in pristine VME areas, areas should be surveyed first. Current requirement is to report VME encounter ‘without delay’ can be open to interpretation. A time limit should be put in place (e.g. within 24 hrs). Follow up actions are unclear.
Article 8 – Area Closures									

Measure	NAFO	NEAFC	SEAFO	GFCM	NPFC	SPRFMO	SIOFA	CCAMLR	Regulation 734/2008
• Based on best scientific advice • Circulated to Members	Areas have been identified and closed by the Scientific Council – mostly seamount closures in their jurisdiction. NAFO identified 20 areas as being vulnerable to bottom contact gears and these have subsequently been closed Closed 26 areas – 2,707,895 km^2	Closures seen as primary tool to protect VMEs – occurred since 2004 This approach included: Review closed areas every 5 years – Recommendation 19:2014 22 closed areas – where fishing is only permitted to occur in historical fishing grounds representing only 2% of the area.	12 closed areas – 16%	3 closed areas – (15.659 km^2)	2 closed areas – 2.1% Closed areas applied to all bottom fisheries between November and December for NW Pacific Ocean. Seasonal closures introduced for fish species but can reduce SAIs on VMEs.	Have 337 areas defined for permitted bottom fishing but no closed areas Seasonal closures for protected, endangered and threatened (PET) species	12 closed areas – 3.2%	86 closed areas – 1,647,092 km^2 (includes Ross Sea MPA). Seasonal closures for seabirds in some Areas.	More clarity on if this refers to closed areas in general or those proposed due to the actions triggered under Article 7.
Article 9 – Vessel Monitoring System (VMS)									
• VMS failure protocol • Action on returning to port	Vessels report hourly. VMS failure required to be repaired within 1 month. Master to report manually on a four-hour basis until this time.	Vessels report hourly. VMS failure required to be repaired within 1 month. Master to report manually on a four-hour basis until this time.	Vessels report every two hours. VMS failure required to be repaired within 1 month. Master to report manually on a four-hour basis until this time.	Vessels report hourly. VMS failure required to be repaired within 1 month. Master to report manually on a four-hour basis until this time.	Vessels report hourly. VMS failure required to be repaired within 1 month. Master to report manually on a four-hour basis until this time.	Vessels report not less than hourly. VMS failure required to be repaired within 30 days. Master to report manually on a four-hour basis until this time.	Vessels report every two hours. VMS failure required to be repaired within 1 month. Master to report manually on a four-hour basis until this time.	Vessels report hourly. VMS failure required to be repaired within a minimum of two months after first reported failure. Master to report manually on a four-hour basis until this time.	Action to be taken defined (annual reporting every 2 hours) but no limitation taken on how long this can continue for, only next time vessel returns to port.
Article 10 – Serious Infringements									
Actions taken against vessels departing from fishing plan including repeated infractions.	Actions not defined.	Actions not defined.	Actions not defined.	Actions not defined.	Actions not defined.	Actions not defined.	Actions not defined.	Actions not defined.	Not clear on how this will be determined (through VMS records, changes in gear types, observer data).
Article 11 - Observers									

• 100% coverage for all vessels with permit
• Observer tasks
  ○ Record catch information
  ○ Alteration of fishing plan
	100% observer coverage.
	
	Observers record required data on VME encounters.
	
	No formal recording of alteration of
		100% coverage (for exploratory fisheries)
		
		Observers record required data on VME encounters.
		
		No formal recording of
			100% coverage.
			
			Observers record required data on VME encounters.
			
			No formal recording of alteration of
				N/A	100% coverage.
					
					Observers record required data on VME encounters.
					
					No formal recording of alteration of fishing plan, just
						100% coverage.
						
						Observers record required data on VME encounters.
						
						No formal recording of alteration of fishing plan, just recording of fishing operations.
							100% coverage.
							
							Observers record required data on VME encounters.
							
							No formal recording of alteration of fishing plan, just
								100% coverage.
								
								Observers record required data on VME encounters.
								
								No formal recording of alteration of fishing plan, just recording of fishing operations.
									More specific information on recording of VME information required (i.e. quantities, species), development of standard forms.
									
									There should be a code of conduct for observers to fully outline the conditions for observers.

Measure	NAFO	NEAFC	SEAFO	GFCM	NPFC	SPRFMO	SIOFA	CCAMLR	Regulation 734/2008
○ Encounters with VMEs ○ Depths ○ Submit report with 20 days to competent authorities ○ Submit report within 30 days to Commission, upon request. • Conditions of observer (in relation to the fishing operator).	fishing plan, just recording of fishing operations. Timescales of submission data unclear, recorded as 'as soon as possible'. Observers should not have any financial or beneficial interest in company.	alteration of fishing plan, just recording of fishing operations. Timescales of submission data unclear, recorded as 'as soon as possible'. Observers should not have any financial or beneficial interest in company.	fishing plan, just recording of fishing operations. Timescales of submission data unclear, recorded as 'as soon as possible'. Observers should not have any financial or beneficial interest in company.		recording of fishing operations. Timescales of submission data unclear, recorded as 'as soon as possible'. Observers should not have any financial or beneficial interest in company.	Timescales of submission data unclear, recorded as 'as soon as possible'. Observers should not have any financial or beneficial interest in company.	recording of fishing operations. Observers submit data on return to their home country, these submitted to Secretariat within 30 days. Observers should not have any financial or beneficial interest in company.	Observers submit data on return to their home country, these submitted to Secretariat within 30 days. Observers should not have any financial or beneficial interest in company.	
Article 12 – Information.									
Members to submit information on Articles 6, 7, 8 and any infringements identified under Article 10 to the Commission.	Data are submitted by the RFMO and are available on the FAO database.	Data are submitted by the RFMO and are available on the FAO database.	Data are submitted by the RFMO and are available on the FAO database.	Data are submitted by the RFMO and are available on the FAO database.	Data are submitted by the RFMO and are available on the FAO database.	Data are submitted by the RFMO and are available on the FAO database.	Data are submitted by the RFMO and are available on the FAO database.	Data are submitted by the RFMO and are available on the FAO database.	These data should be submitted to the FAO. It is not clear to what extent this has been done as there are no records from EU in the FAO database[1]. However, there is no requirement to revise the requirement.

[1] https://www.fao.org/in-action/vulnerable-marine-ecosystems/vme-database/en/vme.html

3.3 Sub-task 8.3 – Stakeholder consultation

In total, 36 responses were received (Table 6). Of these, only four completed the survey in full. The remaining 32 provided partial responses usually the first six questions i.e. their personal details. Sections 2-8 were left blank. The four stakeholders that fully completed the survey include two from the fisheries sector, one from an NGO and one scientist. They included two members of the Spanish fishing sector, a member of the IUCN Fisheries Expert Group, and a scientist from an EU research institute.

Table 6: Response to the online survey showing the number of stakeholders that have taken part.

Type of stakeholder	Number of responses
Fisheries sector	3
National authority	1
NGO	2
Scientist	5
Not stated	25
Total	36

3.3.1 Application of Regulation 734/2008

Respondents to the online questionnaire were asked to indicate to what extent they were applying specific aspects of the Regulation. Regarding whether Member States (MS) issue special fishing permits for the use of bottom fishing gears on the high seas under the scope of the Regulation, responses by the fisheries sector indicate that this aspect of the Regulation is applied to some extent (average score 2.3 on a five-point Likert scale from 'not at all' to 'a very great extent') while the NGO respondent stated that it was applied to a small extent (Figure 1). The breakdown of results for the different stakeholder groups indicates that special fishing permits for the use of bottom fishing gears on the high seas are issued by MS to some extent.

Regarding whether MS issue the special fishing permits after having carried out an assessment on the potential impacts of the vessel's intended fishing activities including whether the activities are not likely to have significant adverse impacts on VMEs, apart from the scientist who stated that this is done to a small extent, the other three respondents indicate that this is done to a great extent. Comments provided on this aspect however, indicate that the fisheries sector thinks there is double standards. They stated that 'the fishing sector is extremely surprised and disgusted with the different treatment granted to the interactions related to fishing and those derived from other anthropogenic activities. As an example, the position clearly is in favour of the development of underwater mining, an industry that will determine a high and indisputable impact on areas that are closed to fishing'.

Respondents also indicated that MS use information on the potential risk to VMEs to a great extent by asking applicants to amend fishing plans to avoid them. An example was provided where fishing fleets that used to operate on seamounts in the Central Atlantic ridge from the 1990s to 2014 were not reissued with fishing licences for those areas despite using semi-pelagic and pelagic trawling gear with little or no contact with potential VMEs. This was because a precautionary approach was being applied to protect potential VMEs around the seamounts. Respondent from the fisheries sector was therefore worried that while they have not been reissued with fishing licences, the International Seabed Authority (ISA) may end up approving mining to take place in the areas around the North Atlantic central ridge. ISA has published a public consultation within the framework of the negotiation process on the seabed mining regulations, which deals specifically with the Regional Environmental Management Plan (REMP) for the North Atlantic central ridge. The respondent was therefore wondering how deep-sea mining on the mountains and oceanic ridges would protect potential VMEs. Similarly, it was mentioned that it is discouraging for fisheries to see how Canada is putting out to tender an oil field in the middle of the Flemish Cap, directly affecting closed area 9 (by NAFO) and potential VMEs closed within the exploitation license.

On whether MS prohibit the use of bottom gears because there has been no proper scientific assessment carried out and made available on VMEs, respondents from the fisheries sector stated that this is applied to a great extent. The scientist who responded however, stated that this is applied to a small extent. The fishing sector provided similar comments, i.e. insisting that there is lack of logic in applying such rigid criteria to fishing activity while applying totally lax ones to underwater mining.

