ICES Workshop to evaluate long-term biodiversity/ecosystem benefits of NEAFC closed and restricted areas (WKECOVME)

Abril, Catarina; Bastardie, Francois; Campbell, Neil; Colaço, Ana; Diz, Daniela; Fock, Heino; Grady, Laura; Kenchington, Ellen; Kenny, Andrew; Klein, Emily

Total number of authors:
16

Link to article, DOI:
10.17895/ ices.pub.24198771

Publication date:
2023

Document Version
Publisher's PDF, also known as Version of record

Citation (APA):
Abril, C., Bastardie, F., Campbell, N., Colaço, A., Diz, D., Fock, H., Grady, L., Kenchington, E., Kenny, A., Klein, E., Kirkegaard, E., Ingólfsson, Ó. A., Langton, R., Matear, L., Szynaka, M., & Valanko, S. (2023). *ICES Workshop to evaluate long-term biodiversity/ecosystem benefits of NEAFC closed and restricted areas (WKECOVME)*. International Council for the Exploration of the Sea (ICES). ICES Scientific Report Vol. 5 No. 89 https://doi.org/10.17895/ ices.pub.24198771

ICES WORKSHOP TO EVALUATE LONG-TERM BIODIVERSITY/ECOSYSTEM BENEFITS OF NEAFC CLOSED AND RESTRICTED AREAS (WKECOVME)

VOLUME 5 | ISSUE 89

ICES SCIENTIFIC REPORTS

RAPPORTS
SCIENTIFIQUES DU CIEM

ICES INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
CIEM CONSEIL INTERNATIONAL POUR L'EXPLORATION DE LA MER

International Council for the Exploration of the Sea
Conseil International pour l’Exploration de la Mer

H.C. Andersens Boulevard 44-46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

ISSN number: 2618-1371

ICES Scientific Reports

Volume 5 | Issue 89

ICES WORKSHOP TO EVALUATE LONG-TERM BIODIVERSITY/ECOSYSTEM BENEFITS OF NEAFC CLOSED AND RESTRICTED AREAS (WKECOVME)

Recommended format for purpose of citation:

ICES. 2023. ICES Workshop to evaluate long-term biodiversity/ecosystem benefits of NEAFC closed and restricted areas (WKECOVME). ICES Scientific Reports. 5:89. 88pp. https://doi.org/10.17895/ices.pub.24198771

Editors

Eskild Kirkegård

Authors

Catarina Abril • Francois Bastardie • Neil Campbell • Ana Colaço • Daniela Diz • Heino Fock
Laura Grady • Ellen Kenchington • Andrew Kenny • Emily Klein • Eskild Kirkegård
Olafur Arnar Ingolfsson • Rebecca Langton • Liam Matear • Monika Szynaka • Sebastian Valanko

International Council for
the Exploration of the Sea
Conseil International pour
l'Exploration de la Mer

Contents

i Executive summary

The workshop to evaluate long-term biodiversity/ecosystem benefits of NEAFC closed and restricted areas (WKECOVME) was formed as part of the formal ICES advisory process in response to requests from the North-East Atlantic Fisheries Commission (NEAFC) for advice on Other Effective Area-Based Conservation Measures (OECMs) in relation to long-term biodiversity/ecosystem benefits of NEAFC's areas restricted to bottom fishing, and VME closed areas and on the potential maximum depths of bottom fishing. With the aim of establishing a scientific basis for providing the advice the Workshop was requested: to evaluate the biodiversity of the areas concerned, to evaluate threats affecting or expected to affect the biodiversity attributes; to evaluate the NEAFC management measures as to whether they achieve, or are expected to achieve, positive and sustained outcomes for the in situ conservation of biodiversity; and to provide a commentary on current and potential maximum depth on the use of bottom-contacting fishing gears in the NEAFC regulatory area.

WKECOVME compiled information on biodiversity attributes present in the areas restricted to bottom fishing and in the VME closed areas and established a comprehensive list of biodiversity attributes by area. Only benthic and demersal attributes were consistently considered, given the focus on bottom-contact fishing in the NEAFC request. In defining biodiversity attributes WKECOVME used examples provided by Convention on Biological Diversity (CBD) it the guidance on OECMs (CBD/COP/DEC/14/8).

WKECOVME compiled information on pressures and threats in the NEAFC regulatory area and evaluated how they affect or potentially can affect the biodiversity attributes in the area.

As a guidance to evaluate the NEAFC management measures for the VME closures and the restricted bottom fishing areas as to whether they achieve, or are expected to achieve, positive and sustained outcomes for the in situ conservation of biodiversity, WKECOVME used the relevant criterion provide by CBD in its OECM guidance.

The information on the current and potential maximum fishing depth with bottom-contacting gears in the NEAFC Regulatory Area presented in this report is based on analyses of the bottom fishing footprint and on information on the depth distribution of deep-sea fish species.

ii Expert group information

Expert group name	Workshop to evaluate long-term biodiversity/ecosystem benefits of NEAFC closed and restricted areas (WKECOVME)
Expert group cycle	Annual
Year cycle started	2023
Reporting year in cycle	1/1
Chair(s)	Eskilde Kirkegård, Denmark
Meeting venue(s) and dates	7-11 August, ICES HQ, Copenhagen, Denmark (16 participants)

1 Evaluation of the biodiversity attributes of the areas concerned

1.1 Definitions

Benthic-pelagic coupling is manifested as the exchange of energy, mass, or nutrients between benthic and pelagic habitats (Griffiths et al. 2017).

Biodiversity is defined by the CBD as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (CBD 1992).

Biodiversity attributes are not defined by the CBD but Criterion C: Achieves sustained and effective contribution to *in situ* conservation of biodiversity (CBD/COP/DEC/14/8 Annex II B) states "Recognition of other effective area-based conservation measures is expected to include the identification of the range of biodiversity attributes for which the site is considered important (e.g. communities of rare, threatened or endangered species, representative natural ecosystems, range restricted species, key biodiversity areas, areas providing critical ecosystem functions and services, areas for ecological connectivity).".

Communities of rare, threatened or endangered species has been defined in the context of EBSAs (CBD 2009) as "areas contain either (i) unique "the only one of its kind", rare (occurs only in few locations) or endemic species, populations or communities, and/or (ii) unique, rare or distinct, habitats or ecosystems; and/or (iii) unique or unusual geomorphological or oceanographic features (Gollner et al. 2021).

Ecological connectivity has been defined as the "unimpeded movement of species and the flow of natural processes that sustain life on earth" (Convention on the Conservation of Migratory Species of Wild Animals 1979).

Ecologically or Biologically Significant Areas (EBSA). EBSAs are special areas in the ocean that serve important purposes, in one way or another, to support the healthy functioning of oceans and the many services that it provides. In Decision IX/20, the Conference of the Parties to the CBD adopted the scientific criteria for identifying ecologically or biologically significant marine areas in need of protection in open-ocean waters and deep-sea habitats.

Range restricted species has been interpreted by WKECOVME to mean "Endemic – native and restricted to a defined region or area" (Gibson et al. 2008).

Vulnerable marine ecosystems (VMEs). A VME is described in the FAO Deep-sea Fisheries Guidelines by its characteristics and by its vulnerability (FAO 2009). Vulnerability is dependent upon the nature of the fishery and hence region dependent.

2 Evaluation of the Biodiversity Attributes of the Areas Concerned

2.1 Biodiversity Attributes

The CBD in its guidance on Other Effective Conservation Measures (OECMs) provides examples of biodiversity attributes under Criterion C: Achieves sustained and effective contribution to in situ conservation of biodiversity (CBD/COP/DEC/14/8 Annex II B). Recognition of other effective area-based conservation measures is expected to include the identification of the range of biodiversity attributes for which the site is considered important. Six examples are listed:

1. communities of rare, threatened or endangered species,
2. representative natural ecosystems,
3. range restricted species,
4. key biodiversity areas,
5. areas providing critical ecosystem functions and services,
6. areas for ecological connectivity.

WKECOVME proceeded to collate information on those biodiversity attributes in NEAFC's 1) areas restricted to bottom fishing, and 2) closed areas according to the NEAFC Recommendation 19 : 2014 on area management measures for the protection of vulnerable marine ecosystems in the NEAFC Regulatory Area. The locations of these areas are found on the NEAFC website (https://www.neafc.org/managing_fisheries/measures/ra_map) which shows the three areas restricted to bottom fishing (NEAFC RA 1 (XRR Reykjanes Ridge), NEFAC RA 2 (XNS/Banana Hole), NEAFC RA3 (XBS/Loophole)) and other area closures. Closed areas according to the VME Recommendation (19:2014) include 5 Mid-Atlantic VME Closures (midMAR, southernMAR, northernMAR, Antialtair Seamount, Altair Seamount). There are also 14 VME closures associated with the Hatton Rockall Closures, excluding the Rockall Haddock Box which is considered separately for its transboundary position between national waters and the high seas, and which is targeted at managing impacts of fisheries on juvenile haddock. In addition, there is another closed area (Irminger Sea Redfish Closure) which was not part of the areas closed to protect VME but overlaps with RA1 and contains biodiversity attributes. Consequently, we have included that area in this summary. The codes used to distinguish those areas in the descriptions of the location of the biodiversity attributes discussed below, are provided in Table 2.1.

Only benthic and demersal attributes were consistently considered under Biological Attributes, given that the focus was on bottom-contact fishing (ToR 1.a.ii, iii). Marine mammals and birds are featured primarily in Section 2.1.2 on "communities of rare, threatened or endangered species" where listed species are considered. Some of these species are deep-diving where they can interact with fishing gear, while others are vulnerable to ship strikes at the surface. For example, mutiple species including whales, seals and dolphins forage in deep waters (Rogan et al. 2017). In the Azores archipelago, sperm whales forage mainly between 700 and 1200 m depth (Oliveira 2014). Devil rays which are considered surface dwellers, are capable of descending at speeds up to 6.0 m s^{-1} to depths of almost 2,000 m and water temperatures <4 °C (Thorrold et al. 2014). The shape of the dive profiles suggests that the rays are foraging at these depths in deep scattering layers. ICES (2023) has recently held a Workshop on seabird Bycactch monitoring in the NEAFC Regulatory Area (WKBB) in response to a special request for advice from NEAFC on seabird bycatch in the NEAFC Regulatory Area. WKBB mapped high risk areas for 20 seabird species susceptible to bycatch mortality. Consequently, marine mammals and birds have been included where they are a prominent documented attribute for the area.

Table 2.1. Number codes used in this text with their corresponding closure name following the terminology used by NEAFC (https://www.neafc.org/managing_fisheries/measures/ra_map). *The 'Other Seamounts' category (Code 5) was added to assist the workflow of defining biodiversity attributes (Sections 2.2-2.7).

Number Code (Location)	Closure Category Name following NEAFC
1	**Mid Atlantic VME Closures**
1a	Mid-MAR
1b	Southern MAR
1c	Northern MAR
1d	Antialtair Seamount
1e	Altair Seamount
2	Rockall Haddock Box
3	Hatton Rockall Closures
3a	m hatton bank 2 area 2
3b	m hatton bank 1
3c	l hatton-rockall basin area 1
3d	Hatton Rockall Basin (l) Area 2
3e	Area (k) South West Rockall Bank 2
3f	Area (k) Southwest Rockall Bank 1
3g	Edora Bank Closure
3h	Area (i) West Rockall Mounds
3i	Area (h) Logachev Mounds
3j	Rockall Bank: Area (g) South-West Rockall Area 3
3k	Rockall Bank: Area (g) South-West Rockall Area 2
3l	sw_rockall1_v2
3m	Rockall Bank; Area (g) North West Rockall
3n	area f hattonbank 1
4	Irminger Sea Redfish Closure
5*	Other Seamounts*
6	Restricted Areas (RAs)
6a	NEAFC RA 1 (XRR Reykjanes Ridge)
6b	NEAFC RA 2, Norwegian Sea (XNS/ Banana Hole)
6c	NEAFC RA 3 Barents Sea (XBS, Loophole)

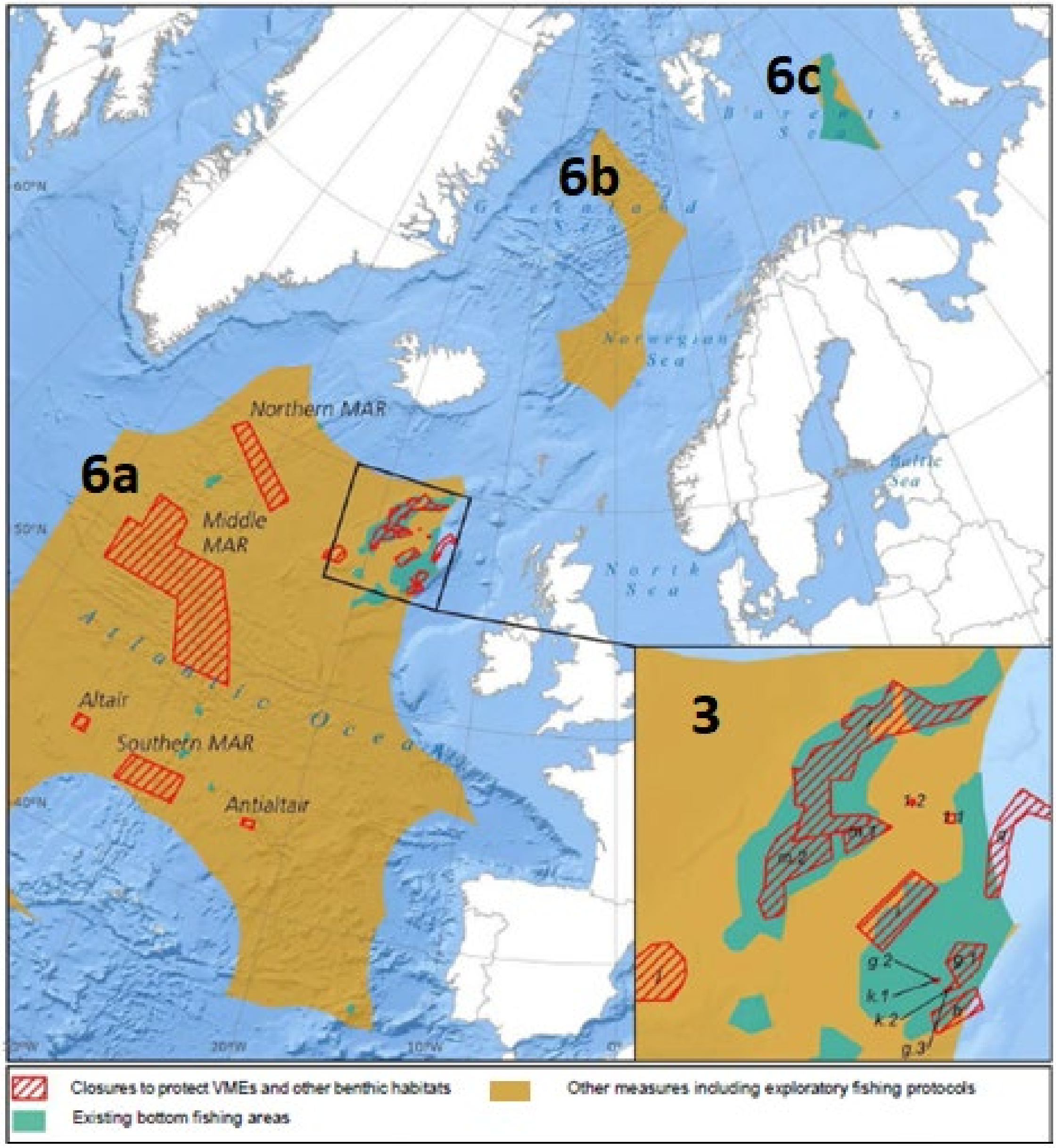


Figure 2.1. Map of the locations identified as in Table 2.1 showing the location of the three Restricted Areas (Codes 6a, 6b, 6c) and a close-up of the Hatton Rockall Closures (Code 3) and the Mid Atlantic VME Closures (Code 1 shown on the map in red and named directly). Existing bottom fishing areas are shown in green. Bottom fishing closures for VMEs protection are shown in red. The restricted bottom fishing areas are the parts of NEAFC RA not identified as VME closures or bottom fishing areas (greyscale). The Rockall Haddock Box and the Irminger Sea Redfish Closure (Table 2.1) can be viewed at the NEAFC website (https://www.neafc.org/managing_fisheries/measures/ra_map).

2.1.1 Data Sources

The list of biodiversity attributes share similarities with the criteria used by the CBD to identify EBSAs (CBD/COP/DEC/IX/20), and all of the CBD biodiversity attributes are represented by the EBSA criteria (Fig. 2.2). Additionally, the CBD EBSA criteria include "Vulnerability, fragility, sensitivity or slow recovery" which are not directly linked to the biodiversity attributes but may factor in to where a community has rare, threatened or endangered species if that status relates to a recovery response from a pressure (Section 2.1.2). The FAO VME criteria (FAO 2009) have strong linkages to the biodiversity attributes of 'key biodiversity areas' and 'areas providing critical ecosystem functions and services' but have no links to the 'representative natural ecosystems' biodiversity attribute (Fig. 2.2). Further, the FAO VME criteria 'fragility' and 'life-history traits that make recovery difficult' are not directly linked to the biodiversity attributes but, as for the EBSA criteria, may factor in to whether a community has rare, threatened or endangered species. Additionally, the definition of a VME links vulnerability to the nature of the fishery and whether significant adverse impacts of fishing have occurred. The link to the damage caused by bottom contact fishing is an explicit component of the VME definition (FAO 2009).

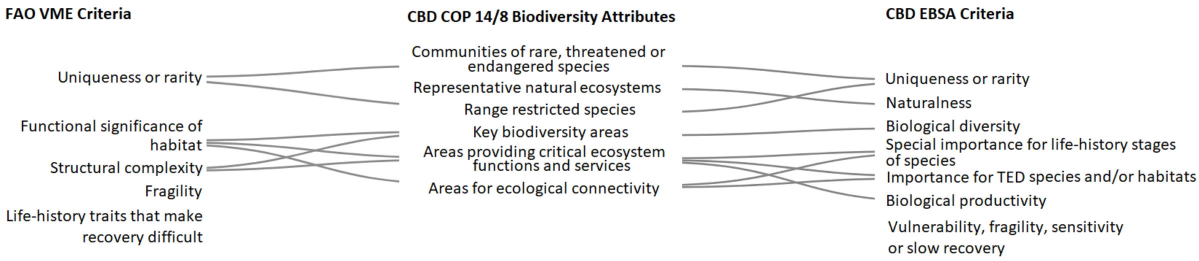


Figure 2.2. Comparison of the criteria used for VME (FAO 2009) and CBD EBSA (CBD/COP/DEC/IX/20) identification with those provided as CBD Biodiversity Attributes for OECM descriptions of in situ conservation of biodiversity (Criterion C). TED=Threatened, Endangered and Declining.

Given the similarities between the biodiversity attributes and the EBSA and VME criteria (Fig. 2.2), WKECOVME reviewed the documentation for the five EBSAs located in the region (CBD/COP/15/L.13; CBD Secretariat 2023a-e), and the ICES advice to NEAFC on VMEs, utilizing the ICES VME Database (https://www.ices.dk/data/data-portals/Pages/vulnerable-marine-ecosystems.aspx). ICES Ecosystem Overviews were also consulted, in particular that of the Oceanic Northeast Atlantic, which covers most of Restricted Area 1 (https://www.ices.dk/advice/ESD/Pages/Oceanic_Northeast_Atlantic.aspx?diagramid=49). The IUCN Red List of Threatened Species (https://www.iucnredlist.org/) was consulted for listed species, while OSPAR documentation (e.g., OSPAR Status Assessments) was also reviewed. In addition, the published scientific literature was consulted independently of citations within the above documents. All of these sources have previously been peer-reviewed and in some cases formed part of previous ICES Advice.

Another development in international conservation is the concept of Key Biodiversity Areas (KBAs) (https://www.keybiodiversityareas.org/about-kbas) developed through the IUCN. Key Biodiversity Areas are sites "of global importance to the planet's overall health and the persistence of biodiversity". Areas are selected using a set of criteria (https://portals.iucn.org/library/node/49979) to provide consistent, scientifically rigorous yet practical methods. The criteria require knowledge of the abundance and distribution of the species in the region relative to global numbers – data which are not available for most of the deep-sea taxa in this report. Three KBAs are listed in the NEAFC area and all three have been identified for the protection of sea birds using tracking data. Where appropriate WKECOVME makes mention of them in our summaries.

WKECOVME recognizes that the attributes identified herein provide a non-exhaustive list of attributes present in each of the NEAFC areas. Additional support for these attributes is likely to be found in the scientific literature, however, by drawing primarily on the products of other expert groups we feel that we have identified the most important attributes for each area.

2.1.2 Communities of rare, threatened or endangered species

Despite the North Atlantic probably being the best studied ocean basin for deep-water benthic invertebrates, data on the distribution of many organisms are still scarce. This lack of information may result from a combination of: i) the absence of sampling in most deep-sea areas because of high costs and technological challenges; ii) difficulties with identification of the species sampled or in collections; or iii) they may simply be naturally rare across their distribution range (Weaver et al. 2019). The WKECOVME collated information on this biodiversity attribute in Table 2.2.

Table 2.2. Details of the evidence base for the presence of the biodiversity attribute "Communities of rare, threatened or endangered species" with reference to their location following the codes in Table 2.1.

Description	Location(s)
The Hatton and Rockall Banks, as well as their associated slopes and connecting basin, represent unique offshore pelagic and bathyal habitats from the surface to 3000m deep that collectively constitute a unique and prominent feature of the northeast Atlantic. In addition, it comprises an area of polygonal faults that may be a unique seabed feature and the recent discovery of cold-seep species that are new to science suggests the area is very likely to be biolofically and ecologically unique (Jacobs 2006; Jacobs & Howell 2007; Berndt et al 2012; Oliver & Drewery 2014; Neat et al. 2019). The banks encompass a large depth range with strong environmental gradients (e.g., temperature, pressure, and food availability) that give rise to a high diversity of species and habitats (Billett 1991; Bett 2001; Howell et al. 2002; Davies et al. 2006; Roberts et al. 2008; Howell et al. 2010). The seabed communities captured within the area include cold-water coral formations, sponge aggregations and potential seep communities (Oliver & Drewery 2014; Neat et al. 2019) and observations in the early 1970s found cold-water coral communities occurring on the Rockall Bank down to a depth of 1,000 m (Wilson 1979). Thickets of *Lophelia pertusa* occurred principally at depths between 150-400m. Large coral growth features have recently (2011) been discovered to be present on the northern Rockall Bank (Howell et al. 2009; Huvenne et al. 2011, Roberts et al. 2013). Frederiksen et al. (1992) reported a high diversity of corals on the northern Hatton Bank, including *Paragorgia*, *Paramuricea* (IUCN Red List genus), Isididae (IUCN Red List family) and Antipatharia as well as the scleractinians *L. pertusa* and *M. oculata*. Since these observations further records of coral gardens and coral frameworks have been noted throughout the Rockall and Hatton area, including the Logachev Mounds and the Western Rockall Bank Mounds (Kenyon et al. 2003; Roberts et al. 2003; Narayanaswamy et al. 2006; Howell et al. 2007; Durán Muñoz et al. 2009; Piechaud et al. 2015). Scleractinian cold-water coral frameworks have been reported to support over 1,300 species in the Northeast Atlantic, some of which have yet to be described (Roberts et al. 2006). New species and associations have been reported recently (e.g., Myers & Hall-Spencer 2007; Le Guilloux et al. 2010; Söffker et al. 2011) and a great variety of large invertebrate fauna (megafauna) occur in this region including giant protozoans (xenophyophores), vase shaped white sponges, actiniarians, antipatharian corals, hydroids, bryozoans, asteroids, ophiuroids, echinoids, holothurians and crustaceans (Narayanaswamy et al. 2006; Howell et al. 2007; Roberts et al. 2008). Large mega-infauna such as echiuran worms are evident from observations of their feeding traces. Little is known, however, of the smaller fauna living within the sediment. Deep-sea sponge aggregations are present in the Hatton-Rockall Basin and these are defined as OSPAR "Threatened and Declining Species and Habitats". In addition, the flanks of the gullies appear to support extensive, dense aggregations of mixed species sponge communities, including *Pheronema carpenteri* aggregations (Howell et al. 2016). Many of the above mentioned species form habitat complexes which are recognised and identified as Vulnerable Marine Ecosystems under the FAO's guidelines for the management of deep-sea fisheries (FAO 2009). Species identified by the Workshop on sea Bird Bycatch monitoring in the NEAFC Regulatory Area (WKBB) (ICES 2023) as interacting with fishing gear through bycatch records include two IUCN Vulnerable species (V) [Atlantic puffin (*Fratercula arctica*), black-legged kittiwake (*Rissa tridactyla*)], 6 species of Least Concern (LC) [Northern Fulmar (*Fulmarus*	3 (Hatton Rockall Closures), 2 (in part) (Rockall Haddock Box)

Description	**Location(s)**
glacialis), common guillemot (*Uria aalge*), little auk (*Alle alle*), northern gannet (*Morus bassanus*), thick-billed murre (*Uria lomvia*), great skua (*Catharacta skua*)].	
The hydrothermal vent fields of the MAR play a pivotal role in sustaining abundant populations of deepsea species through the chemosynthetic primary production (Van Dover et al. 2002). Information about the Moytirra vent is relatively scarce. This is the first known deep-sea hydrothermal vent field on the slow-spreading Mid-Atlantic Ridge north of the Azores, and as a result has only been subject to a few studies, most of which describe its genesis and geological data, but provide little biological information (Wheeler et al. 2013). The area comprises hydrothermal vent fields and seamounts that are very distinct in terms of biology and geology, showing different compositions, locations and ages. Wheeler described the Moytirra vent field (named after the Irish mythological “plain of the pillars”) in 2013. This vent is the only fully described high temperature hydrothermal vent known between the Azores and Iceland, making it a unique geophysical structure in the high seas of the North Atlantic and within the MAR. Unique communities are formed around vents, attracting unusual creatures such as red-plumed giant tube worms and massive clams, which cluster around the dark chimneys where vent fluids emerge. Deep-sea hydrothermal vents along the neo-volcanic zones of mid- ocean ridges and back-arc spreading centers in all the oceans are extraordinary oases of vibrant and exotic life based on chemosynthesis rather than photosynthesis (VanDover et al. 2018) These ecosystems are small in nature (tiny islands in the vast expanse of the deep sea) with ecological importance disproportionate to their size (Hunter et al. 2017). They are often associated with hydrothermally active polymetallic sulfides (PMS) and are recognized as rare and vulnerable, with intrinsic value (VanDo-ver et al. 2018). Biomass at active vents is dominated by species that rely on venting fluids and that can live nowhere else. Vent organisms are exquisitely sensitive to nuances in fluid flux, chemical composition of vent fluids, and temperature, to the geological setting, and to biological interactions. Species assemblages may differ markedly from one vent site to the next in the same region because habitat conditions are also markedly different (Van Dover et al. 2018 and references there in). Differences among, for example, north Atlantic sites are recorded in dominant species on sulfide chimneys, at chimney bases, and in dominant accompanying species, dominant peripheral species, and dominant carnivorous species. Important dissimilarities among the faunas of adjacent vent sites are thus viewed as the norm, not the exception (Desbruyeres et al. 2001).While vent ecosystems are visually dominated by a few abundant species, many taxa at vents appear to be rare (comprising < 5% of the total abundance in samples), and some are known from only one or a few collected specimens, even where sampling efforts have been extensive (Collins et al. 2012). Species identified by the Workshop on sea Bird Bycatch monitoring in the NEAFC Regulatory Area (WKBB) (ICES 2023) as interacting with fishing gear through bycatch records include two IUCN Vulnerable species (V) [Atlantic puffin (*Fratercula arctica*), black-legged kittiwake (*Rissa tridactyla*)], 15 species of Least Concern (LC) [Northern Fulmar (*Fulmarus glacialis*), common guillemot (*Uria aalge*), little auk (*Alle alle*), northern gannet (*Morus bassanus*), thick-billed murre (*Uria lomvia*), great skua (*Catharacta skua*), razorbill (*Alca torda*), Cory’s shearwater (*Calonectris borealis*), Scopoli’s shearwater (*Calonectris diomedea*), Audubon’s shearwater (*Puffinus lherminieri*), great shearwater (*Ardenna gravis*), Manx shearwater (*Puffinus puffinus*), long-tailed jaeger (*Stercorarius longicaudus*), sooty shearwater (Ardenna grisea), pomarine jaeger (Stercorarius pomarinus)].	6a (NEAFC RA 1 XRR Reykjanes Ridge)
Studies that demonstrated the ecological and biological importance of the seamounts in the NE Atlantic have been conducted by Santos et al. (2008). Turtle biotelemetry studies suggest that the turtles exhibit different movement behaviours near seamounts, remaining in these places for prolonged periods. This provides further evidence that these topographic features can be hotspots for adult and juvenile loggerheads (IUCN Red List species). The seamounts are also an important area for birds; for example, Cory’s shearwater (*Calonectris borealis*, an IUCN red list species) breeds in the Azores and has been shown to forage over the region of the MAR (Magalhães et al. 2008). This species performs a dual-foraging strategy that combines short and long foraging trips. Most short trips have been found to be confined to the MAR just north of the Azores (within about 300 km) (Magalhães et al. 2008; Xavier et al. 2011). The Evlanov Seamount and Basin is listed as a KBA for the Cory’s shearwater (Key Biodiversity Areas Partnership 2023a). Two other	5 (Other Seamounts)

Description	**Location(s)**
KBAs are identified in this region: Northeast Atlantic 2 (Key Biodiversity Areas Partnership 2023b) and Northeast Atlantic 3, both for the Zino's petrel, *Pterodroma madeira* (Key Biodiversity Areas Partnership 2023c) which is listed as NT (near threatened) on the IUCN Red List. Around 6 % of the 536 species identified in all seamounts in this area are legally protected or recognized as threatened by CITES, IUCN Red List, European Union Habitats and Birds Directives, VMEs, Bern Convention or OSPAR Convention. In this area OSPAR identified, as threatened or declining, the deepwater sharks *Centroscymus coeleopsis*, *Centrophorus squamosus* and *Dipturus batis*, the commercial fish *Hoplostethus atlanticus* and the two species of corals *Lophelia pertusa* and *Madrepora oculata*. Other examples of species with legal protection (CITES Appendix I) are the cetaceans *Balaenoptera borealis*, *Balaenoptera musculus*, *Balaenoptera physalus*, *Megaptera novaeangliae*, *Physeter macrocephalus*, *Tursiops truncatus*, the turtles *Caretta caretta*, *Dermochelys coriacea*, (CITES Appendix II) and the corals *Antipathella subpinnata*, *Aulocyathus atlanticus*, *Caryophyllia ambrosia*, *Desmophyllum dianthus*, *Flabellum alabastrum*, *Flabellum angulare*, *Fungiacyathus fragilis*, *Lophelia pertusa*, *Madrepora oculata*, *Schizopathes affinis*, *Solenosmilia variabilis*, *Stauropathes arctica* and *Stephanocyathus moseleyanus*. The species of whales *Balaenoptera physalus*, *Balaenoptera musculus*, *Balaenoptera borealis*, *Megaptera novaeangliae*, the sperm whale (*Physeter macrocephalus*), the dolphins *Delphinus delphis* and *Tursiops truncatus* and the sea urchin *Centrostephanus longispinus* are protected by the EU Habitats Directive. The whales *Balaenoptera physalus*, *Balaenoptera musculus*, *Balaenoptera borealis*, *Megaptera novaeangliae*, the sperm whale *Physeter macrocephalus* and the turtles *Caretta caretta* and *Dermochelys coriacea* are protected by Annex II of the Bern Convention. Also present are 11 species listed on the IUCN Red List as near threatened/ vulnerable/endangered/critically endangered (*Balaenoptera physalus, Balaenoptera musculus, Balaenoptera borealis, Caretta caretta, Dermochelys coriacea, Dipturus batis, Hippoglossus hippoglossus, Physeter macrocephalus, Prionace glauca, Thunnus albacares, Thunnus thynnus*). There are also two species of birds (*Calonectris borealis* and *Sterna dougallii*) belonging to the Birds Directive Annex I. The species studied in the area belong to several phyla, classes or orders. The area includes various species of scleractinians and gorgonians. In some seamounts the gorgonian and sponge species were reported to form dense gorgonian coral habitat-forming aggregations which may represent important feeding and sheltering grounds for seamount fishes as well as potential shark nurseries (WWF 2001; Etnoyer & Warrenchuk 2007; OSPAR 2011). Coldwater, deep, habitat-forming corals can shelter higher megafauna in association with the corals (Roberts et al. 2006; Mortensen et al. 2008, Rogers et al. 2008). Seamounts also harbour large aggregations of demersal or benthopelagic fish (Koslow 1997; Morato & Pauly 2004; Pitcher et al. 2007; Morato et al. 2009, 2010).	
In addition to the characteristics of seamounts noted above (Location 5), the Altair seamount the benthic epifaunal community is dominated in most places by sessile megabenthos, chiefly anemones and true corals (Hexacorallia) and sponges. The diversity of corals and sponges is particularly high in the saddle and gully areas (Henry et al. 2014).	1e (Altair Seamount)
There is evidence for the presence of several species/habitats that are considered to be 'Threatened and/or Declining' by OSPAR. These include: Orange roughy (*Hoplostethus atlanticus*, an IUCN Red List species), deep-sea sponge aggregations (Alt et al. 2019), *Lophelia pertusa* reefs (Mortensen et al. 2008) and seamount communities, although more specific data is needed for the Fracture Zone proper. The area is also very important for combined aggregations of seabirds (Boertmann 2011). The ecosystem associated with the MAR seems to be of particular importance to sei (*Balaenoptera borealis*) and sperm whales (*Physeter macrocephalus*), both IUCN Red List species. The highest aggregations of baleen whales and especially sei whales were observed north of and in relation to the CGFZ, which overlaps with earlier observations of Sigurjónsson et al. (1991) (in Skov et al. 1994). *Balaenoptera borealis* in particular was most abundant over the slopes of steep seamounts and water depths between 1500 and 3000 m, whereas *P. macrocephalus* were most common in waters shallower than 2000 m and often seen above high rising seamounts where they presumably found the best feeding conditions, i.e. the highest squid density. Tracking studies of sei, fin and blue whale have described the migration of these species through the area from the Azores to foraging areas in the Labrador Sea as well as Greenlandic and Icelandic waters (Olsen et al. 2009, Silva et al. 2013; Prieto et al. 2014). Furthermore, fin and blue whales remained at	1 (Mid Atlantic VME Closures) including in part 4 (Irminger Sea Redfish Closure)