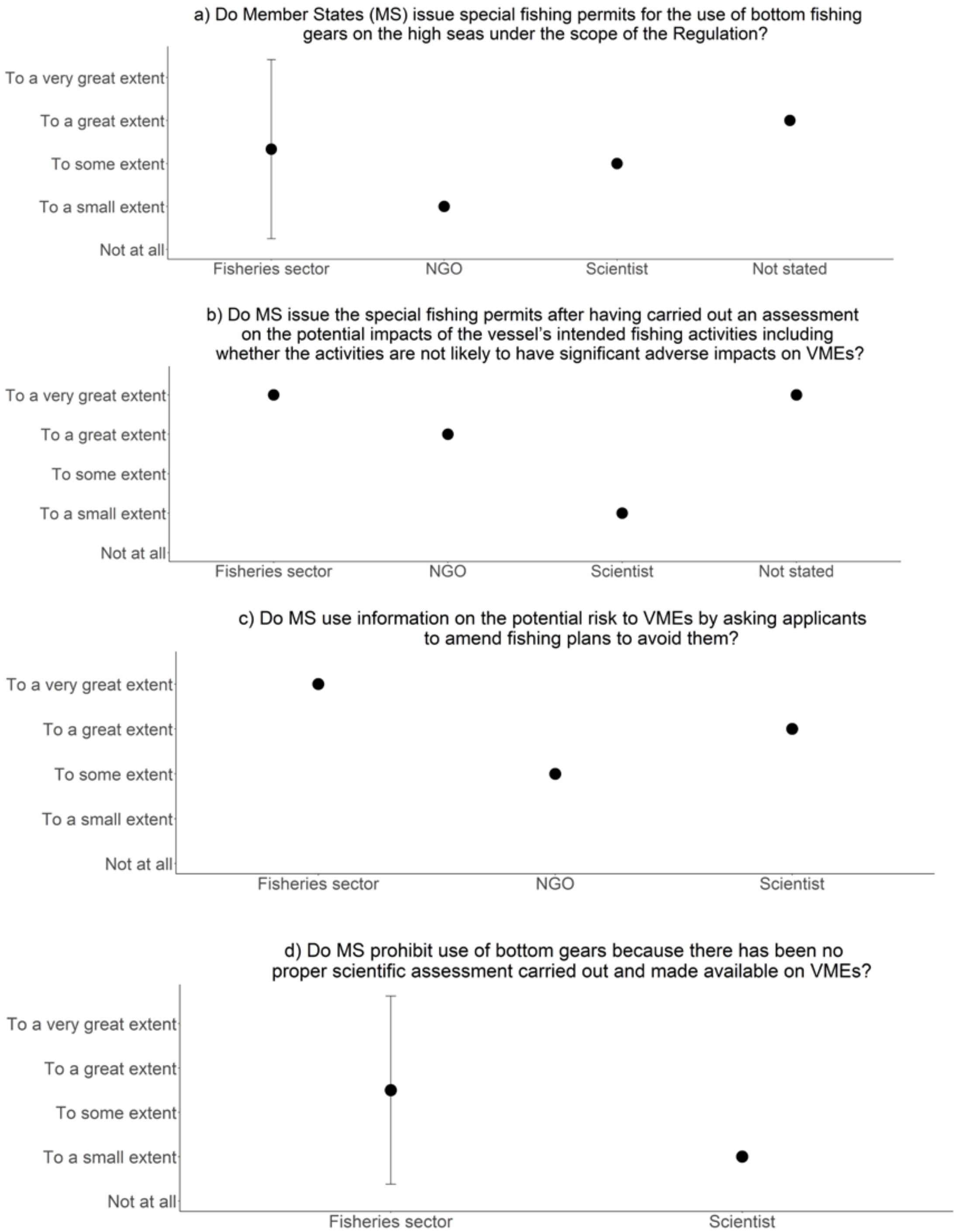


Figure 1: Stakeholder responses towards various aspects on how the Regulation is being applied. Responses are based on two individuals from the fisheries sector and one scientist.

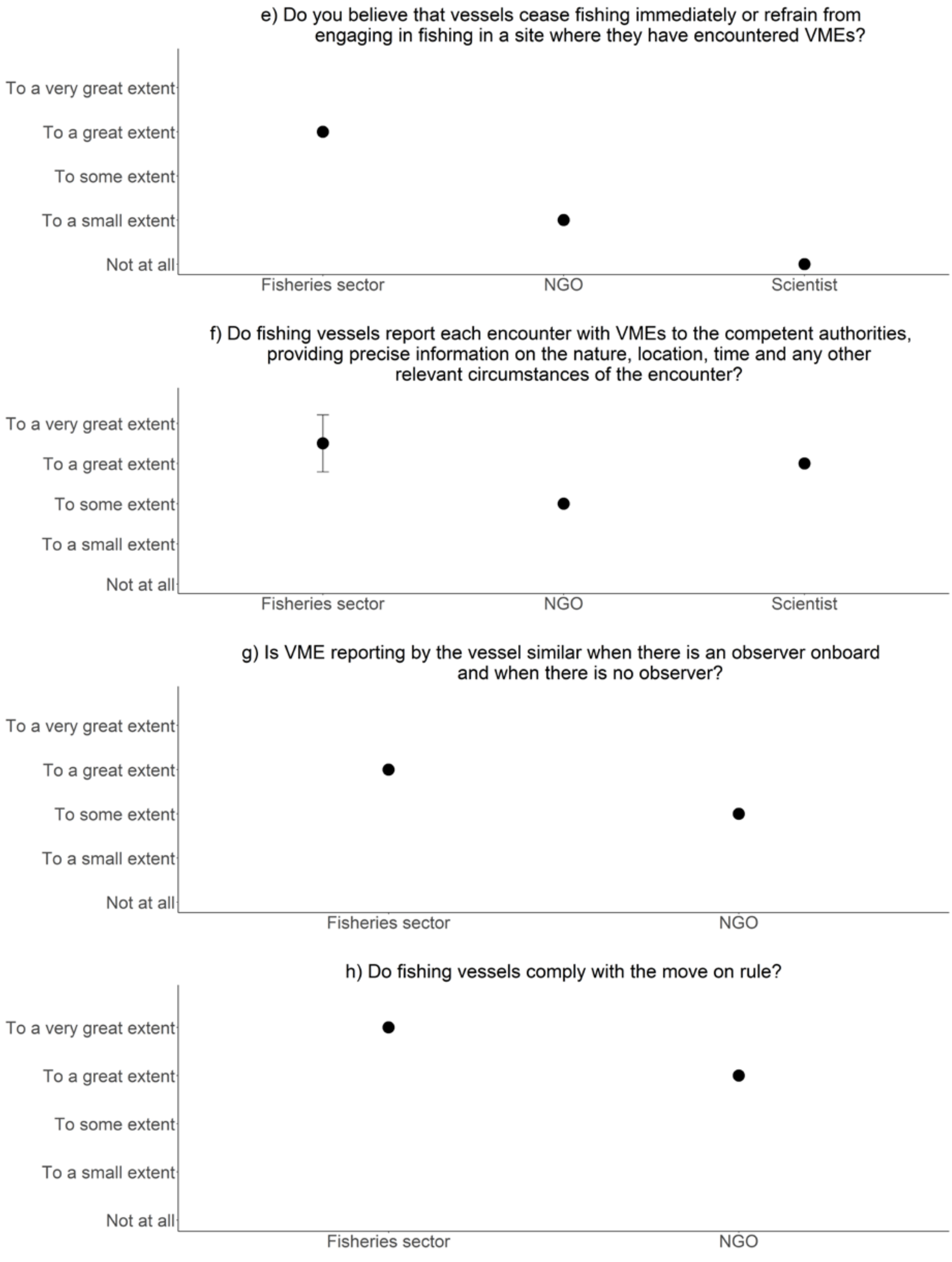


Figure 1: continued

Stakeholder views were varied on whether vessels cease fishing immediately or refrain from engaging in fishing in a site where they have encountered VMEs. The scientist indicated that they do not do this, while the NGO respondent stated that they do this to a small extent. The fisheries sector respondent however, stated that they do this to a great extent. The fisheries sector respondent elaborated on this by stating that their entire fishing route is usually tracked through AIS/VMS, and they tend to use the same trail where there are no established and closed VMEs areas. The stakeholders however, agreed that to a great extent, fishing vessels report each encounter with VMEs to the competent authorities, providing precise information on the nature, location, time and any other relevant circumstances of the encounter. They stated that there is evidence this is happening based on reports from the fishing operators.

Both the NGO and fisheries sector respondents agreed that VMEs reporting by fishing vessels is similar when there is an observer onboard and when there is no observer. The fisheries sector respondent stated that there is somewhat more precise information on the VMEs when the observer is onboard due to the observer's experience but captains also submit good information. Similarly, both NGO and fisheries sector respondents agreed that VME reporting takes place to some extent.

Both the NGO and scientist who responded stated that to some extent, MS have identified areas that are to be closed to fishing with bottom gears due to the occurrence or likelihood of occurrence of VMEs in the region where their fishing vessels operate. However, the fisheries sector respondent indicated that this was happening to a great extent. The way this aspect is applied however varies with some areas having more areas identified than others. For instance, the NEAFC area has been mapped which has led to the establishment of sensitive areas with restricted/authorized areas based on fishing footprints. Similarly, in the South Western Atlantic, nine areas with potential VMEs have been identified that were closed to the fishing activity of the Spanish fleet (not applicable to 3rd country's fleets), areas that are also included in the database of the Spanish Fishing Monitoring Centre that supervises the activity of the Spanish fleet.

Stakeholders indicated that fisheries observers are carried on board according to different programmes established in each area, with specific activities depending on the area, contributing to the data and information that feeds into various observer programmes. On whether the actual Regulation, as formulated, is clear and straightforward for MS to apply, stakeholders agreed to some extent. Some stated that it undoubtedly regulates fishing activities in the high seas to protect VMES while others stated that it could be simplified for ease of understanding. Among the key general comments that were provided:

- tightening up implementation of the existing regulation in areas where oversight is weak would be better than tightening up wording of the Regulation but not improving implementation and surveillance.

- The regulation has led Member States to significantly restrict the operations of the community fleet in the spheres of competence of the regulation itself, compared to the activity of other fleets such as the Chinese, Russian or Turkish.

- With this, the Regulation has generated a break in the level playing field and in the supply of essential fishery protein to the community market.

- The Regulation does not mention depth limits and therefore it needs to be more specific on how depth limits relate to different fisheries, communities etc.

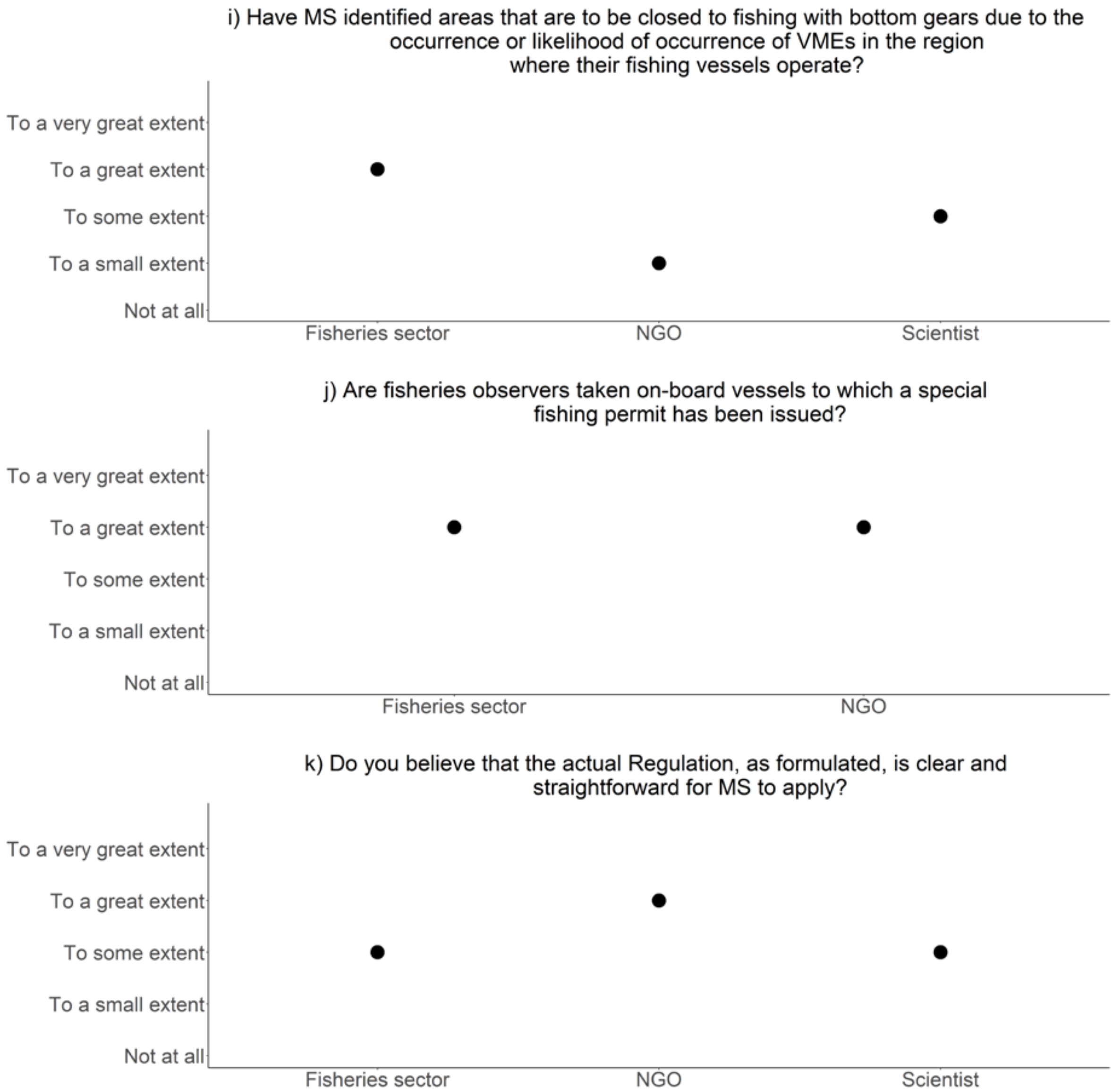


Figure 1: Continued

With regards to factors that have hindered success of the Regulation, the following observation were made by the fisheries sector respondents:

- The Regulation has not failed overall but where there is scope for improvement, the best step would be improvement in surveillance.
- Not having addressed the sector's observations prior to its publication leads to a Regulation that is based only on theoretical principles thereby generating problems in the real daily activity of the fleet.