Description	Location(s)
mid-latitudes along their migration in the area for prolonged periods in the areas of the CGFZ and Reykjanes Ridge, exhibiting area-restricted search (ARS) behaviour, indicative of foraging activity. The MAR-ECO cruise provided a snapshot of seabird distribution along the MAR in summer 2004: 22 species of seabirds were identified, however only the northern fulmar (*Fulmarus glacialis*), great shearwater (*Puffinus gravis*) and Cory´s shearwater (*Calonectris diomedea*) were observed by the hundreds. The distribution of these species reflects the broad characters of water masses in the area (from Mar-Eco cruise report, Nøttestad et al. 2004) and in particular the boundary effect of the frontal zone and the limited nesting sites available only on the Azores and Iceland (Skov et al. 1994). *F. glacialis* were distributed along most of the study transect north of 47° N, and they were by far the most common species of seabird along the central and northern parts of the MAR. Densities were generally below 1 bird per km^2, and no large-scale concentrations were noted. However, discrete elevations in densities were recorded both in the Reykjanes and the CGFZ regions. *P. gravis* were observed only in the vicinity of the Subpolar front just north of the CGFZ. From a relatively low number of trawls during the MAR-ECO Project, fifteen new species were described, including new glass sponges, sea cucumbers, brittlestars, and one new sea star (Gebruk et al. 2010). The sessile megafauna associated with hard non-hydrothermal substrata along the MAR which have been the most studied are cold-water corals and sponges. These organisms are typically long-lived, slow-growing, and have low reproductive inputs, and as such many species are Vulnerable Marine Ecosystem (VME) indicator taxa (ICES 2016, 2019b). Studies of the ‘mushroom corals’ from genera *Anthomastus*, *Heteroplypus* and *Pseudoanthomastus* collected for the MAR North of the Azores and the Reykjanes Ridge identified five species, three of which were described as new species: *Heteropolypus sol, Anthomastus gyratus*, and *Pseudoanthomastus mariejosea* (Molodtsova 2013). Only one of the five species, *A. gyratus*, appeared to have a distribution limited to the MAR and Reykjanes Ridge, the other four species had wider distributions including a combination of the east Atlantic, west Atlantic, and the Azores regions (Molodtsova 2013). One species of black coral, *Heteropathes opreski*, collected from within the Russian Exploration Area is so far only known to occur along the MAR between 34°46.7′ N and 13°19.43′ N at depths 1955–2738 m, and is considered to be potentially endemic to this region (Matos et al. 2014; Molodtsova 2016). The Azores region of the MAR also supports species or species associations that are not present elsewhere, such as the occurrence of the ‘living fossil community’ formed by a long-lived deep-sea oyster and a crinoid (Wisshak et al. 2009) and coral reefs formed by the scleractinian coral *Eguchipsammia cf. cornucopia* (Tempera et al. 2015). The majority of deep-sea sponges recorded from the MAR belong to either Hexactinellida (glass sponges) or Demospongiae; one specimen of Calcarea sponge was collected during MAR-ECO but has not yet been described (Cardenas & Rapp 2015). There are few studies on the distribution of either hexactinellid or demosponge sponges along the MAR. Some species of hexactinellids sampled from the MAR are very rare, such as *Doconesthes sessilis*, previously known from a single specimen (Tabachnick & Collins 2008); and some are new to science, such as *Sympagella cooki* and *Sympagella ecomari* (Tabachnick & Menshenina 2013). For Demospongiae, twenty-two species were collected from the northern MAR between the Azores and Iceland during the MAR-ECO project at 753 – 3046 m depth (Cardenas & Rapp 2015). Fourteen of these demosponge species have an amphi-Atlantic distribution, being found on both the eastern and western sides of the Atlantic (Cardenas & Rapp 2015). However, several of the demosponge species collected were rare and poorly known, such as *Craniella longipilis* (previously *Tetilla longipilis*), *Tetilla sandalina, Craniella azorica* and *Polymastia corticata*, whilst two were new to science, *Forcepia (Forcepia) toxafera* and *Iotroata paravaridens*. For new or rarely collected species, it is not clear whether these are truly restricted to the northern MAR, or if under-sampling means they have not yet been encountered elsewhere.	
Sea pens are the most significant VME-related feature of the box and are found notably in the east. One of these sea pen species (*Ptilella grayi*) has only recently been described and is not known from elsewhere (García-Cárdenas et al. 2019). There are also a range of	2 (Rockall Haddock Box)

Description	**Location(s)**
VME indicator species found within the area including sponges, stony corals and gorgonians. There are no fish species unique to the area, but the critically endangered blue skate is recorded regularly from inside the area. The Rockall Haddock Box was part of a wider area proposed as an EBSA in 2019 (CBD Secretariat 2023b).	
The Barents Sea is home to one of the largest concentrations of seabirds in the world. More than 20 million birds, including 40+ species breed in the region at 1600 colonies (including several IUCN Red List species). The most important species numerically include northern fulmars (*Fulmarus glacialis*) common eiders (*Somateria mollissima*), glaucous gulls (*Larus hyperboreus*), black-legged kittiwakes (*Rissa tridactyla*), common guillemot (*Uria aalge*), Brünnich's guillemots (*Uria lomvia*), razorbills (*Alca torda*), black guillemots (*Cepphus grylle*), little auks (*Alle alle*) and Atlantic puffins (*Fratercula arctica*). Most of the seabirds feed on zero group capelin (*Mallotus villosus*), herring (*Clupea harengus*) and polar cod (*Boreogadus saida*) being key-prey species for many seabirds. Specialists such as the little auk target Arctic species of zooplankton, calanoid copepods being their primary prey (ICES 2019c). Species identified by the Workshop on sea Bird Bycatch monitoring in the NEAFC Regulatory Area (WKBB) (ICES 2023) as interacting with fishing gear through bycatch records include two IUCN Vulnerable species (V) [Atlantic puffin (*Fratercula arctica*), black-legged kittiwake (*Rissa tridactyla*)], one Near Threatened (NT) species, the ivory gull (*Pagophila eburnea*), 10 species of Least Concern (LC) [black guillemot (*Cepphus grylle*), sooty shearwater (*Ardenna grisea*), pomarine jaeger (*Stercorarius pomarinus*), Sabine gull (*Xema sabini*), Northern Fulmar (*Fulmarus glacialis*), common guillemot (*Uria aalge*), little auk (*Alle alle*), northern gannet (*Morus bassanus*), thick-billed murre (*Uria lomvia*), great skua (*Catharacta skua*)]. The Barents Sea is also one of the most species rich regions in the Arctic with respect to marine mammals, many of which are IUCN Red List species. Twenty-three species, including all of the Arctic endemic species that inhabit the North Atlantic Arctic, occur regularly in the region. The resident Arctic species (polar bears *Ursus maritimus*, bowhead whales *Balaena mysticetus*, narwhals *Monodon monoceros*, white whales (or belugas) *Delphinapterus leucas*, ringed seals *Pusa hispida*, bearded seals *Erignathus barbatus*, walruses *Odobenus rosmarus*, harp seals *Pagophilus groenlandicus* and hooded seals *Cystophora cristata*) are tightly ice-affiliated, depending on sea ice habitats for breeding, feeding or both. In addition, migratory species include many of the large baleen whales (fin whales *Balaenoptera physalus*, blue whales *Balaenoptera musculus*, humpback whale *Megaptera novaeanglia*, sei whales *Balaenoptera borealis* and minke whales *Balaenoptera acutorostrata*), and several toothed whales also occur throughout most of the Barents Sea (e.g., killer whales *Orcinus orca*, sperm whales - *Physeter macrocephalus*, northern bottlenosed whales - *Hyperoodon ampullatus*, long-finned pilot whale - *Globicephala melas*). Atlantic white-sided dolphins *Lagenorhnychus acutus* are also increasingly common in the southern parts of the Barents Sea (ICES 2019c).	6c (NEAFC RA 3 Barents Sea (XBS, Loophole))
Species identified by the Workshop on sea Bird Bycatch monitoring in the NEAFC Regulatory Area (WKBB) (ICES 2023) as interacting with fishing gear through bycatch records include two IUCN Vulnerable species (V) [Atlantic puffin (*Fratercula arctica*), black-legged kittiwake (*Rissa tridactyla*)], 14 species of Least Concern (LC) [Northern Fulmar (*Fulmarus glacialis*), common guillemot (*Uria aalge*), little auk (*Alle alle*), northern gannet (*Morus bassanus*), thick-billed murre (*Uria lomvia*), great skua (*Catharacta skua*), razorbill (*Alca torda*), Cory's shearwater (*Calonectris borealis*), Scopoli's shearwater (*Calonectris diomedea*), Audubon's shearwater (*Puffinus lherminieri*), great shearwater (*Ardenna gravis*), Manx shearwater (*Puffinus puffinus*), long-tailed jaeger (*Stercorarius longicaudus*), black guillemot (*Cepphus grylle*)]. The Mohn Ridge at 71°N is a prominent feature in the NEAFC RA 2, Norwegian Sea (XNS/ Banana Hole). Mohn's Treasure, described as an inactive sulfide mound, was discovered at 2,600-m depth on the Arctic Mid-Ocean Ridge (AMOR) in 2002, just outside of the NEAFC RA2 (Ramirez-Llodra et al. 2020). To the south, a hydrothermal vent field is located near the Jan Mayen hotspot at a depth of about 550 m. The area has not been fully explored and it is possible that these features are found inside RA2.	6b (NEAFC RA 2, Norwegian Sea (XNS/ Banana Hole))

2.1.3 Representative natural ecosystems

There has been very limited mapping of the seabed in the region, and little direct survey data is available on the benthic ecosystems present (ICES 2019). Therefore the approach taken was to assess the representation of broader biogeographic regions and seabed type, which are likely to influence the benthic ecosystems. In addition, the representation of specific ecosystems for which some mapping has occurred has also been considered. Whether these represent natural ecosystems will depend on current and historic pressures that they have been exposed to. It is difficult to determine state of benthic ecosystems in the region, but it could be assumed that locations deeper than the current limit of demersal fishing activity will be in an undisturbed state (ICES 2019), which WKECOVME equates with 'naturalness'.

Within each biogeographic region, in addition to unique features, there will be features which may be replicated in other biogeographic regions. Within those, there may be another nesting based on the environmental drivers of community organization. Within those, a series of habitats may be found, each with different species composition (Fig. 2.3). The idea of preserving representative natural ecosystems is to ensure that the diversity of species and habitats are protected. Representative ecosystems and habitats may not have the highest species diversity or other attributes identifying them for protection, but their representativeness is a quality that policy-makers have agreed should be protected (CBD/COP/DEC/IX/20).

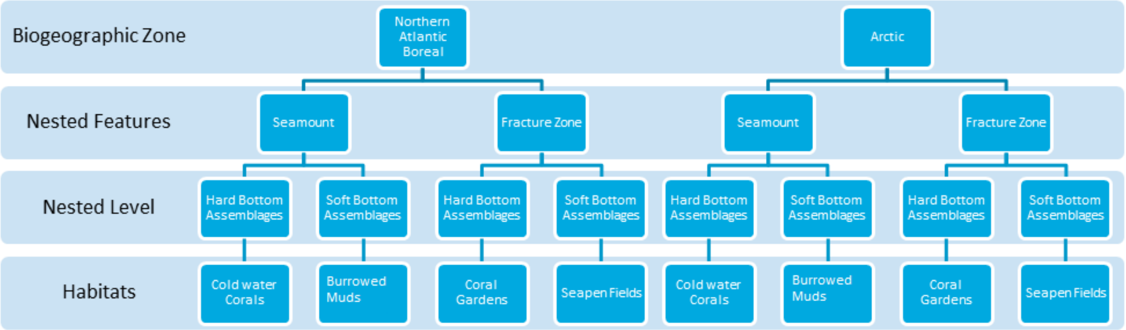


Figure 2.3. Conceptual diagram showing replicated features within each of two biogeographic regions. While the habitats formed are similar, the species composition will be different in each zone.

Representation of deep-sea biogeographic regions

The Global Ocean and Deep-Sea (GOODS) classifications, were refined by Watling et al. (2013) by incorporating hydrodynamic and organic matter flux data. The resulting classification system proposed fourteen Lower Bathyal Provinces (between 801 – 3500 m) and twenty Abyssal provinces (between 3501 – 6500 m) (Watling et al. 2013; Fig. 2.4). While these proposed biogeographic regions have not been validated they are based on environmental variables at the sea-bed and characteristics of water masses that are likely to drive the distribution of benthic ecosystems. Three of the Lower Bathyal Provinces: Arctic, Northern Atlantic Boreal and North Atlantic, and the Abyssal province; North Atlantic occur within the NEAFC restricted areas and closures (Table 2.3) and could be considered the zones in which representative areas are selected. The physical characteristics of those zones are listed in Table 2.3.

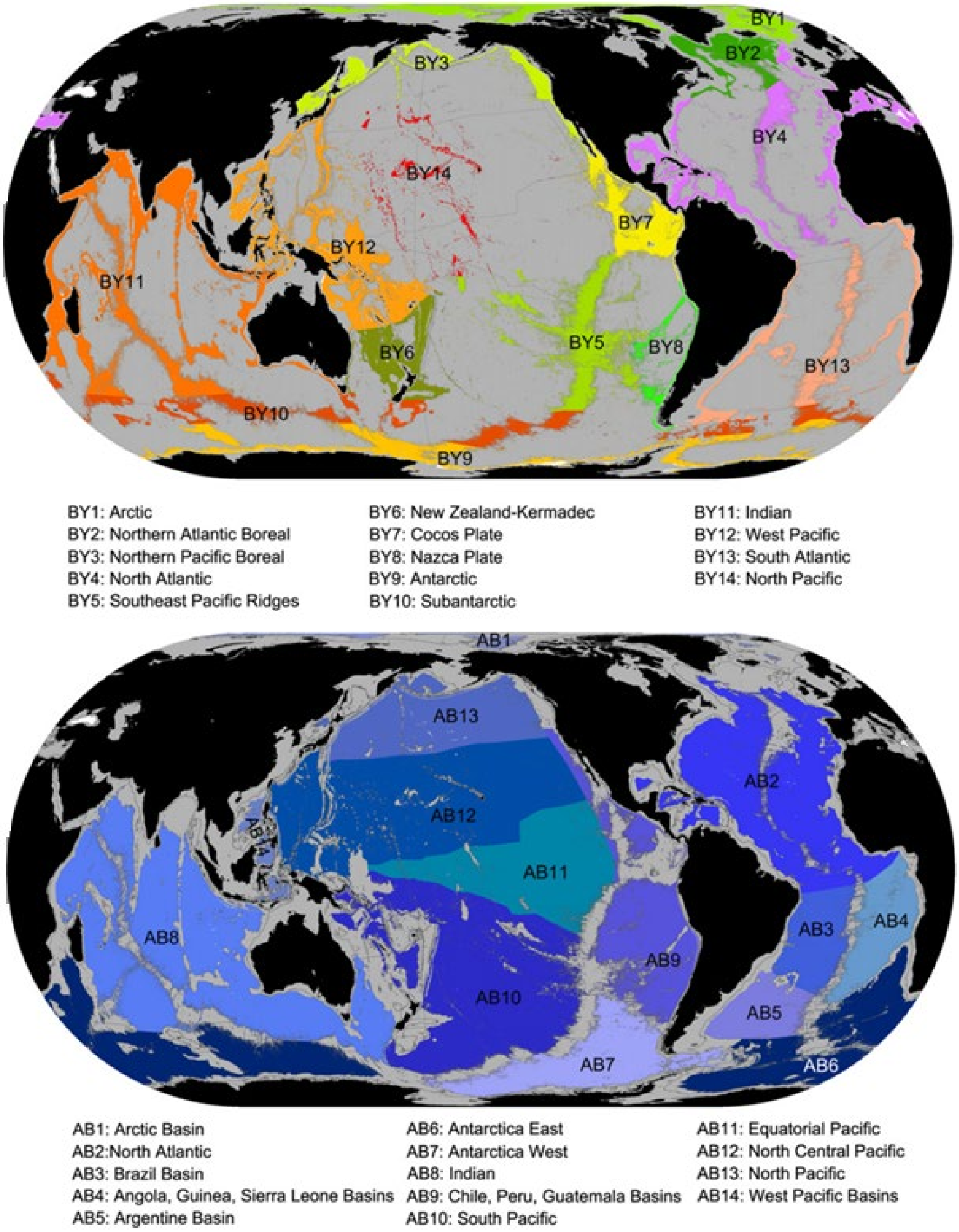


Figure 2.4. The proposed deep sea biogeographic classifications, taken from Figure 19 and 20 in Watling et al. 2013.

Table 2.3. Representation of the deep-sea biogeographic regions in each location. Descriptions are from Watling et al. (2013). Locations are as in Table 2.1.

Biogeographic Region	Location(s)
Arctic (BY1) The average temperature is -0.53°C. The average particulate organic carbon flux (POC) of 5.22 g m^{-2} y^{-1} and the dissolved oxygen concentration is 6.58 ml l^{-1}.	6b (NEAFC RA 2), 6c (NEAFC RA3)
Northern Atlantic Boreal (BY2) The average temperature is higher than in BY1, at 3.19 °C and dissolved oxygen concentration is 6.53 ml l^{-1}. The POC flux has a dominant spring bloom, but with an annual average of 6.61 g m^{-2} $y^{-1.}$	1a (Mid-Mar), 1c (Northern Mar), 3 (Hatton Rockall Closures), 4 (Irminger Sea Redfish Closure), 6a (NEAFC RA1)
North Atlantic (BY4) This is a large province that includes eastern and western part of the Atlantic, along with the Mediterranean Sea. Therefore there are large ranges in the environmental variables, but the average temperature, POC flux and dissolved oxygen concentrations are 5.58°C, 4.92 g m^{-2} $y^{-1.}$and 5.24 ml l^{-1}, respectively.	1b (Southern MAR), 3 (Hatton Rockall Closures)
North Atlantic (AB2) The province is influenced by the North Atlantic Deep Water, and is divided by the Mid Atlantic Ridge. The average temperature is 2.35°C and average oxygen concentration is 5.80 ml $l^{-1.}$ There is a north south gradient in POC, with an annual average over the whole province of 2.09 g m^{-2} $y^{-1.}$	6a (NEAFC RA1)

Topographic Features

Nested within the major biogeographic regions there are topographic features that may be common to each (Fig. 2.3), as well as unique features. In the NEAFC restricted areas examples of common features include seamounts (Fig. 2.5), ridges, slopes and abyssal plain. Within each of those features there may be soft and hard bottom communities, or communities determined by other environmental drivers such as depth or water mass properties. In some cases, topographic features may create biogeographic barriers for some species. For example, recently the Charlie Gibbs Fracture Zone (CGFZ) has been suggested as a major biogeographic barrier for deep-sea demosponges (Cárdenas & Rapp 2015). There are differences in fauna north and south of the CGFZ (Bell et al. 2016). In such cases representative areas within each faunistic group is recommended.

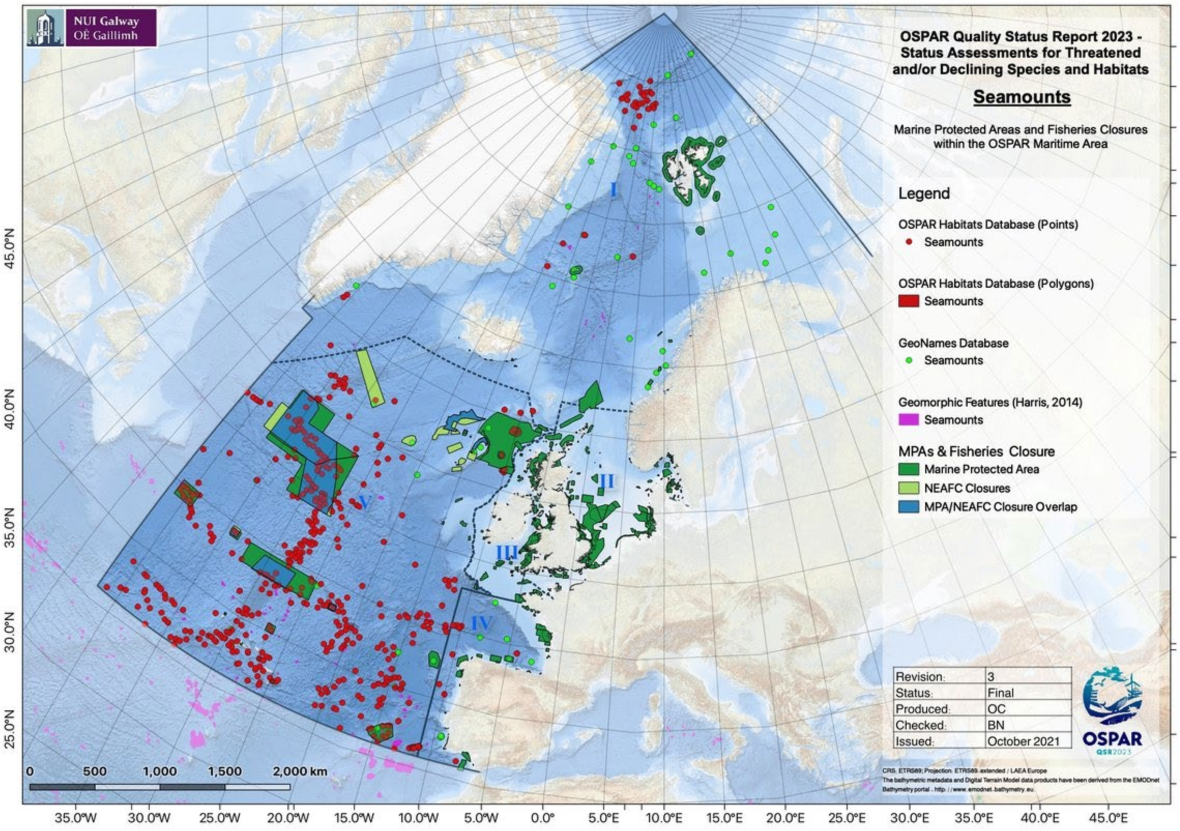


Figure 2.5. Distribution of seamounts (red) in the OSPAR Maritime Area in relation to NEAFC VME Closures and OSPAR MPAs, from OSPAR (2022) Figure 4.

Representation of seabed habitat and communities

EUSeaMap 2021 (https://emodnet.ec.europa.eu/en/euseamap-2021-emodnet-broad-scale-seabed-habitat-map-europe) provides a predicted seabed habitat map for Europe, which covers most of the area, although there is only partial coverage in the west. Various data sources are incorporated into EUSeaMap to create layers of substrate on the seabed, however in some cases there is not enough information to predict the seabed type. This is the case for much of the Mid Atlantic Ridge VME closures (Fig. 2.5). Direct survey data are available for some locations which can provide more specific details on sediment type and benthic communities represented. Examples of replicated habitat features “Sedimentary habitats”, “Hard substrate” and “bioherms” are provided in Table 2.4.

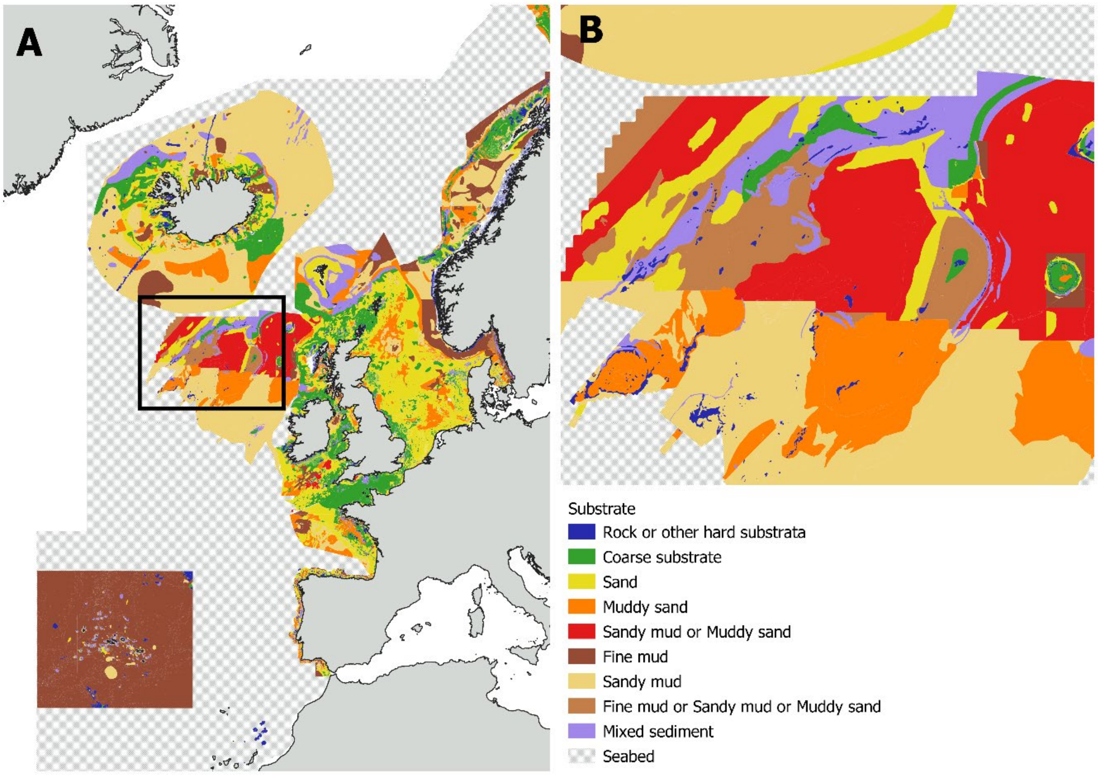


Figure 2.6. Predicted seabed substrate types across A North East Atlantic and B around Hatton-Rockall Closures (EU SeaMap 2021). Areas classified as seabed are locations where there is not enough data to predict substrate type.

Table 2.4. Examples of replicated habitat features known to occur within each biogeographic region. Locations are as in Table 2.1.

Feature	Location(s)
Sedimentary habitats Fine mud is predicted to occur in the southern Mid Atlantic Ridge closure and the Antialtair seamount (Fig. 2.6) (EUSeaMAP 2021). The flanks of the Mid Atlantic Ridge are covered with soft muddy sediments, which generally increase in thickness as the ridge merges with the abyssal plain (van Andel & Bowin 1968). However there are variations in the thickness and sediment type related to variations in topography and hydrodynamics (Shor et al. 1980; CBD Secretariat 2023a, e). EU SeaMap 2021 predicts the presence of a range of types of Atlantic mid bathyal sediments, including mixed sediments, sand, muddy sand and sandy mud around the Hatton Bank and Rockall Closures (Fig. 2.6). Various surveys also indicate heterogeneity of sediment types within this region (CBD Secretariat 2023b). Community analysis of imagery from Hatton Bank identified assemblages of sand and muddy sediments characterised by *Cidaris cidaris* and *Stichopus tremulus*; anemones, polycheates and brittlestars (Howell et al. 2010). The communities associated with mixed sediments are characterised by caryophyllids, *Munida* and encrusting sponges and serpulids (Howell et al 2010). Hatton-Rockall Basin is a soft sediment environment, with polygonal fault system at the surface of the seabed. The tops of the polygons supports communities of sponges including *Pheronema carpenteri*. The soft sediment between the polygons are associated with burrowed mud created by cerianthids and burrowing anemones (Howell et al. 2014).	1b (Southern MAR), 1d (Antialtair Seamount), 2 (Rockall Haddock Box), 3 (Hatton Rockall Closures), 6a (NEAFC RA 1)
Hard substrate The crest of the Mid Atlantic Ridge consists of exposed volcanic rock until approximately 50-75m from the top of the ridge (van Andel & Bowin 1968). Within the Charles Gibbs Fracture Zone, there are also outcrops of sedimentary rocks and other boulders as a result of faulting and currents preventing accumulation of sediments (Shor et al. 1980). Areas of exposed rock have been observed on the summits and steep slopes of the Altair and Antialtair seamouts, with boulders also present (CBD Secretariat 2023d). EUSeaMap 2021 predicts the presence of hard substrate within the Hatton Rockall area. Surveys in the area provide direct evidence that hard substrate within Hatton Bank supports reef communities characterised by sepulids and Munida, as well as isolated Lophelia colonies (Howell et al. 2009; Howell et al. 2010). On North West Rockall Bank, patches of exposed bedrock are associated with higher densities of encrusting sponges and bryozoans (Howell et al. 2014).	1 (Mid Atlantic VME Closures), 3 (Hatton Rockall Closures), 5 (Other Seamounts), 6a (NEAFC RA 1)
Bioherms There is direct evidence of patchy *Lophelia pertusa* reefs on Rockall Bank (Howell et al. 2009). Howell et al. (2010) observed various communities associated with *Lophelia* reefs, such as one live and dead reef framework, some of which was draped in sediments, and coral rubble zones.	3 (Hatton Rockall Closures)

Representation of specific ecosystems

There has been greater mapping effort for some specific ecosystems, particularly those considered threatened or vulnerable (VMEs). As a result, there may be more detailed information on the representation of these ecosystems (Table 2.5). However, there is variation in the specific species composition of these ecosystems across the region which should be represented. Table 2.5 summarizes the VME data from the ICES VME database. As such it does not constitute an exhaustive list of ecosystems that may be present in each location, as sampling of the deep sea is sparse.

Table 2.5. Examples of specific replicated habitats features known to occur within each location (Table 2.1). These are VME Indicators and were captured from the ICES VME Database.

VMEs	Location(s)
Cold Water Coral Reef Surveys around Hatton and Rockall Banks have observed *Lophelia pertusa* and *Madrepora oculata* reefs in the area (Howell et al 2010; ICES VME database). There are confirmed records of *Solenosmilia variabilis* reefs along the mid Atlantic Ridge (VME database extraction May 2022).	1a (Mid-Mar), 3 (Hatton Rockall Closures), 6a (NEAFC RA 1)
Coral Garden Gorgonian and black coral gardens, and cup coral gardens have been identified in the Charles Gibbs Fracture Zone, around Hatton Bank and Logachev Mounds (ICES VME Database). Species which may indicate the presence of coral garden ecosystems have been observed over a wider area, particularly in Hatton and Rockall area. The ICE VME Database shows records of soft corals in RA2 (Barents Sea).	1a (Mid-Mar), 3 (Hatton Rockall Closures), 6c (NEAFC RA 3)
Deep sea sponge aggregations Hatton Rockall Basin supports bird's nest sponge (*Pheronema carpenteri*) sponge aggregations associated with the soft sediments on the polygonal faults, and encrusting sponge aggregations where harder substrate occurs (Howell et al. 2014). There are also records of deep sea sponge aggregations on the mid Atlantic ridge, where demosponges and glass sponges have been observed on slopes and flatter areas (CBD Secretariat 2023b).	1a (Mid-Mar), 3 (Hatton Rockall Closures), 6a (NEAFC RA 1), 6c (NEAFC RA 3)
Hydrothermal vents/fields Hydrothermal vents/fields have been recorded in the VME database along the Reykjanes Ridge and north of the Southern MAR Area.	6a (NEAFC RA 1)
Bryozoan patches Patches of bryozoans have been observed in the Middle Mid Atlantic Ridge Area, including species of *Canda*.	1a (Mid-Mar)
Xenophyophore Aggregation Records of Xenophyophore aggregations are located in middle MAR area and in, and around Logachev Mounds (ICES VME Database). The ecosystem at Logachev are aggregations of the Xenophyophore species *Syringammina fragilissima*.	1a (Mid-MAR), 3i (Logachev Mounds), 6a (NEAFC RA 1)
Seapen field and/or burrowing megafauna Soft muddy sediments bioturbated by Cerianthids and other burrowing anemones is present within Hatton Rockall Basin (Howell et al. 2014). This ecosystem has not been classified as a Vulnerable Marine Ecosystem but has been identified as an OSPAR threatened and declining habitat (ODIMS - Map: OSPAR Threatened or Declining Habitats). Records of the VME habitat – seapen fields occur in the CGFZ and east of Logachev Mounds. However records of seapens occur more widely across the area, especially around Hatton and Rockall (ICES VME Database).	1a (Mid-MAR), 3c/3d (Hatton-Rockall Basin Areas 1 and 2)
Stalked crinoid aggregation The only records of the VME stalked crinoid aggregations are from within Middle MAR area.	1a (Mid-MAR)
Cold seep Surveys of Hatton-Rockall Basin have identified communities which indicate the potential for the presence of cold seep (CBD Secretariat 2023b).	3c (Hatton-Rockall Basin Area 1)

VMEs	Location(s)
Tube dwelling anemone aggregations Aggregations of tube dwelling anemones aggregations occur within Logachev Mounds area, and also outside the boundary to the north east. The aggregations are characterised by species of ceriantharian, including *Pachycerianthus multiplicatus* (ICES VME Database).	3i (Logachev Mounds), 6a (NEAFC RA 1)

2.1.4 Range restricted species

Due to the lack of a CBD definition of a "range restricted species" WKECOVME's interpretation of this term was that it corresponds to an *endemic species*, defined as a species whose geographic range or distribution is confined to a single given area. The Working Group considered regionally endemic fish and invertebrates species for the northeast Atlantic. However, for many species the endemic status remains uncertain due to the lack of data for much of the region due to low sampling effort. Larger fish species are better known (e.g., sharks and rays), while benthic invertebrates and microfauna are poorly studied. For the cartilaginous fishes, nine species are endemic to the northeast Atlantic only, and a further 13 species have a global distribution confined to the northeast Atlantic, adjacent European seas, and adjoining areas of the Mediterranean and northwest African shelf (Gibson et al. 2018). The results of the analysis of endemic cartilaginous fish species are presented in Table 2.6, together with relevant references, and information on species other than cartilaginous fish where endemism has been directly studied. WKECOVME cautions that this list is incomplete as there was insufficient time to fully review the literature

Table 2.6. Known endemic species found in the NEAFC Restricted Areas and VME closures (Table 2.1). IUCN Red List categories: LC=Least Concern; DD=Data Deficient; NT=Near Threatened.