3.3.2 Effectiveness of Regulation 734/2008

Questions on the effectiveness of the Regulation were answered by one person from the fisheries sector and another from NGO (Figure 2). Their views indicate that the Regulation:

- Has contributed significantly towards the identification and protection of VMEs in fishing areas.
- It is not clear how the Regulation promotes scientific research on VMEs
- Has made significant contribution towards data collection programmes in general according to the NGO respondent. However, it has not altered/impacted the data collection programmes of certain countries such as Spain that already collected most of the relevant data according to the fisheries sector respondent.
- Has had a significant contribution towards the assessment of risk of significant adverse impacts (SAIs) from bottom fishing according to the NGO respondent but has had no contribution according to the respondent from the fisheries sector.
- Has contributed significantly towards the assessment and submission of fishing plans alongside potential impacts to VMEs by MS.
- Has had no contribution towards the assessment and submission of potential impacts when applying to undertake bottom fishing. A comment was made that the regulation requires this exercise, but in the case of countries like Spain, the fishing authorities had already been applying similar criteria before.
- Has contributed significantly towards the identification and establishment of area closures according to NGO respondent but no contribution according to fisheries sector respondent.
- Has contributed significantly towards the establishment of bottom fishing footprint.
- Has contributed significantly towards the use of exploratory fishing protocols especially by restricting/disabling the development of exploratory fishing until its verified.
- On the use of encounter protocols and identification and use of thresholds based on gear types and indicator species, the Regulation has contributed significantly according to the NGO respondent but made no contribution according to the fisheries sector respondent.
- Towards the implementation of conservation and management measures that establish monitoring, control and surveillance (MCS) for compliance and enforcement, the regulation requires this exercise, but in many cases, the fishing authorities had already been applying similar control and monitoring criteria before the entry into force of the Regulation.
- Towards the implementation of measures relating to illegal, unregulated and unreported (IUU) fishing, the fisheries respondent stated that it is hard to tell whether the Regulation has had a significant impact on the elimination of IUU fishing, since the activity of non-EU fleets falls outside the Regulation.

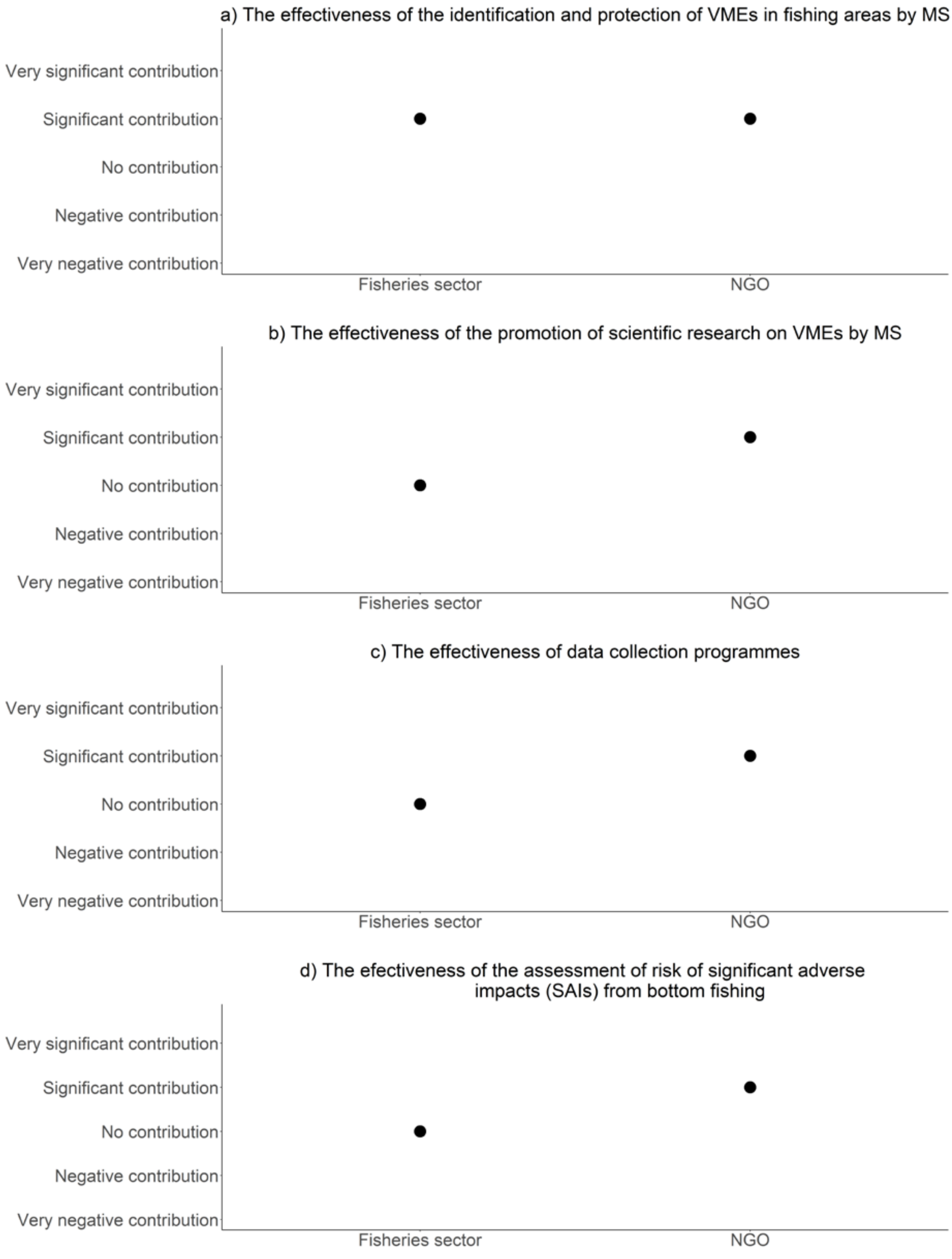


Figure 2: Stakeholder views towards the contribution of the Regulation towards various actions in areas of the high seas where no RFMO has been established or where no interim measures are in place.

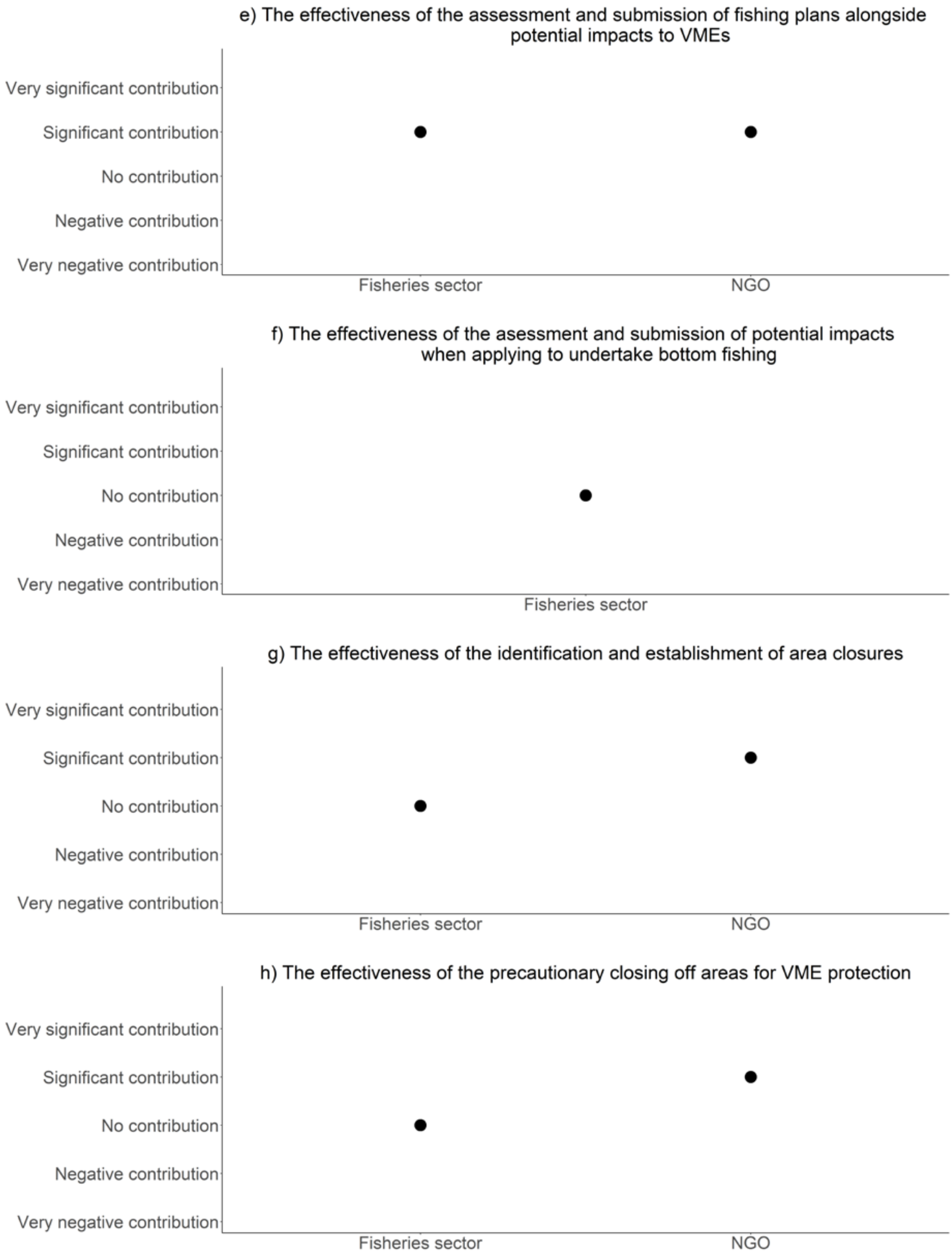
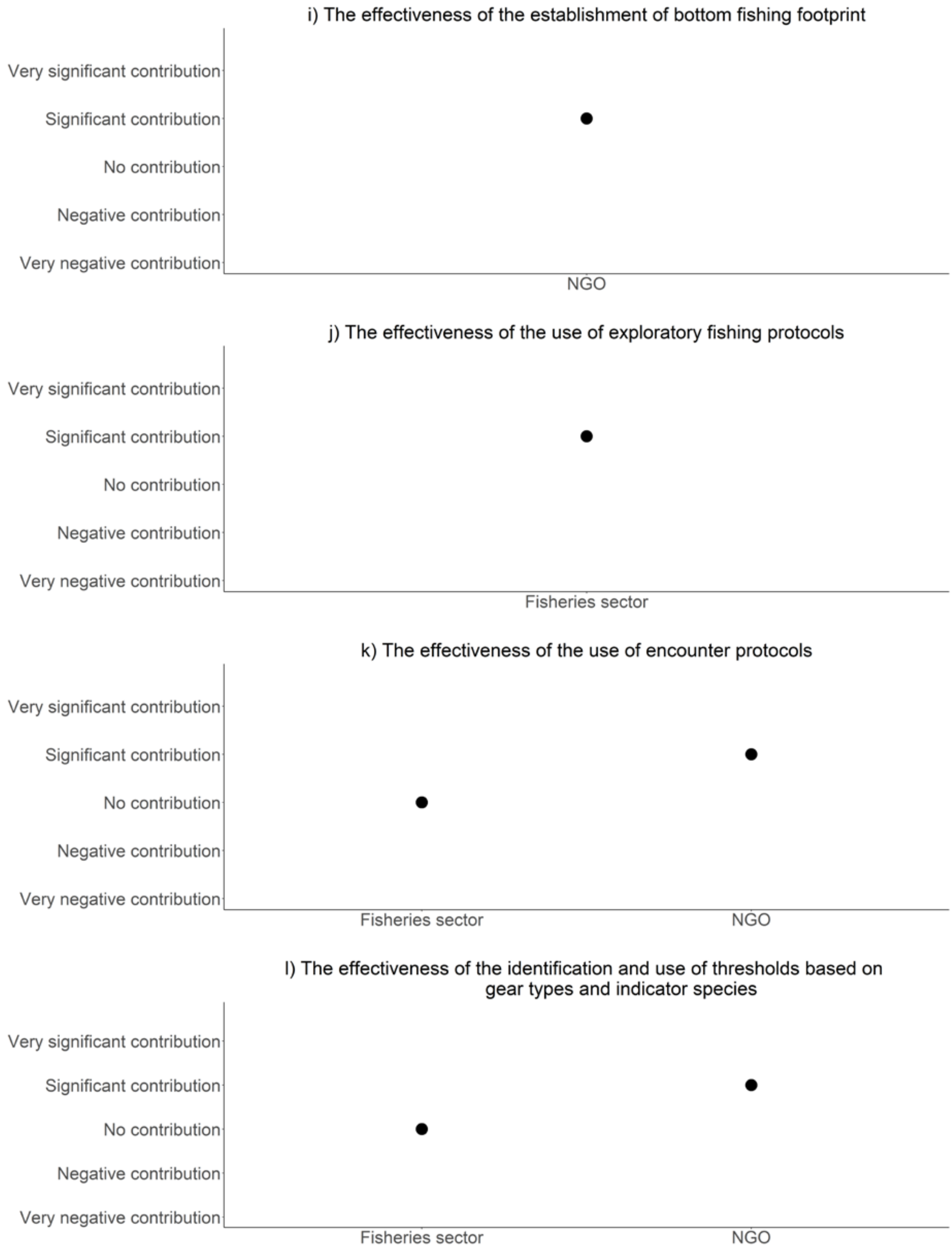