Description	Location(s
Krefft's skate *Malacoraja kreffti* (LC) – regionally endemic species (Gibson et al. 2018) https://www.iucnredlist.org/species/63125/48917872#geographic-range Mid-Atlantic Skate *Rajella kukujevi* (DD) – regionally endemic species (Gibson et al. 2018) https://www.iucnredlist.org/species/161622/48953087	3 (Hatton Rockall Closures)
Blue ray (also known as Blue Pigmy Skate) *Neoraja caerulea* (DD) – regionally endemic species (Gibson et al. 2018) https://www.iucnredlist.org/species/161666/48908962#geographic-range	3 (Hatton Rockall Closures), possibly 1
Norwegian skate *Dipturus nidarosiensis* (NT), Pallid skate *Bathyraja pallida* (LC), Krefft's skate *Malacoraja kreffti* (LC), *Hydrolagus lusitanicus* (LC), Azores dogfish *Scymnodalatias garricki* (DD), Blue ray *Neoraja caerulea* (DD), Blue pygmy skate *Neoraja iberica* (DD), Mid-Atlantic skate *Rajella kukujevi* (DD), and White ghost catshark *Apristurus aphyodes* (DD) are all endemic to the northeast Atlantic (Gibson et al. 2018). Thirteen cartilaginous fishes are known to be endemic to the northeast Atlantic and adjacent waters (Gibson et al. 2018): Angel shark *Squatina squatina* (CR), Common skate *Dipturus batis* (CR), Giant devilray *Mobula mobular* (EN), Sandy ray *Leucoraja circularis* (VU), Rabbitfish *Chimaera monstrosa* (NT), Shagreen ray *Leucoraja fullonica* (NT), Blonde ray *Raja brachyura* (NT), Smalleyed ray *Raja microocellata* (NT), Lusitanian cownose ray *Rhinoptera marginata* (NT), Atlantic catshark *Galeus atlanticus* (NT), Spotted ray *Raja montagui* (LC), Starry smoothhound *Mustelus asterias* (LC), Blackspotted smoothhound *Mustelus punctulatus* (DD). One species of black coral, *Heteropathes opreski*, collected from within the Russian Exploration Area is so far only known to occur along the MAR between 34°46.7' N and 13°19.43' N at	1a (Mid-MAR), 4 (Irminger Sea Redfish Closure)

Description	Location(s
depths 1955–2738 m, and is considered to be potentially endemic to this region (Matos et al. 2014, Molodtsova 2016).	
Endemic species of Rissoidae (Mollusca: Gastropoda) have been identifiedas being endemic to northeast Atlantic Lusitanian seamounts (compared to the adjacent mainland, Galicia Bank and seamounts south of the Azores in the Meteor Seamount chain), including Josephine Seamount (Gofas 2007). *Gofasia vinyllina* is endemic to Josephine Seamount (Gofas 2007) and another 10 species (mostly species of *Manzonia* and *Gofasia*) are endemic to the Gorringe, Josephine, Ampere and Seine seamounts (Gofas 2007).	5 (Other Seamounts), 6a (NEAFC RA 1 XRR Reykjanes Ridge)
Moytirra Vent field - Endemic chemosynthetic fauna associated with the hydrothermal vent have metabolic adaptations that depend on the physical-chemical conditions of such vents and therefore cannot survive elsewhere (Van Dover et al. 2002). Geographical ranges of four boreal warm- to cool-temperate sponge species (*Tethya aurantium*; *Haliclona cinerea*; *Axinella infundibuliformis*; *Halicnemia verticillata*) are completely confined to European parts of the North Atlantic and the adjoining Arctic (Morozov et al. 2021). Of the 54 species of pycnogonids (Arthropoda) recorded below 200 m in the northeastern Atlantic, available evidence suggests that nine are 'endemic' to the norheastern Atlantic Ocean (Bamber & Thurston 1995).	6a (NEAFC RA 1 XRR Reykjanes Ridge)
At least a part of the molluscan fauna in the Norwegian Sea is a remnant of the old North Pacific fauna that lived in the Polar Basin before this was disconnected from the North Pacific by the formation of Bering Strait. These species have since then diverged only very slightly. The abyssal parts of the Norwegian Sea and the Polar Basin form a homogeneous zoogeographic area, with a highly endemic fauna (Boughet & Warén 1979). The cold Nordic Sea deep-water polychaete fauna differs significantly from the North Atlantic deep fauna and rather is more similar to the fauna of deep Arctic waters (Oug et al. 2017).	6b (NEAFC RA 2, Norwegian Sea (XNS/ Banana Hole))
A biogeographical analysis of the Barents Sea sponge fauna was undertaken on the basis of their modern distribution (Morozov et al. 2021). Twenty-four species (37.5%) of the Barents Sea sponge fauna are represented by Arctic endemics (identified when there are pairs of morphologically and genetically close species inhabiting the North Atlantic). The species are *Antho (Acarnia) arctica, Lycopodina cupressiformis, Artemisina arcigera, Myxilla brunnea, Artemisina lundbecki, Phakellia bowerbanki, Craniella abyssorum, Polymastia thielei, Crellomima incrustans, Pseudosuberites sadko, Forcepia fabricans, Tethya norvegica, Haliclona oblonga,Tetilla polyura, Halicnemia wagini, Thenea valdiviae, Iophon koltuni, Lissodendoryx indistincta, Crellomima imparidens, Myxilla perspinosa, Axinella hispida, Haliclona rossica, Sphaerotylus borealis,* and *Polymastia hemisphaerica* (Morozov et al. 2021). The Barents Sea also has 25% of its bryozoan fauna comprised of regional endemic species (Denisenko 2022).	6c (NEAFC RA 3 Barents Sea (XBS, Loophole))

2.1.5 Key biodiversity areas

UNGA resolution 61/105 (2006) called upon States and RFMO/As to protect marine biodiversity in Areas Beyond National Jurisdiction and furthered the concept of vulnerable marine ecosystems (VMEs) as hotspots of biodiversity. NEAFC closed areas according to the VME Recommendation (19:2014) were put in place to protect known and likely VMEs in those areas, and were supported by ICES advice. Therefore the presence of VMEs and VME indicators signals that the area is key for the conservation of biodiversity. This has been well-established in the literature for cold water coral reefs (e.g., Henry & Roberts 2007), sea pen fields (e.g., Miatta & Snelgrove 2022) and sponge grounds (e.g., Beazley et al. 2013; Hawkes et al. 2019). VME and other key areas of high biodiversity are summarized in Table 2.7. Three "Key Biodiversity Areas" have been identified in the NEAFC area, all based on bird tracking data. They include the Elanov Seamount and Basin important for the protection of the Cory's shearwater (Key Biodiversity Areas Partnership 2023a), and the Northeast Atlantic 2 (Key Biodiversity Areas Partnership 2023b) and Northeast Atlantic 3, for the Zino's petrel, *Pterodroma madeira* (Key Biodiversity Areas Partnership 2023c).

Table 2.7. Details of the evidence base for the presence of the biodiversity attribute "Key biodiversity areas" with reference to their location following the codes in Table 2.1.

Description	Location(s)
The Hatton and Rockall Banks, encompass a large depth range with strong environmental gradients (e.g., temperature, pressure, and food availability) that give rise to a high diversity of species and habitats (Howell et al. 2010). The seabed communities captured within the area include VMEssuch as cold-water coral formations, sponge aggregations and potential seep communities (Neat et al. 2019) and observations in the early 1970s found cold-water coral communities occurring on the Rockall Bank down to a depth of 1,000 m (Wilson 1979). Thickets of *Lophelia pertusa* occurred principally at depths between 150-400m. Large coral growth features have been discovered on the northern Rockall Bank (Huvenne 2011). Frederiksen et al. (1992) reported a high diversity of corals on the northern Hatton Bank. Since these observations further records of coral gardens (Bullimore et al., 2013) and coral frameworks have been noted throughout the Rockall and Hatton area, including the Logachev Mounds and the Western Rockall Bank Mounds (Narayanaswamy et al., 2006; Durán Muñoz et al. 2009). Scleractinian cold-water coral frameworks have been reported to support over 1,300 species in the northeast Atlantic, some of which have yet to be described (Roberts et al. 2006). A great variety of large invertebrate fauna (megafauna) occur in this region including giant protozoans (xenophyophores), vase shaped white sponges, actiniarians, antipatharian corals, hydroids, bryozoans, asteroids, ophiuroids, echinoids, holothurians and crustaceans (Narayanaswamy et al. 2006; Roberts et al. 2008). Large mega-infauna such as echiuran worms are evident from observations of their feeding traces. Little is known, however, of the smaller fauna living within the sediment. Deep-sea sponge aggregations are present in the Hatton-Rockall Basin. In addition, the flanks of the gullies appear to support extensive, dense aggregations of mixed species sponge communities, including *Pheronema carpenteri* aggregations (Howell et al. 2016) which are known to be biodiverse habitats.	3 (Hatton Rockall Closures), 2 (in part) (Rockall Haddock Box)
The Charlie-Gibbs Fracture Zone (CGFZ) is a prominent geological feature offsetting the Mid-Atlantic Ridge (MAR), consisting of two parallel fractures, creating a highly variable seafloor bathymetry. It has been defined as the most important latitudinal biodiversity transitional zone on the MAR. ROV operations found high biodiversity and presence of dense sponge aggregations and coral gardens (Keogh et al. 2022). The MAR-ECO cruise provided a snapshot of seabird distribution along the MAR in summer 2004: 22 species of seabirds were identified, however only the northern fulmar (*Fulmarus glacialis*), great shearwater (*Puffinus gravis*) and Cory´s shearwater (*Calonectris diomedea*) were observed by the hundreds. The distribution of these species reflects the broad characters of water masses in the area (from Mar-Eco cruise report, Nøttestad et al. 2004) and in particular the boundary effect of the frontal zone and the limited nesting sites available only on the Azores and Iceland (Skov et al. 1994). *F. glacialis* were distributed along most of the study transect north of 47° N, and they were by far the most common species of seabird along the central and northern parts of the MAR. Densities were generally below 1 bird per km^2, and no large-scale concentrations were noted. However, discrete elevations in densities were recorded both in the Reykjanes and the CGFZ regions. *P. gravis* were observed only in the vicinity of the Subpolar front just north of the CGFZ. The hydrothermal vent fields of the MAR play a pivotal role in sustaining abundant populations of deepsea species through the chemosynthetic primary production (Van Dover et al. 2002). Deep-sea hydrothermal vents are among the most extreme and dynamic environments on Earth. However, islands of highly dense and biologically diverse communities exist in the immediate vicinity of hydrothermal vent flows, in stark contrast to the surrounding bare seafloor (Thornburg et al. 2010). Unique communities are formed around vents, attracting unusual creatures such as red-plumed giant tube worms and massive clams, which cluster around the dark chimneys where vent fluids emerge.	6a (NEAFC RA 1 XRR Reykjanes Ridge)

Description	Location(s)
Coldwater, deep, habitat-forming corals can shelter higher megafauna in association with the corals (Roberts et al. 2006; Mortensen et al. 2008, Rogers et al. 2008). Seamounts also harbour large aggregations of demersal or benthopelagic fish (Koslow 1997; Morato & Pauly 2004; Pitcher et al. 2007; Morato et al. 2009, 2010).	5 (Other Seamounts)
In addition to the general properties of seamounts (location 5), the Altair Seamount the benthic epifaunal community is dominated in most places by sessile megabenthos, chiefly anemones and true corals (Hexacorallia) and sponges. The diversity of corals and sponges is particularly high in the saddle and gully (Henry et al. 2014).	1e (Altair Seamount)
Deep sea sponge aggregations (Alt et al. 2019), *Lophelia pertusa* reefs (Mortensen et al., 2008) and seamount communities are found, although more specific data is needed for the Fracture Zone proper. The area is also very important for combined aggregations of seabirds (Boertmann 2011). From a relatively low number of trawls during the MAR-ECO Project, fifteen new species were described, including new glass sponges, sea cucumbers, brittlestars, and one new sea star (Gebruk et al. 2010). The Azores region of the MAR also supports a 'living fossil community' formed by a long-lived deep-sea oyster and a crinoid (Wisshak et al. 2009) and coral reefs formed by the scleractinian coral Eguchipsammia cf. cornucopia (Tempera et al. 2015).	1 (Mid Atlantic VME Closures) including in part 4 (Irminger Sea Redfish Closure)
Sea pens are the most significant VME-related feature of the box, and are found notably in the east. The Rockall Haddock Box was part of a wider area proposed as an EBSA in 2019 (CBD 2019).	2 (Rockall haddock box)
The Barents Sea is home to one of the largest concentrations of seabirds in the world. More than 20 million birds, including 40+ species breed in the region at 1600 colonies. The most important species numerically include northern fulmars (*Fulmarus glacialis*) common eiders (*Somateria mollissima*), glaucous gulls (*Larus hyperboreus*), black-legged kittiwakes (*Rissa tridactyla*), common guillemot (*Uria aalge*), Brünnich's guillemots (*Uria lomvia*), razorbills (*Alca torda*), black guillemots (*Cepphus grylle*), little auks (*Alle alle*) and Atlantic puffins (*Fratercula arctica*). Most of the seabirds feed on zero group capelin (*Mallotus villosus*), herring (*Clupea harengus*) and polar cod (*Boreogadus saida*) being key-prey species for many seabirds. Specialists such as the little auk target Arctic species of zooplankton, calanoid copepods being their primary prey (ICES 2019c). The Barents Sea is also one of the most species rich regions in the Arctic with respect to marine mammals. The ICES VME Database shows records of deep-sea sponges and soft corals present in this area (ICES 2019b).	6c, NEAFC RA 3 Barents Sea (XBS, Loophole)

2.1.6 Areas providing critical ecosystem functions and services

The CBD EBSA proforma for the Charlie Gibbs Fracture Zone, the Mid North Atlantic Frontal System, the North Azores Plateau, the Southern Reykjanes Ridge and the Hatton and Rockall Banks and Basin (CBD Secretariat 2023a-e) formed the foundation for this summary of the biodiversity attribute "Areas providing critical ecosystem functions and services". Habitat provisioning as a key function related to biodiversity and is one of the links between VMEs and high biodiversity. Sponges are known to convert dissolved organic carbon into particulate matter that can be consumed by other organisms (Sponge Loop - de Goeij et al. 2013) and so play important functional roles in marine ecosystems. Benthic filter feeders and mesopelagic migrants (fish and crustacea) play important roles in nutrient cycling between the deep waters and the productive surface. Some of these functions are captured in other attributes (key areas of biodiversity and ecosystem connectivity). Other functions identified include spawning, feeding and nursery areas for both fish and invertebrates. La Bianca et al. (2023) proposed and ecosystem services (ES) framework to provide a structure for deep-sea ecosystem services. They suggest four supporting services: 1) nutrient cycling; 2) Chemosynthetic primary production; 3) Secondary production; and 4) Biologically-mediated habitat. The then define 10 categories of 'final services' , that is those that result from the interactions of functions (regulating, provisioning and cultural services). Of those, 'Wild animals used for nutritional purposes' is most relevant here. To these we add "Nursery and spawning areas" and provide the links to those functions in the descriptions for the attribute in Table 2.8.

Table 2.8. Details of the evidence base for the presence of the biodiversity attribute "Areas providing critical ecosystem functions and services" with reference to their Location following the codes in Table 1.8.

Description (Ecosystem Function in Bold)	Location(s)
Wild animals used for nutritional purposes: There is also evidence that the mid-ocean ridges are ecologically important for higher trophic levels relative to the surrounding abyssal plains and the open ocean (e.g., blue ling and roundnose grenadier spawning aggregations on the northern MAR (Magnusson & Magnusson 1995, Vinnichenko & Khlivnoy 2004).	1c (Northern MAR)
Biologically mediated habitat. Nursery and spawning areas. The diverse benthic communities at North MAR, comprising cold-water coral reefs, gardens, sponge grounds and massif sponges, provide complex three-dimensional structural habitat that provide refuge, feeding oportunities, and spawning and nursery areas for a wide range of associated sessile and vagile species, including commercially important fish and crustacean species (Beazley et al. 2013; Pham et al. 2015; Gomes-Pereira et al. 2017). For example, deep-water sharks were found to lay eggs among cold-water corals (Henry et al. 2013). There is also evidence that the North MAR may be a potential aggregation/mating site for the rare and vulnerable shark *Chlamydoselachus anguineus* (Kukuev & Pavlov 2008) and a spawning area for roundnose grenadier (*Coryphaenoides rupestris*) and the Bigelow's ray (*Rajella bigelowi*) (Orlov et al. 2006). There is also evidence that the mid-ocean ridges are ecologically important for higher trophic levels relative to the surrounding abyssal plains and the open ocean (e.g., blue ling and roundnose grenadier spawning aggregations on the northern MAR (Magnusson & Magnusson 1995, Vinnichenko & Khlivnoy 2004).	1c (Northern MAR)
Nutrient cycling. Cold water coral reefs are also highly productive regions. Recent research has shown that the Logachev Mound province at Rockall Bank is a hotspot for remineralization of organic matter and specifically for deep water carbon and nitrogen cycling. Benthic respiration rates in the vicinity of the cold- water corals were ~five times higher than those of sediments at comparable depths, aligning with published studies from cold-water coral habitats from continental shelf settings off Scotland and Norway (Catholot et al. 2015; Rovelli et al. 2015). The corals are highly effective at trapping laterally and vertically advected particulate organic matter and its subsequent respiration. In addition the mound structures formed by cold-water coral reef growths interact with local oceanography resulting in a topographically-enhanced carbon pump. This pump draws carbon from the surface waters, and focuses organic matter transport onto the reef structure supporting the high mineralization rates and affecting the surrounding ecosystem (Soetaert et al. 2016). Cold-water corals and areas of natural coral rubble provide shelter, nursery and feeding grounds for a variety of species. The flanks of the gullies appear to support extensive, dense aggregations of mixed species sponge communities, including *Pheronema carpenteri* aggregations (Howell et al. 2016). Sponge aggregations create complex habitats supporting high biodiversity and providing a refuge for fish (Maldonado et al. 2015), and may also play an important role as a sink in the marine silicon cycle (Maldonado et al. 2020) which may influence primary productivity and the carbon cycle. The Logachev Mound province on Rockall Bank is a highly productive system playing an important role in carbon and nitrogen cycling and supporting respiration rates 5 times higher than the surrounding sediment ecosystem.	3 (Hatton Rockall Closures)
Biologically mediated habitat. In some seamounts the gorgonian and sponge species were reported to form dense gorgonian coral habitat-forming aggregations which may represent important feeding and sheltering grounds for seamount fishes as well as potential shark nurseries (WWF 2001; Etnoyer & Warrenchuk 2007; OSPAR 2011). Coldwater, deep, habitat-forming corals can shelter higher megafauna in association with the corals (Roberts et al. 2006; Mortensen et al. 2008, Rogers et al. 2008). Seamounts also harbour large aggregations of demersal or	5 (Other Seamounts)

Description (Ecosystem Function in Bold)	Location(s)
benthopelagic fish (Koslow 1997; Morato & Pauly 2004; Pitcher et al. 2007; Morato et al. 2009, 2010). On the ridge and associated seamounts, which remain very poorly explored, the global habitat suitability models and distribution maps for the North Atlantic modelled the distribution of seven suborders of Octocorallia (Yesson et al. 2012) and five species of framework-forming scleractinian corals (Davies & Guinotte 2011). Both studies revealed that the areas contain important suitable habitats for these taxa. The diverse benthic communities at North MAR, comprising cold-water coral reefs, gardens, sponge grounds and massif sponges, provide complex three-dimensional structural habitat that provide refuge, feeding oportunities, and spawning and nursery areas for a wide range of associated sessile and vagile species, including commercially important fish and crustacean species (Beazley et al. 2013; Pham et al. 2015; Gomes-Pereira et al. 2017).	
Nutrient cycling. Moytirra Vent field - Endemic chemosynthetic fauna associated with the hydrothermal vent have metabolic adaptations that depend on the physical-chemical conditions of such vents and therefore cannot survive elsewhere (Van Dover et al. 2002).	6a (NEAFC RA 1)

2.1.7 Areas for ecological connectivity

Ecological connectivity, defined as in Section 1.1, was viewed by WKECOVME to include both active migration and passive dispersal and can be documented using tagging, genetic profiling and particle tracking modelling techniques amongst others. Movement may be in both vertical and horizontal planes, and we interpret it to also include benthic-pelagic coupling as an ecological process crucial to functions from nutrient cycling to energy transfer in marine food webs. Very little information was available on this attribute, although four key processes were identified (Table 2.9). These included benthic-pelagic coupling, geological processes sustaining ecosystems, genetic connectivity of key foundations species (corals and sponges), bathyal to abyssal connectivity and migratory pathways. Connectivity from bathyal (200-2000m) to abyssal (> 2000m) depths may include continental slopes such as found in the Hatton Rockall area and on seamounts.

WKECOVME notes that the recent ICES advice supplied to OSPAR regarding the proforma to extend the NACES MPA to the seafloor concludes that “While explicit scientific linkages between seafloor seamount/knoll habitats and surface ecosystem productivity and processes are not fully understood, and many seafloor habitats have not been directly observed, their linkages and importance to surface activity has been observed and documented in the revised proforma” (ICES 2023b). This is an important acknowledgement from ICES that benthopelagic coupling exists and must be considered in the context of biodiversity-focused spatial measures.

Table 2.9. Details of the evidence base for the presence of the biodiversity attribute “Areas for ecological connectivity” with reference to their Location following the codes in Table 2.1.

Description	Location(s)
Benthic pelagic coupling. Frontal zones and persistent eddies associated with the Mid-Atlantic Ridge, Southern Reykjanes Ridge, CGBZ and seamounts, aggregate primary productivity and zooplankton, providing a temporally and spatially reliable foraging zone for higher trophic level predators (Falkowski et al. 1998, Dutkiewicz et al. 2001, Kunze et al. 2004, Volkov 2005, Heger et al., 2008, Read et al. 2010, CBD/COP/15/L.13). There is a strong relationship between larval fish communities and hydrography and topography on the Southern Reykjanes Ridge (Fock & John 2006). Larvae are retained above the Ridge by a branching current from the North Atlantic Current due to the Coriolis effect (Fock & John 2006).	1 (Mid Atlantic VME Closures), 2 (Rockall Haddock Box), 3 (Hatton Rockall Closures), 5 (Other Seamounts), 6a (NEAFC RA 1)

Description	Location(s)
Geological processes sustaining ecosystems. The Charlie-Gibbs Fracture Zone area is a unique geomorphological feature in the North Atlantic with significant active geological processes (CBD/COP/15/L.13). It opens the deepest connection between the northwest and northeast Atlantic. Chemicals transported upward in fracture zones include energy substrates, such as H_2 and volatile hydrocarbons, which sustain chemosynthetic, microbial ecosystems at and below the seafloor (Hensen et al. 2019). Oceanic fracture zones play important roles in the chemical interaction between the Ocean and Earth’s interior.	1a (Mid-MAR), 6a (NEAFC RA 1)
Genetic connectivity of foundation species. Taboada et al. (2023) through genetic population assignment analysis inferred that Rockall Bank was a ‘source’ population for the vast majority of the samples of the keystone sponge *Phakellia ventilabrum* collected from around the British Isles. Examination of the population dynamics of the cold water coral, *Lophelia pertusa*, via graph theoretic metrics, identified connectivity from Hatton Bank to other MPAs downstream in UK national waters. The Hatton Bank reefs play a critical larval supply role (Fox et al. 2016).	2 (Rockall Haddock Box), 3 (Hatton Rockall Closures)
Bathyal and abyssal connectivity. The slope-abyss source-sink (SASS) hypothesis suggests that the abyssal seafloor constitutes a vast sink habitat with macrofaunal populations sustained only by an influx of larval 'refugees' from bathyal source areas particularly along continental margins. Bathyal and abyssal populations of deep-sea molluscs (gastropods and bivalves) may form a source-sink system in which abyssal populations rely on immigration from bathyal sources (Rex et al. 2005), especially in low productivity areas (Hardy et al. 2015).	1 (Mid Atlantic VME Closures), 5 (Other Seamounts), 6 (RAs)
Migratory pathways. Tracking studies of sei, fin and blue whale have described the migration of these species through the area from the Azores to foraging areas in the Labrador Sea as well as Greenlandic and Icelandic waters (Olsen et al. 2009, Silva et al. 2013; Prieto et al. 2014).	6a (NEAFC RA 1)

2.2 Summary

The support base for the biodiversity attributes are colour-coded in Table 2.10 according to whether information supporting the presence of the attribute was found (Section 2.2) or suspected (expert opinion). Empty cells indicate that WKECOVME was unable to find evidence that the biodiversity attribute was present, but that should not be taken to mean that they do not exist but rather that within the time available no information was found. This may be because there is none, or that it was overlooked. The table indicates that each of the areas has multiple attributes associated with it. This is not surprising as the areas closed to protect VMEs bring with them all of the biodiversity attributes associated with those habitats that were the basis for their protection in the first place. Similarly, the RAs have seamounts and other features that are known to concentrate biodiversity. The remaining areas of abyssal plain have value as representative natural ecosystems.

Table 2.10. Summary of the documentation collated by WKECOVME indicating the presence of a biodiversity attribute at the NEAFC Location following the codes in Table 2.1 for the regulated areas. Biodiversity attributes: 1= communities of rare, threatened or endangered species; 2 = representative natural ecosystems; 3= range restricted species; 4= key biodiversity areas; 5=areas providing critical ecosystem functions and services; 6=areas for ecological connectivity.

☑ **Biological Attribute Present with Supporting Documentation in Section 2.1**

✅ **Biological Attribute Likely Present based on Expert Opinion**

Specific Location Name Following NEAFC (Location Code)	**Biodiversity Attribute**					
	1	2	3	4	5	6
Mid Atlantic VME Closures (1)	☑	☑		☑	☑	☑
Mid-MAR (1a)	☑	☑		☑	✅	☑
Southern MAR (1b)	☑	☑			✅	☑
Northern MAR (1c)	☑	☑			☑	☑
Antialtair Seamount (1d)	✅	☑			✅	☑
Altair Seamount (1e)	☑	☑		☑	✅	☑
Rockall Haddock Box (2)	☑	☑		☑	✅	☑
Hatton Rockall Closures (3)	☑	☑	☑	☑	☑	☑
m hatton bank 2 area 2 (3a)	☑	☑		☑	☑	☑
m hatton bank 1 (3b)	☑	☑		☑	☑	☑
l hatton-rockall basin area 1 (3c)	☑	☑		☑	☑	☑
Hatton Rockall Basin (l) Area 2 (3d)	☑	☑		☑	☑	☑
Area (k) South West Rockall Bank 2 (3e)	☑	☑		☑	☑	☑
Area (k) Southwest Rockall Bank 1 (3f)	☑	☑		☑	☑	☑
Edora Bank Closure (3g)	☑	☑		☑	☑	☑
Area (i) West Rockall Mounds (3h)	☑	☑		☑	☑	☑
Area (h) Logachev Mounds (3i)	☑	☑		☑	☑	☑
Rockall Bank: Area (g) South-West Rockall Area 3 (3j)	☑	☑		☑	☑	☑
Rockall Bank: Area (g) South-West Rockall Area 2 (3k)	☑	☑		☑	☑	☑
sw_rockall1_v2 (3l)	☑	☑		☑	☑	☑
Rockall Bank; Area (g) North West Rockall (3m)	☑	☑		☑	☑	☑
area f hattonbank 1 (3n)	☑	☑		☑	☑	☑

Specific Location Name Following NEAFC (Location Code)	Biodiversity Attribute					
	1	2	3	4	5	6
Irminger Sea Redfish Closure (4)		☑	☑		✅	☑
Other Seamounts* (5)	☑	☑		☑	☑	☑
Restricted Areas (RAs) (6)	☑	☑	☑	☑	☑	☑
NEAFC RA 1 (XRR Reykjanes Ridge) (6a)	☑	☑	☑	☑	☑	☑
NEAFC RA 2, Norwegian Sea (XNS/ Banana Hole) (6b)		☑			✅	✅
NEAFC RA 3 Barents Sea (XBS, Loophole) (6c)	☑	☑		☑	✅	✅

2.3 Key Messages

Data on the distribution of many benthic invertebrates are still scarce and patchy in the deep sea. However, inferences about their distribution can be made by knowing something about known biodiversity attributes associated with nearby similar habitats and features. For example, there has been a rapid expansion in the development and application of deep-sea habitat and species distribution models (SDMs), especially in the north Atlantic (Robert et al. 2016), which has resulted in a much better understanding of the distributions of potentially high biodiversity habitats when applied to inform VME conservation management strategies (Howell et al. 2016; Robinson et al. 2017).

With respect to "representative naturalness", which is defined as an "area with a comparatively higher degree of naturalness as a result of the lack of or low level of human-induced disturbance or degradation" (CBD 2009, see Gollner et al. 2021), it is arguably within the NEAFC restricted areas (NEAFC RA 1 – 3) that noteworthy biodiversity attributes or features are most likely to be found. Indeed, one such feature in NEAFC RA 1 (XRR Reykjanes Ridge) is the Moytirra deep-sea hydrothermal vent field, located to the north of the existing southern MAR closure at approximately 45.5^{o} N, 27.85^{o} E. The NEARC Restricted Areas can be fished if a process for exploratory fishing is followed. Identifying areas with important biodiversity attributes in the RAs could enable further protections from exploratory fishing activities and bring awareness to these areas by other sectors who potentially may have the capacity to cause harm to the biodiversity attributes.

3 List of potential threats resulting from pressures, and specific evaluation of the pressures and likely threats from fishing activities affecting or expected to affect the areas and the biodiversity attributes

3.1 Existing and historic threats and associated pressures

NEAFC Regulatory Area 1 (RA1 - Reykjanes Ridge) is mostly aligned with the spatial extent of the Oceanic Northeast Atlantic ecosystem. It currently, and historically, has fewer human activities than other ICES ecoregions (ICES, 2019). Fishing is the most extensive activity within the region, with shipping and telecommunications being the main other activities. Historically, radioactive waste dumping has also occurred here, but, following a ban in 1993, no longer takes place.

NEAFC Regulatory Area 2 (RA2 - the Banana Hole) lies within the Norwegian Seas ecoregion, which also includes parts of the Norwegian exclusive economic zone (EEZ) and the Fisheries Protection Zone around Svalbard. The only activities known to be occurring within the NEAFC RA2 are fishing with pelagic gears and shipping.

NEAFC Regulatory Area 3 (RA3 - the Loophole) lies within the Barents Sea ecoregion, which extends to the whole Barents Sea. NEAFC RA3 includes a large existing fishing area for bottom trawling and setting of traps. Shipping also occurs in the area.

Marine litter and climate change influence all three regions. Some bioprospecting for marine genetic resources may also occur, but this will be of minimal impact.

Future threats within these areas could include potential activity from deep-sea mining, oil and gas activity, renewable energy development and mesopelagic fisheries.

Pressures from these activities (current and possible future) have been collated in Table 3. The list of pressures is taken from the ICES ecosystem overview technical guidelines (ICES, 2023) to maintain consistency in terminology. Full definitions can be found in Annex 2 of ICES (2023). The list is not considered exhaustive of every possible pressure, but highlights predominant pressures from each activity.

Table 3.1. Pressures associated with the current and potential future activities occurring within NEAFC RA 1, 2 and 3. Pressures listed are taken from ICES, 2023.

Activity/ Pressure	Physical seabed disturbance[1]	Introduction of contaminating compounds	Introduction of non-indigenous species (NIS)	Marine Litter*	Noise	Light	Selective extraction of species (incl. bycatch)
Fishing	x	x	x	x	x	x	x
Shipping		x	x	x	x	x	
Telecommunications	x		x		x		
Bioprospecting							x
Marine litter[2]	x	x	x				
Deep-sea mining	x	x			x	x	
Oil and gas	x	x			x	x	
Renewable energy	x		x		x	x	

Fishing

Detailed overviews of fisheries in NEAFC RA1 have been provided by ICES ecosystem (ICES, 2019) and fisheries overviews (ICES, 2022a). Few stocks are targeted and the main fisheries are:

(1) Pelagic fisheries for beaked redfish and blue whiting. The latter fishery dominates, comprising ca 75 % in terms of total landings since 2016, while redfish landings account for ca 15 %. Blue whiting fisheries are located on the Rockall-Hatton Plateau while the redfish fisheries are carried out in the northwestern part of RA1/ Irminger Sea. Blue whiting are currently subject to overexplotation as fishing mortality exceeds maximum sustainable yield levels, resulting from (among others) consistent deviations from the long-term management strategy since 2018 as evident from the sum of unilateral quotas (ICES 2022e).

(2) Demersal fisheries which account for ca 10 % of total landings. This can be distinguished between demersal trawl fisheries for e.g., Greenland halibut, black scabbardfish and benthic trawl fisheries for e.g., roundnose grenadier. A specific midwater fishery targeting alfonsino is carried out on seamount fishing areas northeast of the Azores (ICES, 2022f);

(3) Bottom longlining, which is presently carried out on Josephine seamount (ICES, 2022b), but was also historically conducted on Hatton Bank (Durán Muñoz et al., 2011), and;

(4) Pelagic longlining, which is carried out in the southern part of NEAFC RA 1, targeting swordfish and tunas.