Figure 2: Continued



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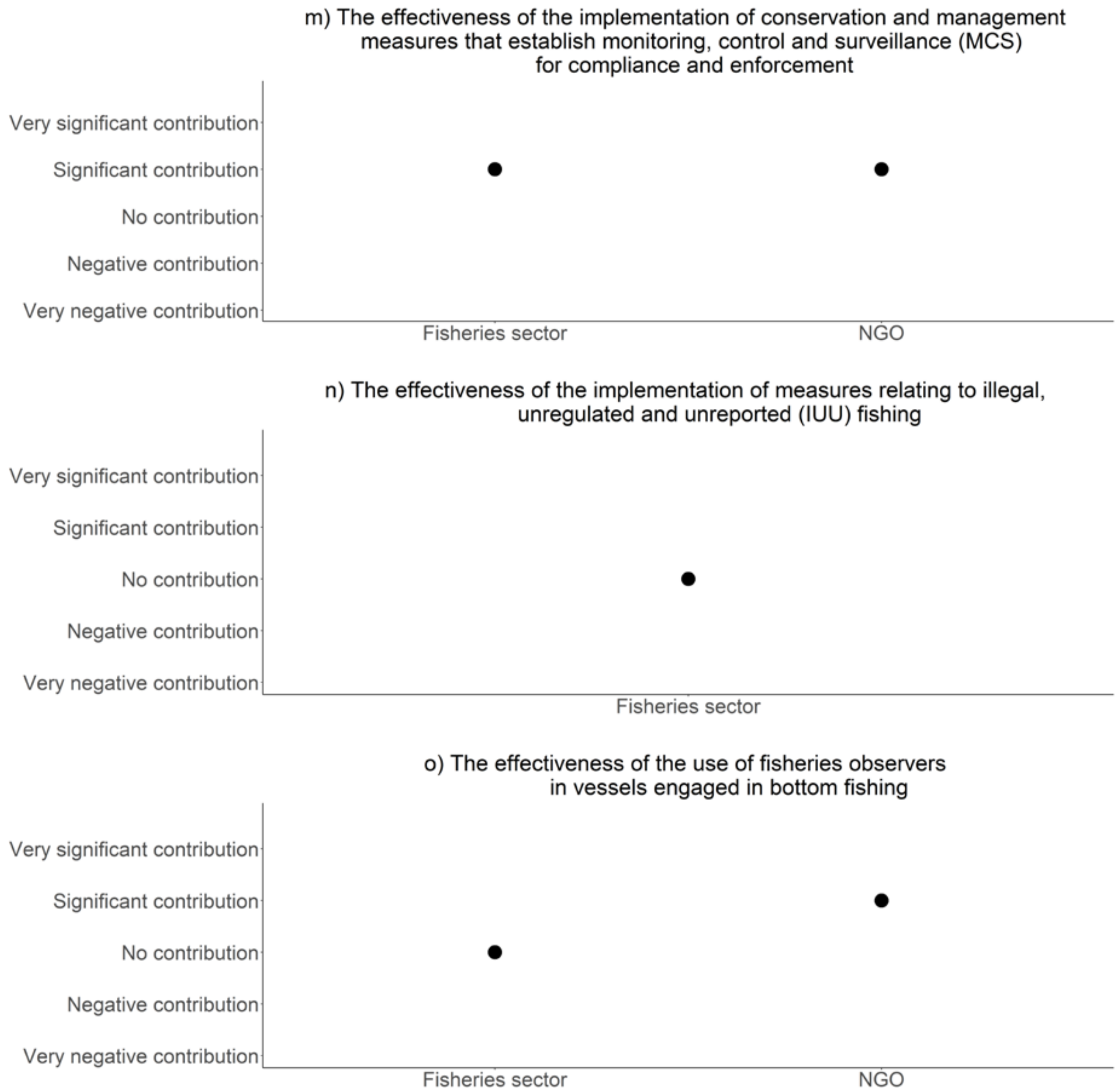


Figure 2: Continued

3.3.3 Efficiency in applying Regulation 734/2008

Questions on the efficiency in applying the Regulation were answered by one member of the fisheries sector, one scientist and a member of NGO (Figure 3). While the fisheries sector respondent stayed neutral regarding the timeliness of reporting, both the Scientist and NGO respondents stated that they were satisfied. Regarding the appropriateness of compliance and enforcement, both the fisheries sector and NGO respondents stayed neutral to this question. The respondents stated that compliance and enforcement are part of any fishing regulation, so these cannot be attributed to this Regulation. The scientist did not think there was any enforcement, stating that its compliance is based on VMS/AIS data that he thought depended on the fishers keeping the systems on. Regarding the appropriateness of the administrative burden to apply the regulation, the NGO respondent indicated that they were satisfied while the fisheries sector respondent stated that they were unsatisfied. The fisheries sector respondent commented that the Regulation was formulated from a theoretical point of view and therefore does not reflect the reality on the fishing ground, and is therefore an administrative overload.

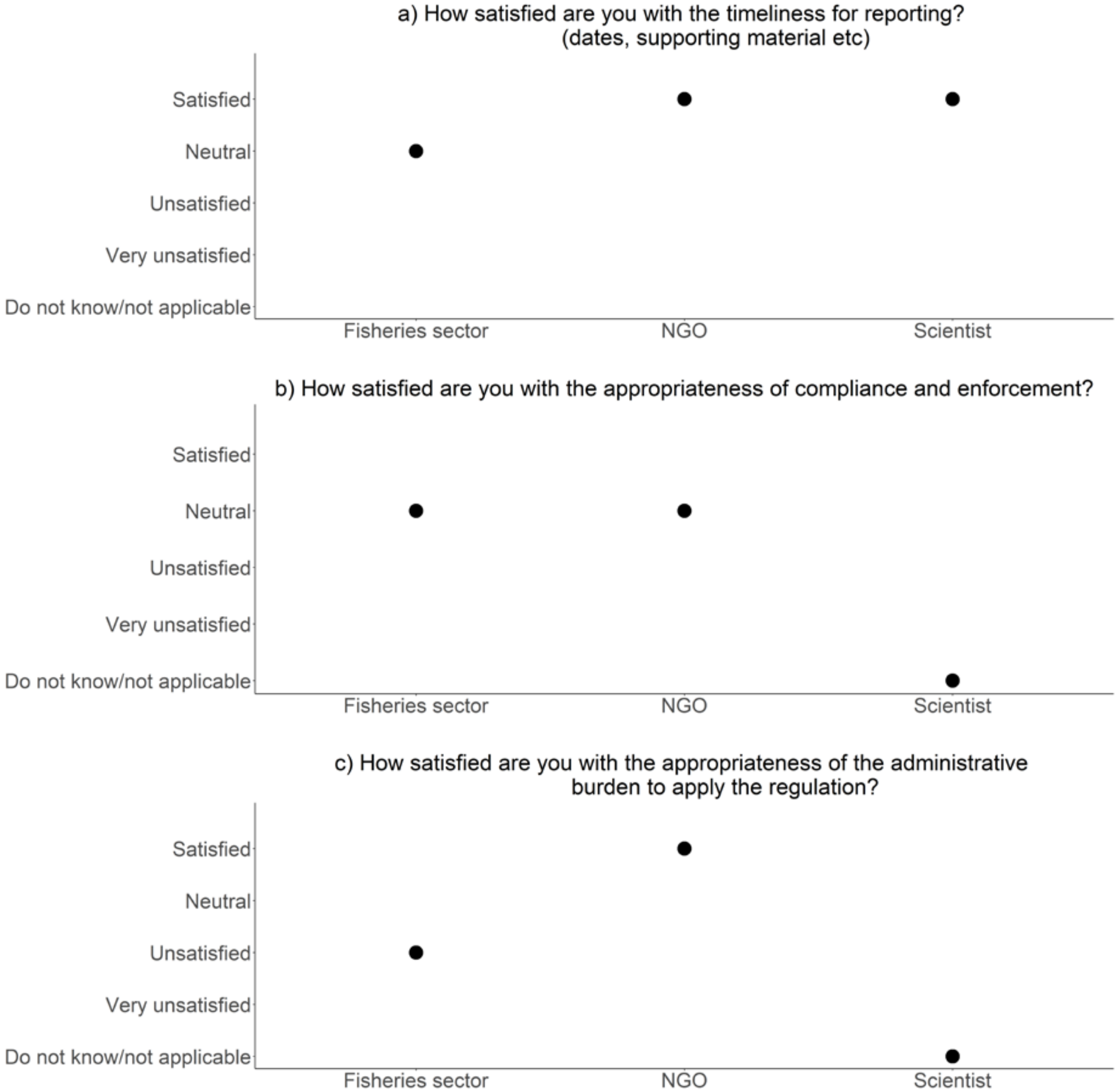
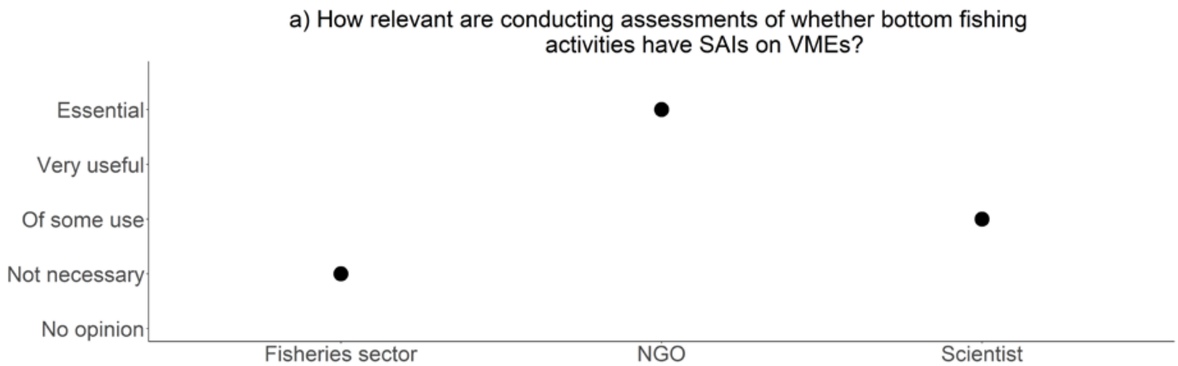


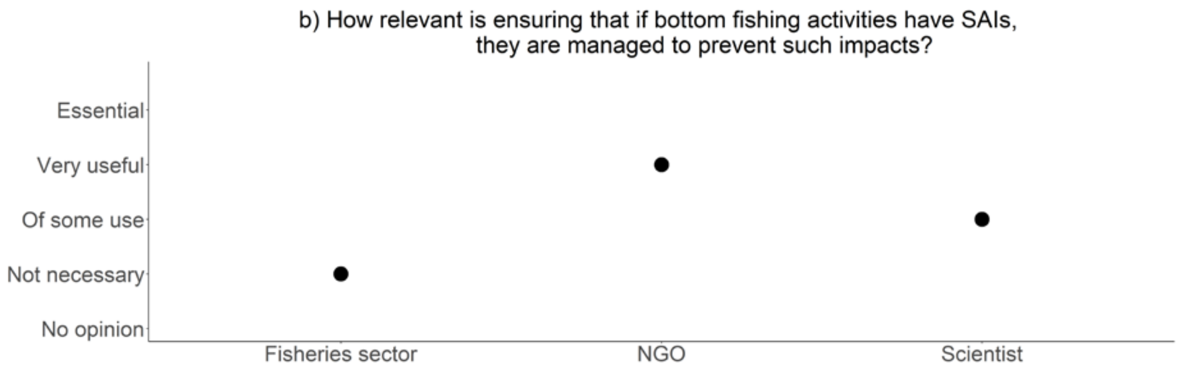
Figure 3: Stakeholder responses on how satisfied they are with different elements of Regulation 734/2008.

3.3.4 Relevance of Regulation 734/2008

Questions on the relevance of Regulation 734/2008 to protect VMEs from the adverse impacts of bottom fishing gear were answered by one member of the fisheries sector, one scientist and a member of an NGO (Figure 4). While the respondent from the fisheries sector stated that the Regulation was not necessary when conducting assessments of whether bottom fishing activities have SAIs on VMEs, the scientist though the Regulation had some use while the NGO respondent stated that it was essential. The fisheries sector respondent expanded on why they think the Regulation is not necessary by stating that 'what the Regulation intends to achieve with respect to adverse effects on VMEs is not understood and seems unnecessary since fishing takes place within the existing fishing footprint and not in identified and closed VMEs zones'. The scientist expanded on their response by stating that most States rely on the regulations set by UNGA; more work needs to be done for these regulations to be effective.

Similar responses were provided on the different aspects studied with the fisheries sector respondent stating that the Regulation was not necessary as it has resulted in a lack of level playing field, the scientist stating that it is of some use while the NGO respondent stating that the Regulation was essential towards (i) ensuring that if bottom fishing activities have SAIs, they are managed to prevent such impacts; (ii) establishing and implementing protocols to cease fishing where an encounter with VMEs occurs during bottom fishing activities, and reporting such encounters so that appropriate measures can be adopted with respect to that site; and (iii) implementing measures in accordance with the precautionary approach, ecosystems approaches and international law, and to sustainably manage deep-sea fish stocks.





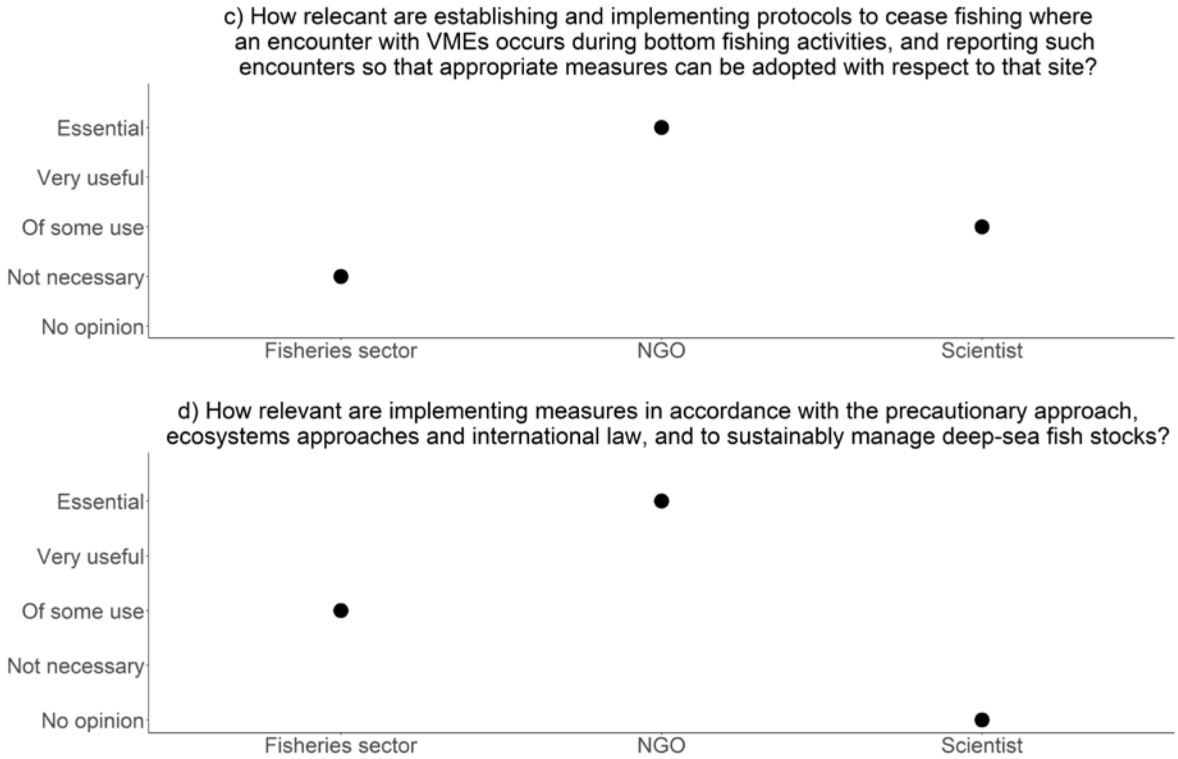


Figure 4: Stakeholder responses on the relevance of the Regulation towards the protection of VMEs from the adverse impacts of bottom fishing gear.

3.3.5 Coherence of Regulation 734/2008 with other interventions

Coherence of the Regulation was assessed by comparing how well-aligned it was with the measures adopted by the best performing RFMOs (NEAFC, NAFO) and those under Chapter 4 of the Sustainable Management of External Fishing Fleets (SMEFF) regulation. Responses were provided by one member of the fisheries sector, one scientist and one member of an NGO. Towards coherence with the measures by the best performing RFMOs, the fisheries sector respondent stated that the two Regulations are very similar while both the scientist and member of NGO stated that the measures are complementary but could be better coordinated. Regarding coherence with measures under SMEFF, both the fisheries sector and NGO respondents stated that there was an overlap. The scientist had no opinion on these aspects. Without further information no more information has included on this.