---

[1] Physical seabed disturbance can occur via abrasion (the scraping of the substrate), resuspension of the substrate (siltation), removal of the substrate, and deposition (smothering) (ICES, 2023)

[2] Marine litter could be both the source of multiple pressures, and a pressure itself.

The spatial footprint of bottom trawling is confined to the Rockall-Hatton plateau (ICES, 2022a). The analysis of commercial fishing vessels tracks revealed that bottom trawling does observe the delimitations of the areas closed to bottom fishing according to NEAFC Recommendation 19:2014 (ICES, 2019). It must be noted that in deep-sea fisheries, ship track and trawl track may differ in space due to displacement of either vessel or gear by wind and currents. Within "existing bottom fishing areas", fishing is distributed in patches, so that untrawled space remains.

An overview of fisheries in NEAFC RA2 was provided by ICES (2021a). The Mohn Ridge is an important fishing ground regarding the fishing footprint in NEAFC RA2, both for pelagic and bottom trawling. The pelagic fisheries, using purse seine and pelagic trawls, account for the largest catches by weight and target blue whiting, mackerel, herring, and other pelagic species. Landings of pelagic species within the ecoregion in the last decades have been variable. Mackerel's fishing mortality exceeds maximum sustainable yield, as the sum of unilateral quotas for this stock and resulting catches have exceeded the scientific advice by on average 41% since 2010. (ICES 2022h). The fishing mortality for herring is also high, and total harvesting has exceeded the advised Total Allowable Catch (TAC) since 2013 (ICES 2022i). The largest demersal fishery targets cod, haddock and saithe using bottom trawls, purse-seine, Danish seine and gillnets, and to a lesser extent hook and line gear. Smaller fisheries target other gadoid species, Greenland halibut, and beaked redfish.

For NEAFC RA3 a spatial footprint is available from ICES (2021b). The main fisheries are bottom trawling and setting of traps. Pelagic fisheries target capelin, using midwater trawl, and demersal fisheries target cod, haddock and other gadoids (ICES, 2022j). There are also crustacean fisheries for deep-sea prawn, red king crab and snow crab (ICES, 2022j).

Fisheries associated pressures include (1) extraction of biomass from the ecosystem, both for the target species and in terms of bycatch, (2) introduction of litter and ship-bound pollution, and (3) physical seabed disturbance, which includes surface abrasion, subsurface abrasion and sediment resuspension/smothering.

Extraction of biomass can have a significant effect on bentho-pelagic coupling. Figure 5.8 shows that for the Rockall-Hatton plateau, overlap between pelagic catches and VME closure areas is small, yet, as explained in section 2.1.7 "Areas for ecological connectivity", bentho-pelagic coupling exists and must be considered in the context of biodiversity-focused spatial measures. In this regard it is essential that elements of the ecosystems connected with demersal habitats in the vertical plane (such as pelagic fish species) be harvested sustainably and aligned with ecosystem-based fisheries management, as biomass removal has impacts not only on target and bycaught species but also through the wider ecosystem via predator-prey relationships. Such considerations are further important given the potential for climate change impacts to interact with fisheries outcomes.

For marine litter, lost and abandoned gear ("ghost fishing", see ICES, 2007) is considered critical. It must be noted, that due to drifting abandoned nets, "ghost fishing" may be exported from fishing areas to unfished areas. Bottom gillnets create a particular "ghost fishing" problem, and retrieval by means of bottom dredges may also be problematic in vulnerable areas (see Large et al., 2009). An example of this can be found in Southeast Rockall bank in which panels of gillnets were found between 400 and 800 meters during a BIM survey, whilst in various parts of Porcupine bank, multiple kilometers of gillnets were retrieved from various depth strata during a CEFAS survey, both with mesh sizes used for anglers and the gillnets ghost-fishing brought up large numbers of crab and other species in smaller numbers (Large et al. 2009).

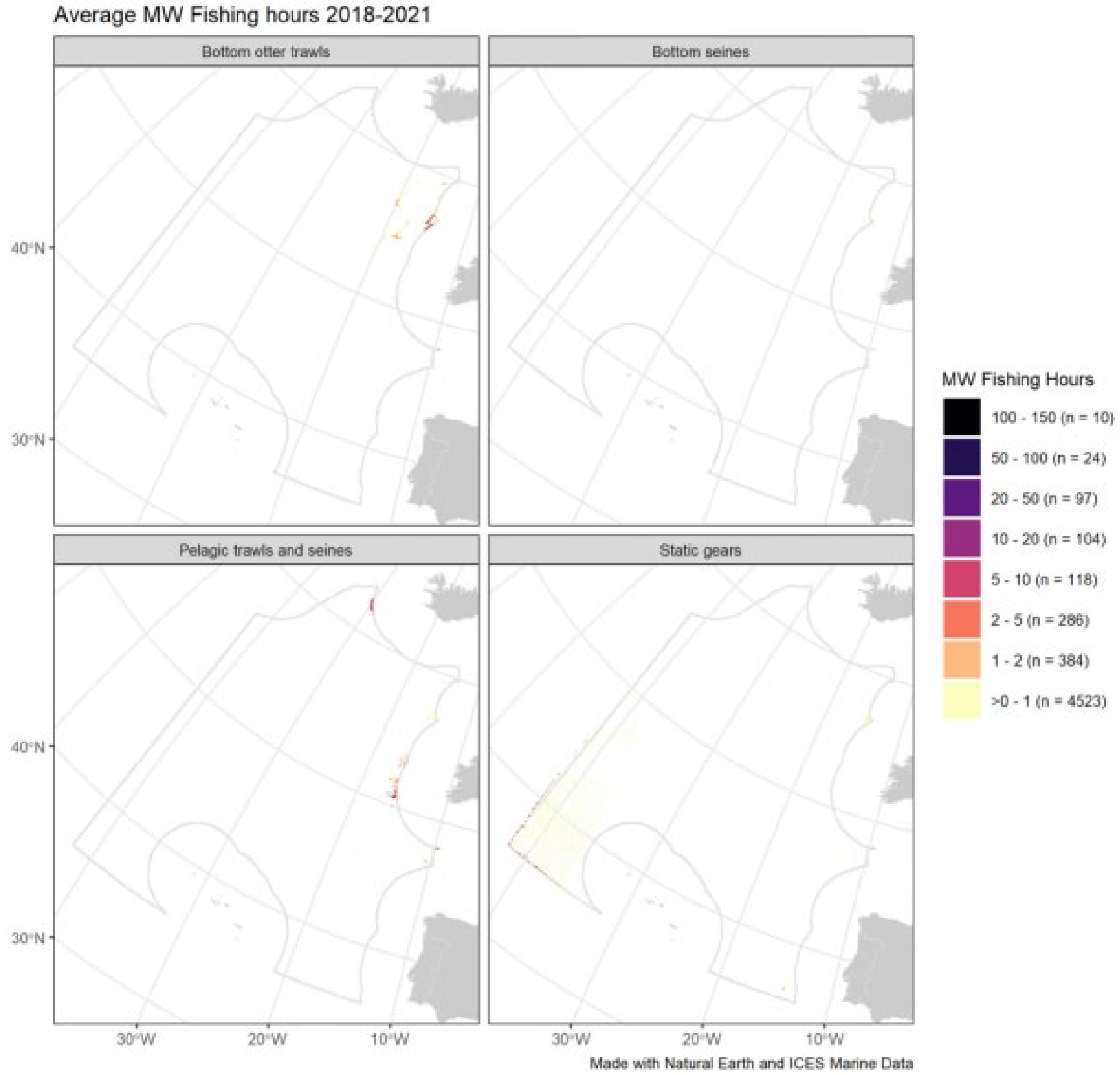


Figure 3.1 Average annual fishing effort (MW fishing hours) in the Oceanic Northeast Atlantic ecoregion, by gear type. Fishing effort data are only shown for vessels > 12 m. Figure taken from ICES 2022a.

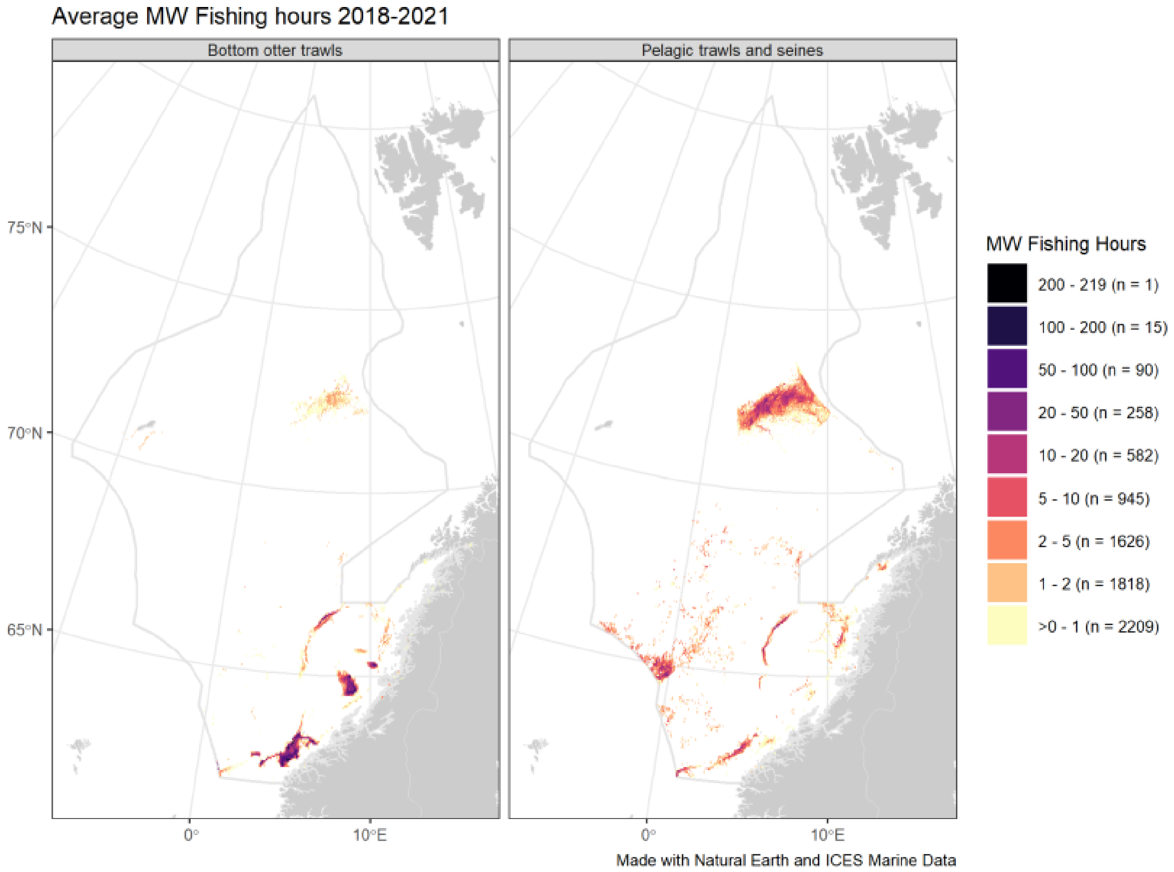


Figure 3.2. Average annual fishing effort (MW fishing hours) in the Norwegian Sea ecoregion, by gear type. Fishing effort data are only shown for vessels > 12 m. Figure taken from ICES 2021b.

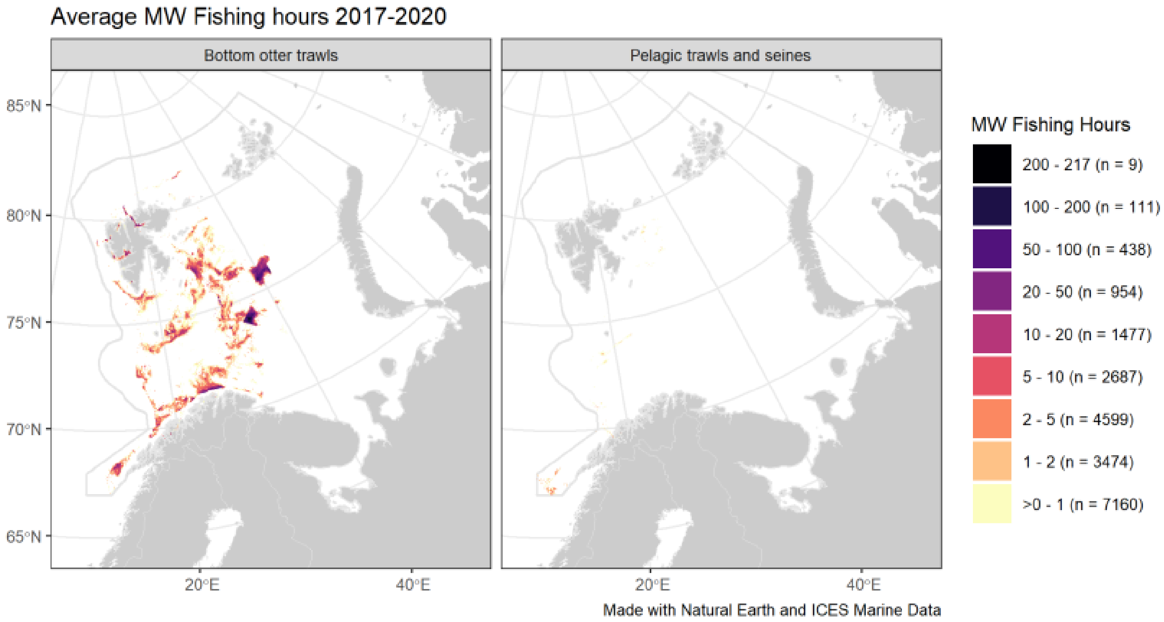


Figure 3.3. Average annual fishing effort (MW fishing hours) within the Barents Seas ecoregion by gear type. Fishing effort data are only shown for vessels >12m length. Figure taken from ICES 2021b.

Shipping

Shipping is extensive across the Oceanic Northeast Atlantic ecoregion, especially in the southern part of the ecoregion (ICES, 2019), overlapping with NEAFC RA1 and also occurs across NEAFC RA2 and 3 (Figure 3.4). There are known activities in the shipping industry that contribute to a range of environmental impacts, such as underwater noise, discharging of ballast water, the use of antifouling paints, and the disposal of marine debris and waste.

There is little information specifically observing the shipping industry's effects on the areas mentioned in this region. However, one of the better-known impacts includes the number of heavy metals being released into the water, for which high Contamination Severity Index (CSI) values were identified near industrial and shipping zones (Christophoridis et al. 2019).

The shipping industry has also produced significant emissions contributing to the acidification of the oceans by depositing sulfur oxides (SOx) forming sulfuric acid (H2SO4) and nitrogen oxides (NOx) forming nitric acid (HNO3). While pH changes might be less in open waters compared to coastal waters, the amount of shipping vessels passing through any area can still reduce the alkalinity of the water and the acidification caused by shipping can be within similar levels to CO2 - driven acidification near the coast (Hassellöv et al. 2013), however this varies on a global scale (Doney et al. 2007).

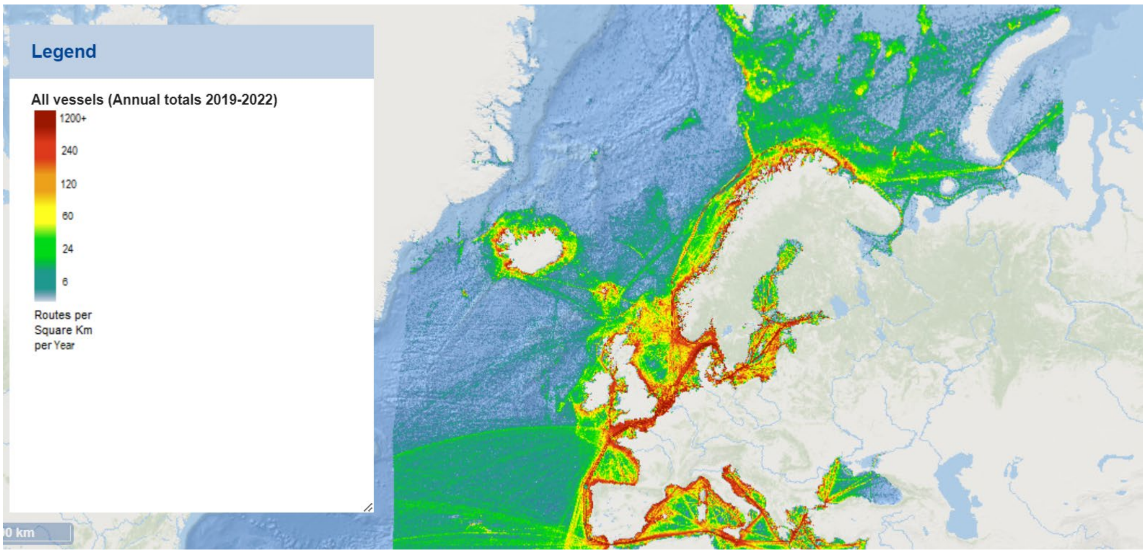


Figure 3.4. Vessel route density map based on annual totals (routes per sq km per year) for all vessels (including fishing) from 2019-2022. Image taken from the EMODnet Human Activities mapping portal. © European Union, 2022. https://emodnet.ec.europa.eu/en/human-activities [Accessed 10/08/23].