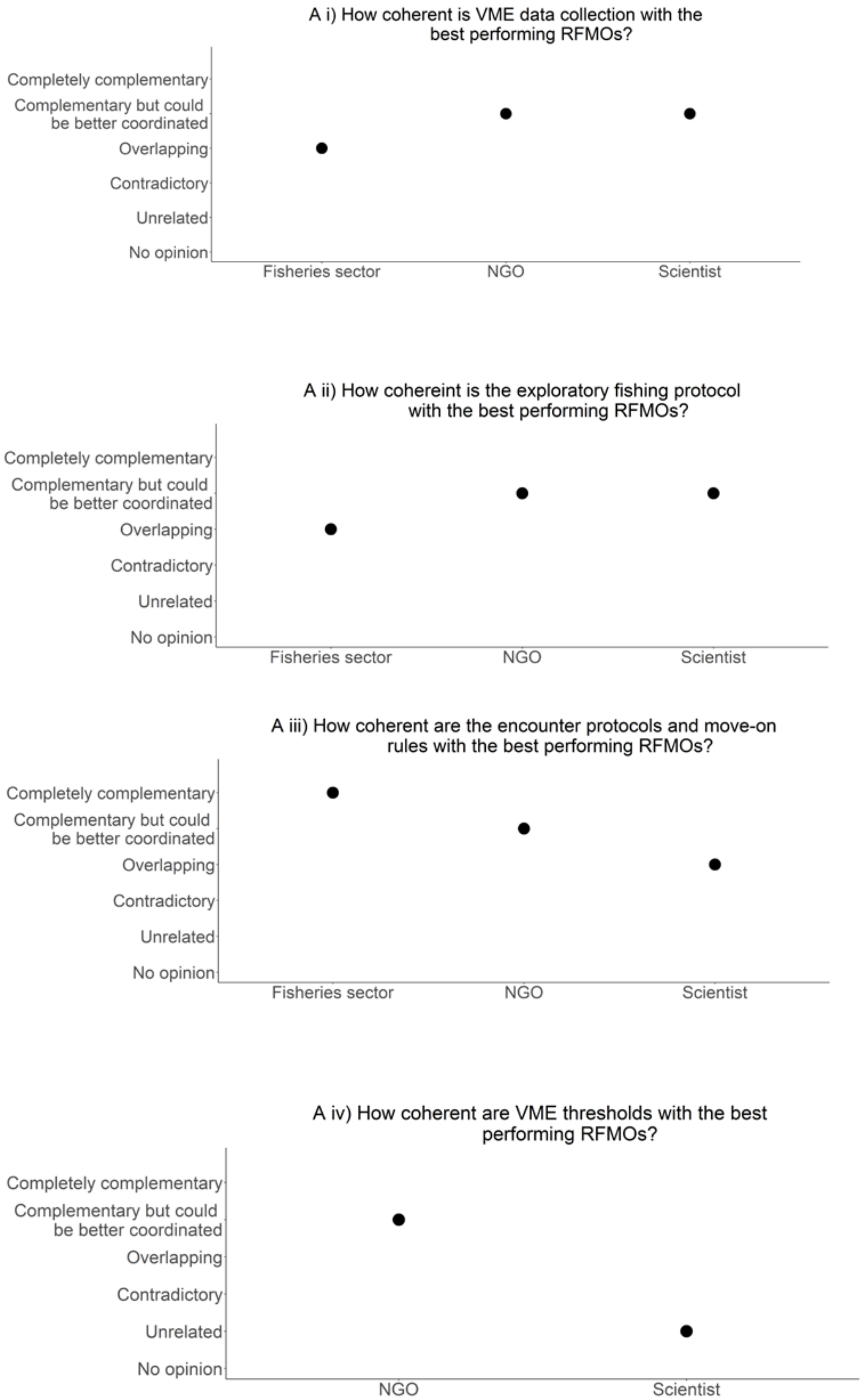


Figure 5: Responses on the coherence of measures for the protection of VMEs under Regulation 734/2008 with those of other interventions.

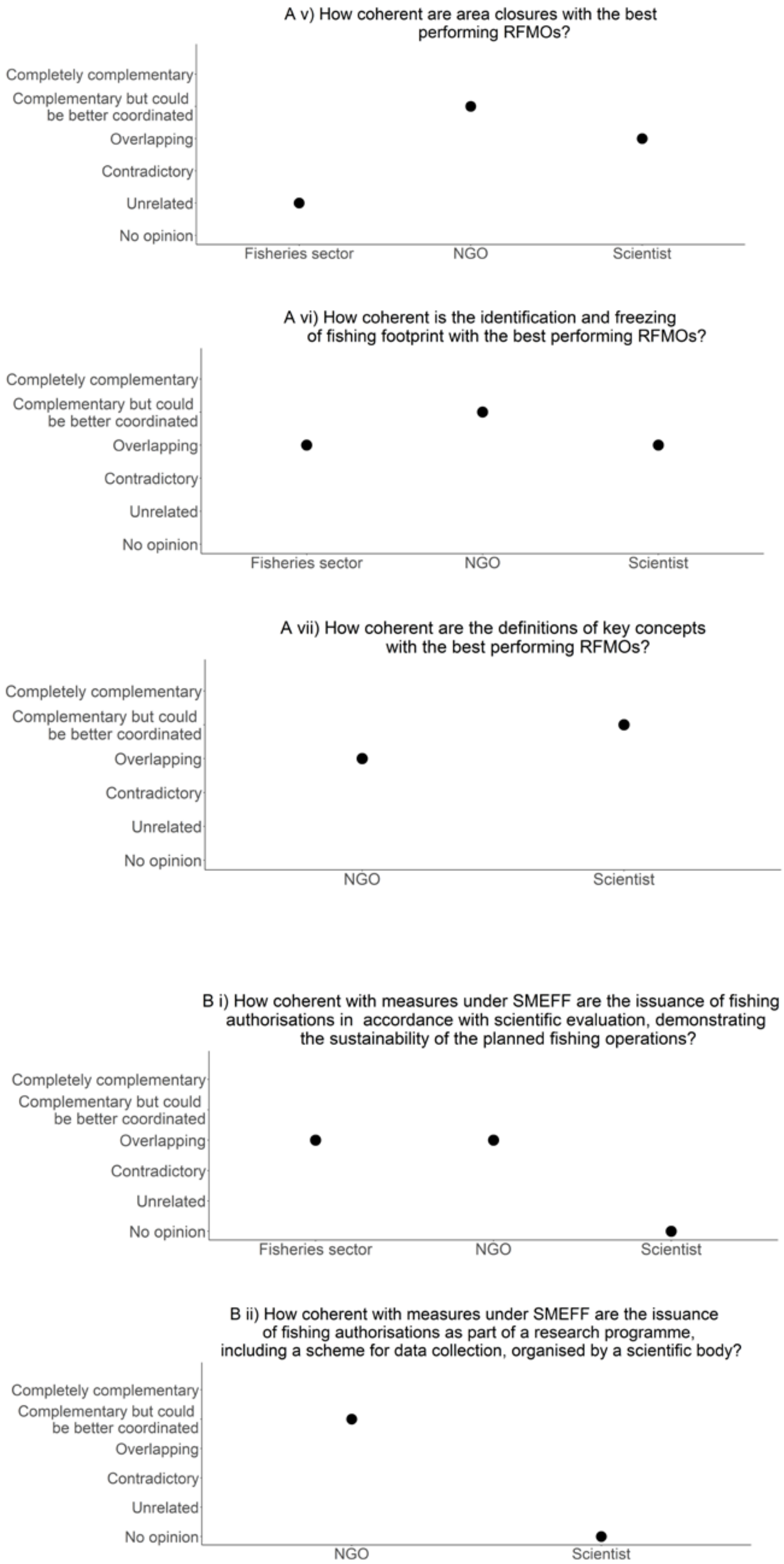


Figure 5: Continued

3.3.6 EU added value of Regulation 734/2008

When asked to provide opinion on the most likely consequences of stopping applying Regulation 734/2008, the member of NGO stated that it would increase the amount of fishing on VMEs with impacts on seabed habitats and related biodiversity that were harmful and long-lasting, the fisheries sector respondent stated that it would have little consequences in practice, while the scientist stated that it depends on how much the regulation is applied. A common EU regulation relating to VMEs could be very helpful but it needs to be updated to encompass the EAFM approach.

Regarding what needs improving/updating under Regulation 734/2008, the following thoughts were provided:

- Surveillance and strengthening of knowledge of seabed in poorly studied parts of the seabed.
- Reducing the level of bureaucracy required and simplification of the measures contained in the Regulation. Furthermore, there is a need to make the conditions set more flexible, especially due to the contradiction generated by the application of extremely strict criteria for fishing activities and the promotion and support of new activities on the seabed whose impacts will be exponentially greater than the intended protection that the regulation has been addressing.
- Made more specific towards each region and the socio-political environment of the different regions, better definition of the key concepts such as a definition of VMEs, thresholds, encounter protocols and move on rules and getting a wider range of stakeholders involved in defining the Regulation

On the question of what the different stakeholders would do to improve the effectiveness and applicability of Regulation 734/2008, the following thoughts were provided:

- 100% Observer coverage and strict reporting deadlines.
- Open a real and direct consultation between the fisheries sector and the public authorities to adapt the rules to the reality of the fishing activities of the EU fleet. In this vein, any Regulation that has the support and contribution of the fishing sector will always be better implemented and monitored, besides being fairer.
- More data, more information, more regional focus - additionally documents with species thresholds etc for that particular region (type of fishery, type of control, geomorphology of the area, taking into account all the different aspects).
- Must take into account the local condition of the area within the Regulation - the EU is a diverse community and the regulation needs to reflect this.

4. Sub-task 8.4 – Conclusions and recommendations

The aim of this study was to analyse the extent to which the Regulation is effective, efficient, still relevant given the current needs, coherent and complementary to other interventions and has achieved EU added value. We also aimed to identify where the Regulation needs to be updated to reflect best practices and best available science, as well as providing recommendations on how the Regulation can be updated (if needed) to reflect the findings. A stakeholder consultation was therefore undertaken to gather the views of people who are impacted by its implementation. Despite several efforts to get stakeholders to take part, the response was too low. It is therefore difficult to draw any key conclusions. However, given that the key area covered by the Regulation is FAO Area 41 which is mainly fished by Spanish flagged vessels, the respondents included two members of the Spanish fishing sector, a member of the IUCN Fisheries Expert Group, and a scientist from an EU research institute. Despite the low sample size, the views discussed in this report are informative of the different aspects of the Regulation and should inform aspects on how and which areas of the Regulation could be updated/revised if that decision is taken.

With the introduction of the newer UN Resolutions the regulation will need updating to bring it more into line with the more recent requirements. This has also been undertaken, or is in the process of being undertaken, by a number of RFMOs as more information become available to inform decisions. Regulation 71/123 emphasises the importance of entities applying the requirements under the previous regulations related to conducting effective assessments (and updating if the fishing plan changes), collection and sharing of scientific data, promoting compliance with measures to protect VMEs and make the results of the any assessments publicly available.

As has been identified in previous tasks, the Regulation does not define any threshold levels or follow up actions once the move on rule has been triggered.

Most RFMOs include the requirements of the Regulation under their VME sampling protocols and in many cases, they are more advanced in that they include more information the VME taxa, threshold levels and subsequent actions when a threshold encounter is reached (see Table 5). EU vessels fishing in these areas will submit their assessments and data to the RFMO in question (normally through their Member State) following the RFMO guidelines. However, this does not apply to the Southwest Atlantic (FAO Area 41) which will fall under the UNGA resolutions and any domestic requirements put in place, which are not reviewed here.

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Annex 1: Summary of consultation used

	Member State	Name entity	Stakeholder category	Main contact	Date first contact	Deadline proposed	Date reminder	How consulted ?	Comments
1	EU	Long Distance Fisheries Advisory Council (LDAC)	EU	Alexandre Rodriguez	10/05/2022	10/06/2022	25/05/2022	Survey	No response
2	EU	Europeche	EU	Daniel Voces	10/05/2022	10/06/2022	25/05/2022	Survey	Survey completed
3	Spain	ARVI	Fisheries secor	Edelmiro Ulloa	10/05/2022	10/06/2022	25/05/2022	Survey	Survey completed
4	Spain	University of A Coruña	Scientist	Fernando González Laxe	10/05/2022	10/06/2022	25/05/2022	Survey	No response
5	Spain	CEPESCA	Fisheries secor	Javier Garat	10/05/2022	10/06/2022	25/05/2022	Survey	No response
6	Spain	Secretaría de Pesca	Fisheries secor	Margarita Mancebo	10/05/2022	10/06/2022	25/05/2022	Survey	No response
7	Spain	CETMAR	Scientist	María Rosa Chapela	10/05/2022	10/06/2022	25/05/2022	Survey	No response
8	Netherlands	Deep-Sea Conservation Coalition	NGO	Matthew Gianni	10/05/2022	10/06/2022	25/05/2022	Survey	Positive response, meeting cancelled - stoppped responding (Needs a follow up)
9	Spain	University of Santiago de Compostela	Scientist	Sebastián Villasante	10/05/2022	10/06/2022	25/05/2022	Survey	No response
10	Spain	INTECMAR	Scientist	Xose Molares	10/05/2022	10/06/2022	25/05/2022	Survey	No response
11	Spain	Pesquerias Georgia SL	Fisheries secor	Juan Antonio Regal	10/05/2022	10/06/2022	25/05/2022	Survey	Passed on to Joost - positive response, stopped resonding
12	EU	SEAFO EU-representative	EU	Ignacio Granell	10/05/2022	10/06/2022	25/05/2022	Survey	No response
13	UN	FAO	UN	William Emerson	10/05/2022	10/06/2022	25/05/2022	Survey	Postmaster - undelivered
14	Denmark	ICES	Scientist	Sebastian Velanko	10/05/2022	10/06/2022	25/05/2022	Survey	No response
15	Italy	GFCM	RFMO	Miguel Bernal	10/05/2022	10/06/2022	25/05/2022	Survey	No response
16	Italy	GFCM	RFMO	Betulla Morello	10/05/2022	10/06/2022	25/05/2022	Survey	No response
17	Italy	GFCM	RFMO	Aurora Nastasi	10/05/2022	10/06/2022	25/05/2022	Survey	No response
18	Italy	ISPRA	NGO	Leonardo Tunesi	10/05/2022	10/06/2022	25/05/2022	Survey	Positive response - stopped responding
19	Italy	ISPRA	NGO	Sasa Raicevich	10/05/2022	10/06/2022	25/05/2022	Survey	No response
20	Spain	IEO-CSIC	Scientist	Covadonga Orejas	10/05/2022	10/06/2022	25/05/2022	Survey	Doesn't count self as stakeholder
21	France	IFREMER	Scientist	Sandrine Vaz	10/05/2022	10/06/2022	25/05/2022	Survey	No response
22	France	IFREMER	Scientist	Marie-Claire Fabri	10/05/2022	10/06/2022	25/05/2022	Survey	Doesn't count self as stakeholder
23	Netherlands	Wageningen Marine Research (WUR)	Scientist	Oscar Bos	10/05/2022	10/06/2022	25/05/2022	Survey	Doesn't count self as stakeholder
24	Italy	Polytechnic University of Marche (UNIVPM)	Scientist	Emanuela Fanelli	10/05/2022	10/06/2022	25/05/2022	Survey	Survey completed
25	Netherlands	NIOZ	NGO	Gert Jan Reichart	10/05/2022	10/06/2022	25/05/2022	Survey	Started but did not complete
26	Netherlands	NIOZ	NGO	Marck Smit	10/05/2022	10/06/2022	25/05/2022	Survey	No response
27	Spain	Ministerio de Agricultura, Pesca y Alimentación	National authority	Pilar	10/05/2022	10/06/2022	25/05/2022	Survey	Started but did not complete
28	Belgium	UGent	Scientist	Ann vanreusel	10/05/2022	10/06/2022	25/05/2022	Survey	Started but did not complete
29	UN	IUCN Fisheries Expert Group	NGO	Jake Rice	10/05/2022	10/06/2022	25/05/2022	Survey	Survey completed
30	Portugal	Sociedade de Pesca Miradouro SA	Fisheries secor	Carlos Leitao	10/05/2022	10/06/2022	25/05/2022	Survey	Started but did not complete
31	Netherlands	Deep-Sea Conservation Coalition	NGO	Deep Sea Conservation Coalition Members	10/05/2022	10/06/2022	25/05/2022	Survey	No response
32	Germany	IUCN	NGO	IUCN Environmental Law Centre (ELC)	10/05/2022	10/06/2022	25/05/2022	Survey	No response
33	Austria	Fisheries attaches	National authority	Paul Unglaub	10/05/2022	10/06/2022	25/05/2022	Survey	No response
34	Belgium	Fisheries attaches	National authority	Barbara Roegiers	10/05/2022	10/06/2022	25/05/2022	Survey	No response
35	Bulgaria	Fisheries attaches	National authority	Georgi Ralchev	10/05/2022	10/06/2022	25/05/2022	Survey	No response
36	Cyprus	Fisheries attaches	National authority	Savvas Michaelides	10/05/2022	10/06/2022	25/05/2022	Survey	No response
37	Czechia	Fisheries attaches	National authority	Tomas Vacenovsky	10/05/2022	10/06/2022	25/05/2022	Survey	No response
38	Czechia	Fisheries attaches	National authority	Vera Kohoutkova	10/05/2022	10/06/2022	25/05/2022	Survey	No response
39	Germany	Fisheries attaches	National authority	Anne Winter	10/05/2022	10/06/2022	25/05/2022	Survey	No response
40	Denmark	Fisheries attaches	National authority	Martin Chemnitz Mortensen	10/05/2022	10/06/2022	25/05/2022	Survey	No response
41	Estonia	Fisheries attaches	National authority	Kristiina Digryte	10/05/2022	10/06/2022	25/05/2022	Survey	No response
42	Estonia	Fisheries attaches	National authority	Ulvi Päädam	10/05/2022	10/06/2022	25/05/2022	Survey	No response
43	Spain	Fisheries attaches	National authority	Iria Soto	10/05/2022	10/06/2022	25/05/2022	Survey	No response
44	Spain	Fisheries attaches	National authority	Ramón de la Figuera Morales	10/05/2022	10/06/2022	25/05/2022	Survey	No response
45	Finland	Fisheries attaches	National authority	Jarmo Vilhunen	10/05/2022	10/06/2022	25/05/2022	Survey	No response
46	France	Fisheries attaches	National authority	Théo Barbe	10/05/2022	10/06/2022	25/05/2022	Survey	No response
47	Greece	Fisheries attaches	National authority	Varvara (Vanda) Laliotou	10/05/2022	10/06/2022	25/05/2022	Survey	No response
48	Croatia	Fisheries attaches	National authority	Ivana Miletic	10/05/2022	10/06/2022	25/05/2022	Survey	No response
49	Hungary	Fisheries attaches	National authority	Gabor Hollo	10/05/2022	10/06/2022	25/05/2022	Survey	No response
50	Ireland	Fisheries attaches	National authority	Colm Ó Súilleabháin	10/05/2022	10/06/2022	25/05/2022	Survey	No response
51	Italy	Fisheries attaches	National authority	Silvia Nicoli	10/05/2022	10/06/2022	25/05/2022	Survey	No response
52	Lithuania	Fisheries attaches	National authority	Ieva Zundiene	10/05/2022	10/06/2022	25/05/2022	Survey	No response
53	Luxembourg	Fisheries attaches	National authority	Marc Kreis	10/05/2022	10/06/2022	25/05/2022	Survey	No response
54	Latvia	Fisheries attaches	National authority	Ricards Derkacs	10/05/2022	10/06/2022	25/05/2022	Survey	No response
55	Malta	Fisheries attaches	National authority	Thomas Bajada	10/05/2022	10/06/2022	25/05/2022	Survey	No response
56	Netherlands	Fisheries attaches	National authority	Corné van Alphen MPA	10/05/2022	10/06/2022	25/05/2022	Survey	No response
57	Poland	Fisheries attaches	National authority	Krystian Krolik	10/05/2022	10/06/2022	25/05/2022	Survey	No response
58	Portugal	Fisheries attaches	National authority	Margarida Carrega	10/05/2022	10/06/2022	25/05/2022	Survey	No response
59	Romania	Fisheries attaches	National authority	Ionut Petrescu	10/05/2022	10/06/2022	25/05/2022	Survey	No response
60	Sweden	Fisheries attaches	National authority	Tomas Dahlman	10/05/2022	10/06/2022	25/05/2022	Survey	No response
61	Slovenia	Fisheries attaches	National authority	Gvido Mravljak	10/05/2022	10/06/2022	25/05/2022	Survey	No response
62	Slovenia	Fisheries attaches	National authority	Leon Megušar	10/05/2022	10/06/2022	25/05/2022	Survey	No response
63	Slovenia	Fisheries attaches	National authority	Uroš Zgonec	10/05/2022	10/06/2022	25/05/2022	Survey	No response
64	Slovakia	Fisheries attaches	National authority	Zlatica Daubnerová	10/05/2022	10/06/2022	25/05/2022	Survey	No response

ANNEX 13

Task 8 - Questionnaire[1]

Evaluation of European Council Regulation (EC) No 734/2008 on the protection of vulnerable marine ecosystems (VMEs) in the high seas from the adverse impacts of bottom fishing gears

Dear Stakeholder,

Thank you for taking part in this survey, which is part of EASME/EMFF/2019/014 study on "Improving environmental sustainability of deep-sea fisheries with emphasis on the conservation of VMEs" being carried out by a consortium of six scientific institutes. **The aim is to provide a comprehensive analysis of Regulation (EC) No 734/2008 to ensure that it reflects the most recent scientific advice and best practices.** The consortium is contracted by the European Commission's Executive Agency for European Climate, Infrastructure and Environment Executive Agency (CINEA), on behalf of the Directorate General for Maritime Affairs and Fisheries (DG MARE).

A key aspect of this study is to consult relevant stakeholders to understand the specific viewpoints and needs of the different actors that fall under the scope of the EC Regulation.

In June 2008, the European Union adopted Council Regulation (EC) No 734/2008 (the Regulation) on the protection of VMEs in the high seas from the adverse impacts of bottom fishing gears. Its purpose was to transpose the measures contained in the United Nations General Assembly (UNGA) Resolution 61/105 into Union law for vessels flying flags of its Member States, for those **areas of the high seas where no Regional Fisheries Management Organization (RFMO) had been established or where no interim measures were put in place** during negotiations for the establishment of an RFMO.

The Regulation establishes that the competent authorities of an EU Member State can only issue special fishing permits for the use of bottom fishing gears on the high seas if specific conditions are met. Member States are obliged to carry out an assessment of the potential impacts of the vessels intended fishing activities and can only issue a special fishing permit after concluding that such activities were not likely to have significant adverse impacts (SAIs) on VMEs. The use of bottom gears is prohibited in areas where no proper scientific assessment has been carried out and made available. The Regulation also contains provisions on unforeseen encounters with VMEs, area closures and an observer scheme for all vessels which have been issued with a special fishing permit.

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[1] The present questionnaire was designed to explore the views of stakeholders regarding Council Regulation (EC) No 734/2008, and to obtain feedback on key issues. Detailed information on the methodology used and main findings are in the Task 8 section of the final report.

With this survey, we aim to explore the views of stakeholders regarding Regulation (EC) No 734/2008 and to obtain feedback from you on:

a) The extent to which the Regulation is effective, efficient, still relevant, coherent and has achieved EU added value.
b) Measures in the Regulation that might need updating to reflect current knowledge and best practices.

The survey will take 20 – 25 minutes to complete.

Privacy

All information you provide during this survey will be treated anonymously. Responses will only be presented in aggregated form such that they cannot be traced back to individuals or organisations.

Contact

Should you have any questions concerning the survey and the project, please contact:

- Stephen Mangi Chai at MRAG_EU s.mangi.chai@mrag-europe.eu
- Pablo Durán Muñoz at IEO pablo.duran@ieo.es; and Mar Sacau mar.sacau@ieo.es

Thank you very much for your collaboration.

Online survey questions

Fields marked with * are mandatory.

Identification [Your personal details (name and e-mail) may be used to contact you regarding this survey, in particular to check that the summary of the outcome of the survey reflects your views].

1. Your name *

2. Your email address*

3. Your organisation*

4. Are you responding on behalf of an organisation or as an individual? * [as part of an organisation; as an individual]

5. Do you consent to the Project Team using your response for the purpose of this study? * [Yes/No]

6. What type of stakeholder category are you? [National authority; Scientist; Fisheries sector; NGO; Other (please specify)]

Application of Regulation 734/2008

Question		Method of answering	Options
7	In your opinion, to what extent,		
	a) Do Member States (MS) issue special fishing permits for the use of bottom fishing gears on the high seas under the scope of the Regulation?	Likert scale, with comments	(1) To a very great extent; (2) To a great extent; (3) To some extent; (4) To a small extent; (5) Not at all Specific comments …
	b) Do MS issue the special fishing permits after having carried out an assessment on the potential impacts of the vessel's intended fishing activities including whether the activities are not likely to have significant adverse impacts on VMEs?	Likert scale, with comments	(1) To a very great extent; (2) To a great extent; (3) To some extent; (4) To a small extent; (5) Not at all Specific comments …
	c) Do MS use information on the potential risk to VMEs by asking applicants to amend fishing plans to avoid them?	Likert scale, with comments	(1) To a very great extent; (2) To a great extent; (3) To some extent; (4) To a small extent; (5) Not at all Specific comments …
	d) Do MS prohibit use of bottom gears because there has been no proper scientific assessment carried out and made available on VMEs?	Likert scale, with comments	(1) To a very great extent; (2) To a great extent; (3) To some extent; (4) To a small extent; (5) Not at all Specific comments …
	e) Do you believe that vessels cease fishing immediately or refrain from engaging in fishing in a site where they have encountered VMEs?	Likert scale, with comments	(1) To a very great extent; (2) To a great extent; (3) To some extent; (4) To a small extent; (5) Not at all Specific comments …
	f) Fishing vessels report each encounter with VMEs to the competent authorities, providing precise information on the nature, location, time and any other relevant circumstances of the encounter?	Likert scale, with comments	(1) To a very great extent; (2) To a great extent; (3) To some extent; (4) To a small extent; (5) Not at all Specific comments …

	g) VMEs reporting by the vessel is similar when there is an observer onboard and when there is no observer?	Likert scale, with comments	(1) To a very great extent; (2) To a great extent; (3) To some extent; (4) To a small extent; (5) Not at all Specific comments …
	h) Fishing vessels comply with the move on rule?	Likert scale, with comments	(1) To a very great extent; (2) To a great extent; (3) To some extent; (4) To a small extent; (5) Not at all Specific comments …
	i) Have MS identified areas that are to be closed to fishing with bottom gears due to the occurrence or likelihood of occurrence of VMEs in the region where their fishing vessels operate?	Likert scale, with comments	(1) To a very great extent; (2) To a great extent; (3) To some extent; (4) To a small extent; (5) Not at all Specific comments …
	j) Are fisheries observers taken on-board vessels to which a special fishing permit has been issued?	Likert scale, with comments	(1) To a very great extent; (2) To a great extent; (3) To some extent; (4) To a small extent; (5) Not at all Specific comments …
	k) Do you believe that the actual Regulation, as formulated, is clear and straightforward for MS to apply?	Likert scale, with comments	(1) To a very great extent; (2) To a great extent; (3) To some extent; (4) To a small extent; (5) Not at all Specific comments …
8	Do you have any comments on how Regulation 734/2008 has helped MS regulate fishing activities in the high seas under its scope?	Open	
9	If Regulation 734/2008 has not helped MS regulate fishing activities in the high seas under its scope, what factors have hindered its success?	Open	

Effectiveness of Regulation 734/2008

10	How would you describe the contribution of Regulation 734/2008 towards the following actions in areas of the high seas where no RFMO has been established or where no interim measures are in place?		
	a) Identification and protection of VMEs in fishing areas by MS	Likert scale, with comments	(1) Very significant contribution (2) Significant contribution; (3) No contribution; (4) Negative contribution; (5) Very negative contribution Specific comments …
	b) Promotion of scientific research on VMEs by MS	Likert scale, with comments	(1) Very significant contribution (2) Significant contribution; (3) No contribution; (4) Negative contribution; (5) Very negative contribution Specific comments …
	c) Data collection programmes	Likert scale, with comments	(1) Very significant contribution (2) Significant contribution; (3) No contribution; (4) Negative contribution; (5) Very negative contribution Specific comments …
	d) Assessment of risk of significant adverse impacts (SAIs) from bottom fishing	Likert scale, with comments	(1) Very significant contribution (2) Significant contribution; (3) No contribution; (4) Negative contribution; (5) Very negative contribution Specific comments …
	e) Assessment and submission of fishing plans alongside potential impacts to VMEs	Likert scale, with comments	(1) Very significant contribution (2) Significant contribution; (3) No contribution; (4) Negative contribution; (5) Very negative contribution Specific comments …
	f) Assessment and submission of potential impacts when applying to undertake bottom fishing	Likert scale, with comments	(1) Very significant contribution (2) Significant contribution; (3) No contribution; (4) Negative contribution; (5) Very negative contribution Specific comments …
	g) Identification and establishment of area closures	Likert scale, with comments	(1) Very significant contribution (2) Significant contribution; (3) No contribution; (4) Negative contribution; (5) Very negative contribution Specific comments …

	h) Precautionary closing off areas for VME protection	Likert scale, with comments	(1) Very significant contribution (2) Significant contribution; (3) No contribution; (4) Negative contribution; (5) Very negative contribution Specific comments …
	i) Establishment of bottom fishing footprint	Likert scale, with comments	(1) Very significant contribution (2) Significant contribution; (3) No contribution; (4) Negative contribution; (5) Very negative contribution Specific comments …
	j) Use of exploratory fishing protocols	Likert scale, with comments	(1) Very significant contribution (2) Significant contribution; (3) No contribution; (4) Negative contribution; (5) Very negative contribution Specific comments …
	k) Use of encounter protocols	Likert scale, with comments	(1) Very significant contribution (2) Significant contribution; (3) No contribution; (4) Negative contribution; (5) Very negative contribution Specific comments …
	l) Identification and use of thresholds based on gear types and indicator species	Likert scale, with comments	(1) Very significant contribution (2) Significant contribution; (3) No contribution; (4) Negative contribution; (5) Very negative contribution Specific comments …
	m) Implementation of conservation and management measures that establish monitoring, control and surveillance (MCS) for compliance and enforcement	Likert scale, with comments	(1) Very significant contribution (2) Significant contribution; (3) No contribution; (4) Negative contribution; (5) Very negative contribution Specific comments …
	n) Implementation of measures relating to illegal, unregulated and unreported (IUU) fishing	Likert scale, with comments	(1) Very significant contribution (2) Significant contribution; (3) No contribution; (4) Negative contribution; (5) Very negative contribution Specific comments …

	o) Use of fisheries observers in vessels engaged in bottom fishing	Likert scale, with comments	(1) Very significant contribution (2) Significant contribution; (3) No contribution; (4) Negative contribution; (5) Very negative contribution Specific comments …

Efficiency in applying Regulation 734/2008

11	Please indicate how satisfied you are with the following elements of Regulation 734/2008?		
	a) Timeliness for reporting (dates, supporting material etc)	Likert scale, with comments	(1) very satisfied, (2) satisfied, (3) neutral, (4) unsatisfied, (5) very unsatisfied, (6) do not know/not applicable Specific comments …
	b) Appropriateness of compliance and enforcement	Likert scale, with comments	(1) very satisfied, (2) satisfied, (3) neutral, (4) unsatisfied, (5) very unsatisfied, (6) do not know/not applicable
	c) Appropriateness of the administrative burden to apply the regulation	Likert scale, with comments	(1) very satisfied, (2) satisfied, (3) neutral, (4) unsatisfied, (5) very unsatisfied, (6) do not know/not applicable

Relevance of Regulation 734/2008

12	How relevant is Regulation 734/2008 to protect VMEs from the adverse impacts of bottom fishing gear, for the following aspects?		
	a) Conducting assessments of whether bottom fishing activities have SAIs on VMEs	Likert scale, with comments	(1) Essential; (2) Very useful; (3) Of some use; (4) Not necessary; (5) No opinion Specific comments …
	b) Ensuring that if bottom fishing activities have SAIs, they are managed to prevent such impacts	Likert scale, with comments	(1) Essential; (2) Very useful; (3) Of some use; (4) Not necessary; (5) No opinion Specific comments …

	c)	Establishing and implementing protocols to cease fishing where an encounter with VMEs occurs during bottom fishing activities, and reporting such encounters so that appropriate measures can be adopted with respect to that site	Likert scale, with comments	(1) Essential; (2) Very useful; (3) Of some use; (4) Not necessary; (5) No opinion Specific comments …
	d)	Implementing measures in accordance with the precautionary approach, ecosystems approaches and international law, and to sustainably manage deep-sea fish stocks	Likert scale, with comments	(1) Essential; (2) Very useful; (3) Of some use; (4) Not necessary; (5) No opinion Specific comments …

Coherence of Regulation 734/2008 with other interventions

13	How coherent are measures for the protection of VMEs under Regulation 734/2008 with those of the following interventions?				
	a) Measures by the best performing RFMOs (NEAFC, NAFO)				
		i.	VME data collection	Likert scale, with comments	(1) Completely complementary; (2) Complementary but could be better coordinated; (3) Overlapping; (4) Contradictory; (5) Unrelated; (6) No opinion Specific comments …
		ii.	Exploratory fishing protocol	Likert scale, with comments	(1) Completely complementary; (2) Complementary but could be better coordinated; (3) Overlapping; (4) Contradictory; (5) Unrelated; (6) No opinion Specific comments …
		iii.	Encounter protocols and move-on rules	Likert scale, with comments	(1) Completely complementary; (2) Complementary but could be better coordinated; (3) Overlapping; (4) Contradictory; (5) Unrelated; (6) No opinion Specific comments …
		iv.	VME thresholds	Likert scale, with comments	(1) Completely complementary; (2) Complementary but could be better coordinated; (3) Overlapping; (4) Contradictory; (5) Unrelated; (6) No opinion

				Specific comments …
		v. Area closures	Likert scale, with comments	(1) Completely complementary; (2) Complementary but could be better coordinated; (3) Overlapping; (4) Contradictory; (5) Unrelated; (6) No opinion Specific comments …
		vi. Identification and freezing of fishing footprint	Likert scale, with comments	(1) Completely complementary; (2) Complementary but could be better coordinated; (3) Overlapping; (4) Contradictory; (5) Unrelated; (6) No opinion Specific comments …
		vii. Definition of key concepts	Likert scale, with comments	(1) Completely complementary; (2) Complementary but could be better coordinated; (3) Overlapping; (4) Contradictory; (5) Unrelated; (6) No opinion Specific comments …
	b) Measures under Chapter 4 of the Sustainable Management of External Fishing Fleets (SMEFF)			
		i. Issuance of fishing authorisations in accordance with scientific evaluation, demonstrating the sustainability of the planned fishing operations	Likert scale, with comments	(1) Completely complementary; (2) Complementary but could be better coordinated; (3) Overlapping; (4) Contradictory; (5) Unrelated; (6) No opinion Specific comments …
		ii. Issuance of fishing authorisations as part of a research programme, including a scheme for data collection, organised by a scientific body	Likert scale, with comments	(1) Completely complementary; (2) Complementary but could be better coordinated; (3) Overlapping; (4) Contradictory; (5) Unrelated; (6) No opinion Specific comments …

EU added value of Regulation 734/2008

14	In your opinion, what are the most likely consequences of stopping applying Regulation 734/2008?	Open	
15	In your opinion what needs improving/updating under Regulation 734/2008?	Open	
16	What would you do to improve the effectiveness and applicability of Regulation 734/2008?	Open	
17	Is there anything else you would like to say/share about Regulation 734/2008?	Open	

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