Telecommunications

Subsea cables have been installed in areas of the seafloor for telecommunications, the transfer of electricity between landmasses, and the landfall of electricity from offshore sources such as wind turbines (OSPAR, 2012). Cables occur across NEAFC RA1 (Figure 3.5), but not within RA2 and 3. Their installation, maintenance and removal can result in a range of pressures, such as marine noise, changes to sediment regimes (including resuspension and increased turbidity), physical seabed disturbance, and habitat loss / permanent changes in substrate type (Merck & Wasserthal, 2009; OSPAR, 2012).

Seabed disturbance caused by cabling is often localised, limited to the width of the cable corridor and temporary, occurring throughout the installation period. Habitat loss and permanent changes to substrate type can occur if protective structures to safeguard cable foundations are required. For example, cable burial may not be feasible in depths greater than 3000 m, or in areas of hard bedrock, and therefore requires cable armouring (Merck & Wasserthal, 2009). Protective structures can introduce substrata that are uncommon to the area of installation, which can attract flora and fauna that are atypical to the area. In instances where cables are unburied and unprotected, it is possible for abrasion to occur, if they are dragged across the seafloor by strong currents or wave action (Merck & Wasserthal, 2009).

Throughout their lifespan, cable installations can result in localised pollution, including heat emission, chemical reactions between seawater and cable insulation jackets and the generation of electromagnetic fields occurring in the vicinity of the cable (Copping et al., 2020; Vasilescu and Dinu, 2021; Chapman et al., 2023). However, impacts associated with electromagnetic fields from cables on fish and benthic species are poorly understood and further research is required (Copping et al., 2020; Chapman, et al., 2023).

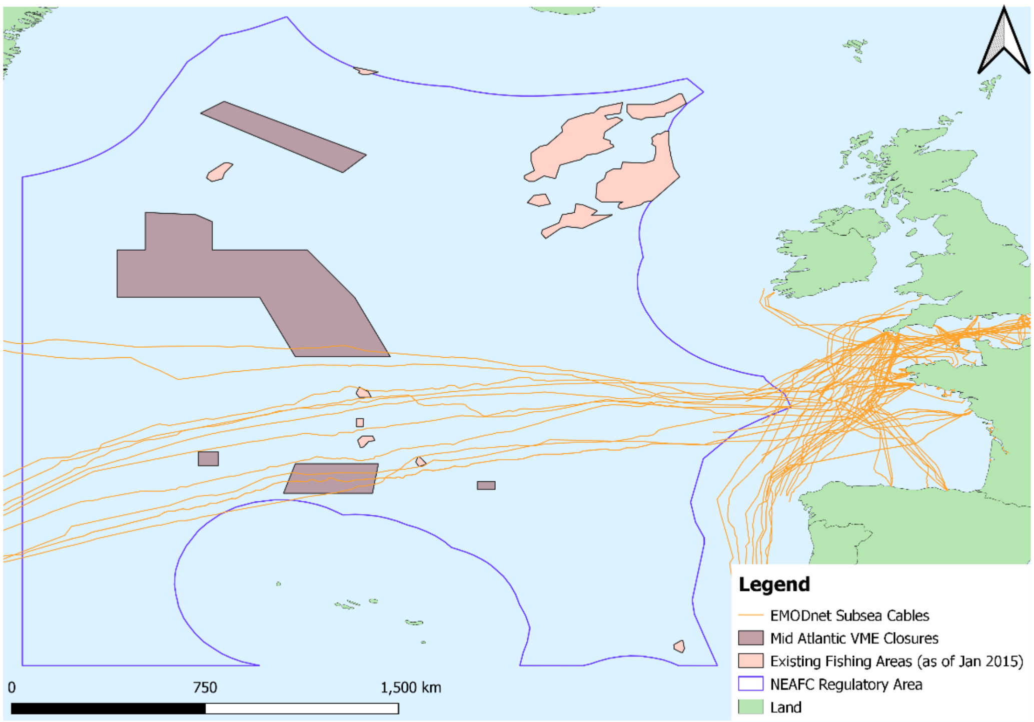


Figure 3.5. Telecommunications cables occurring across the NEAFC RA1 (data from EMODnet human activities data portal, accessed 10/08/23).

Radioactive waste dumping

More than 150 000 tonnes of low-level radioactive waste was dumped in the North-East Atlantic from 1949-1982, mainly at depths of 3000 - 5000m. Since then, in 1993, a global ban on the dumping of radioactive waste at sea was put in place under the 1972 London Convention (OSPAR, 2015). A report from the surveillance programme, which assessed impacts of the dumped radioactive waste, indicated no evidence of harm to the environment (OSPAR, 2015). It is therefore unlikely that this historic activity will have further impacts on the biodiversity and ecosystems within the region.

Bioprospecting of marine genetic resources

Marine genetic resources are of growing importance to the blue economy (Blasiak et al., 2021) and approximately 11% of marine genetic resources associated with patent applications are found in deep-sea and hydrothermal vent communities, reflecting increased research in remote and extreme environments (Blasiak et al., 2018). Typically, at the early stages of collection, referred to as bioprospecting, impacts are minimal, especially in comparison with impacts of fisheries (Beattie et al., 2011). Modern technologies permit the preliminary identification of bioactive compounds from small samples (<100g), and very few of these make it through the screening stage to commercialization.

Nevertheless, there is some evidence of over-collection, although it is currently difficult to assess the impacts of marine bioprospecting due to the fact that the sample quantity and abundance of the target organism are rarely published (Bekiari, 2023). Smaller, rarer species are more at risk than larger more abundant ones, and removal of species with episodic recruitment and poor recovery trajectories (e.g., deep-sea corals) may cause extirpation. For this reason implementation of environmental impact statements for bioprospecting activities are encouraged. However, if a useful compound is identified there are several options available for large-scale production, and typically chemical synthesis or in some cases, mariculture, are preferred over continued wild harvest.

Marine Litter

Marine litter can be defined as 'persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment' and can have deleterious effects on marine habitats and species (UNEP, 2021). Sources of marine litter include fluvial and aeolian litter transport from terrestrial environments, inadequate waste management, tourism, and maritime industries such as shipping, aquaculture, and fishing (Moriarty et al., 2016; Nelms et al., 2017; UNEP, 2021). Plastics have been reported as the most ubiquitous, harmful, and persistent type of litter in marine environments, contributing up to ~85% of all marine waste (Galgani et al., 2015; Kammann et al., 2018; UNEP, 2021). Some of the highest recorded plastic concentrations have been observed in deep-sea sediments, and trenches and canyons recorded as sinks for marine debris transported from shallower waters (Buhl-Mortensen & Buhl-Mortensen, 2017; Kane et al., 2020). Furthermore, deep-sea organisms have evolved over extended durations of consistent environmental conditions, and therefore, may be highly vulnerable to anthropogenic pressure associated with marine litter (Danovaro et al., 2017; Ashford et al., 2019).

Pressures associated with litter can include entanglement, ingestion, transport of non-native and invasive species, dispersal of organic and inorganic contaminants, and smothering (Chen et al., 2019; Consoli et al., 2019; García-Gómez et al., 2021). Marine litter can sink rapidly to the seafloor, taking hundreds of years to break down and in the case of plastics, degrade to micro-sized particles (Barnes et al., 2009; Hardesty et al., 2015; Thushari & Senevirathna, 2020). Pressures associated with fishing-related litter may pose key immediate threats to marine life; fishing gear has specifically been designed to catch marine organisms, and therefore, can have high-level ghost gear efficiency, contributing to species mortalities and biodiversity loss (Gilman et al., 2021).

Climate change

Climate change outcomes will impact productivity, biodiversity, and distribution of species in the region and are likely already having an effect, with implications for ecosystems and people. Even in the deep sea, impacts are predicted to result from ocean warming, acidification, deoxygenation, and changes in circulation and currents, as well as indirect impacts such as changes in productivity, the cascade of consequences through the ecosystem. In deeper waters, recent habitat suitability modeling of the North Atlantic predicts such impacts, i.e. that warming, acidification, and food availability, will significantly reduce suitable habitat for deep sea corals (>28% loss depending on species) and that deep-water fishes will shift northwards (Morato et al. 2020). These authors stress the importance of further understanding of how climate change will impact deep-sea species, with specific focus on ecosystem linkages and services. Findings align with other research, such as Johnson et al. (2018), who found climate change will impact species and spatial management areas across the North Atlantic, and the role of water masses and circulation predicted by Puerta et al (2020).

Refugia and the ability to shift range are important for marine species to respond and adapt to climate change, and this is particularly relevant to areas aimed at biodiversity benefits. For example, larvae of deep-sea corals and sponges will need to be able to disperse from source populations via currents. More actively mobile species, like fish, can better respond to declining habitats, but the conservation of effective corridors for that movement will be critical. Morato et al. (2020) found the potential for climate refugia in region was possible but discrete and limited, with some potential for habitat expansion for some fishes, but that such expansion would need to be supported by other ecosystem elements, e.g. food availability. Moreover, the potential for species to shift to new locations depend on ecological connectivity and species dispersal mechanisms, which again vary depending on species and life stages. We note that identifying refugia may mean considering areas not currently evaluated as high for biomass or biodiversity (e.g. Johnson et al. 2018).

Other impacts are likely to interact with climate change to exacerbate stress. Fishing is the most obvious and documented, but others will be important as well. For example, marine litter may also reduce the capacity for species to respond and be resilient to climate change impacts, and research is needed to understand those connections (e.g. Lincoln et al. 2022).

3.2 Potential future threats and associated pressures

Deep-sea mining

The ICES ecosystem overview for the Oceanic Northeast Atlantic ecoregion highlights that there is, as yet, no mineral exploration or extraction activity in the ecoregion (ICES, 2019). Contract areas for deep-sea mining of polymetallic sulphides along the Mid Atlantic Ridge are located further south, outside of NEAFC RA1 (Figure 3.6). The activity is regulated by the International Seabed Authority (ISA).

In the Extended Continental Shelf claim areas of Portugal, studies suggest that cobalt-rich crusts and polymetallic nodules may occur in Madeira’s national continental shelf, and massive sulphide deposits exist around the Azores’ continental shelf (Ecorys, 2014). Should mining activity be considered in the future on the extended continental shelf, it would be subject to legislation under national jurisdiction.

Within the Norwegian Sea ecoregion, deep sea mining has some future potential to occur, which could overlap with NEAFC RA2. As of June 2023, the Norwegian government issued a press release announcing a proposal to open parts of its extended continental shelf to this activity (Ministry of Petroleum and Energy of Norway, 2023). A study conducted by the Norwegian Petroleum Directorate (NPD) suggests the occurrence of manganese crusts and sulphides within these areas (NPD, 2023). Again, activity here would be subject to national legislation.

Key pressures expected to occur from deep-sea mining on biodiversity and ecosystems include noise, habitat loss, physical seabed disturbance, including smothering from sediment plumes, heavy metal contamination and changes in fluid flux regimes (Van Dover, 2014; Carreiro-Silva et al., 2022). Recent modelling studies indicate that the dispersion of sediment plumes may reach the linear distance of "10 to 20 km, cover an area of 17 to 150 km^2, and extend more than 800 m in the water column" (Morato et al., 2022).

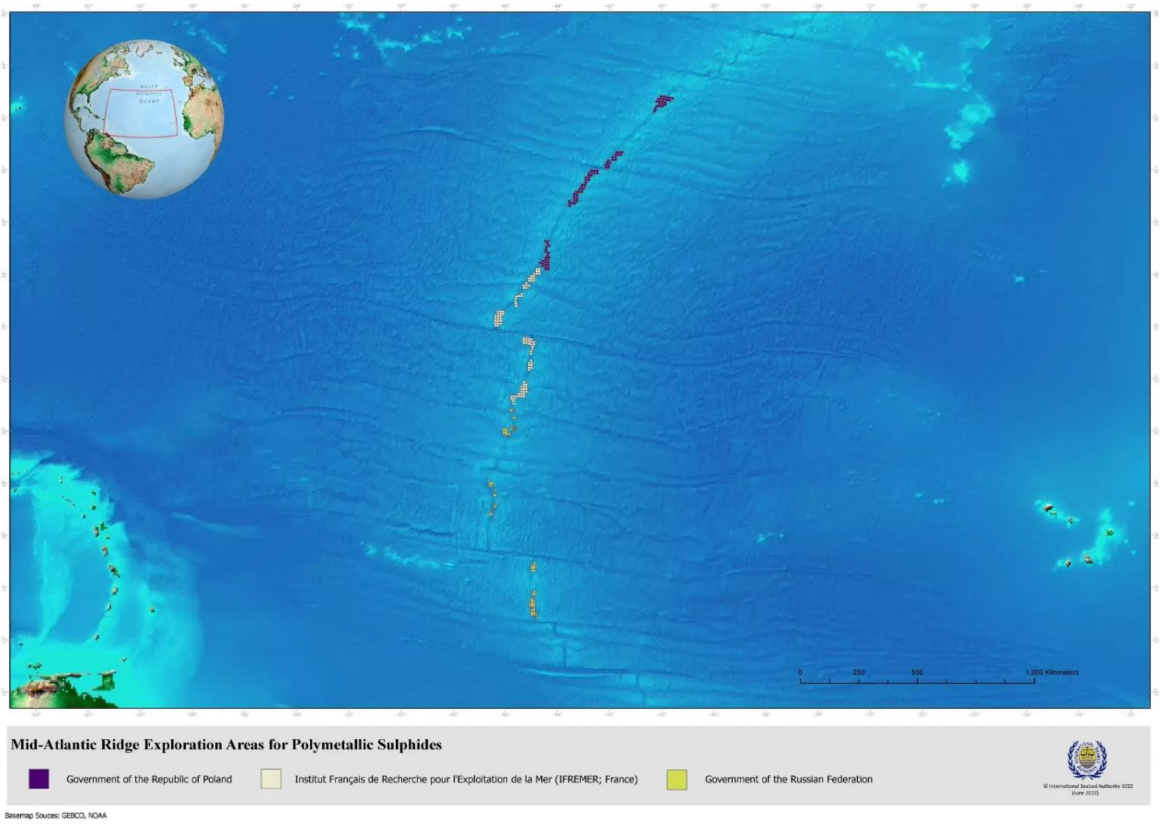


Figure 3.6. Exploration contract areas for Polymetallic Sulphides along the Mid Atlantic Ridge. Image from International Seabed Authority. https://www.isa.org.jm/exploration-contracts/maps/ [Accessed 10/08/23].

Oil and gas

Evidence from the OSPAR QSR 2023 indicates that only one oil and gas installation occurs within OSPAR Region V (wider Atlantic) and this occurs on the Irish continental shelf (Marappan et al., 2022) and thus outside of NEAFC RA1. Exploratory oil wells have been drilled in waters >1000m on the Rockall Trough, but these occur on the UK continental shelf, and are not active. No other oil and gas activity currently occurs within the region.

In NEAFC RA2, two boreholes are present, but both are abandoned. No existing oil and gas activity occurs within NEAFC RA3.

Key pressures from oil and gas activity would include noise, physical seabed disturbance (e.g. abrasion, change from soft to hard substrata, habitat loss), introduction of contaminating compounds, diffuse pollution and oil spills.

Renewable energy

At present, there are no renewable energy projects in NEAFC RA1, 2 or 3, and there do not appear to be any officially planned as of this report. For offshore wind, the size of wind farms and their distance from shore has increased considerably in recent years, and that trend will likely continue as countries shift to renewable sources, as costs decline, and as technology, especially for floating wind farms, advances. However, fixed-bottom installations do not currently go beyond waters of 60m depth. Floating offshore wind may be located in much deeper waters, the European Commission estimated a potential 3,000GW of floating wind in European waters 100-1000m (European Commission 2020), but this sector is early in its development. OSPAR determined the relative intensity for renewables in OSPAR Region V to be low, with no increasing trend to 2030 (OSPAR 2021). Other offshore technologies, like floating solar photovoltaics, are also in early stages of exploration.

For marine species, much of the renewable energy impacts occur in the construction phase, via removal of sediments, noise, collision, sediment suspension and smothering, and other disturbance (hydrography). Over the lifespan of the project, fixed-bottom wind farms alter benthic structures, which can have biodiversity benefits via increased hard substrate, or adverse effects if acting as stepping stones for invasive species, but therewith are risks of habitat loss, collisions, disruption of electromagnetic fields, noise and entanglement. On the other hand, wind farms and their surroundings are often closed to fishing for safety reasons, which may reduce pressure on species and habitats, offering some passive biodiversity benefits. Impacts of new renewables are less well understood, including floating arrays and installations in deep water, due to the fact that they are in early stages of development. Overall, however, potential for renewable energy in the region is low, and is an area for consideration in the future, should (floating) technology advance into deeper waters here.

Mesopelagic fisheries

While not yet operating, there is the potential for mesopelagic fishing in the region; previous surveys found substantial biomass of mesopelagic fish here useful for animal feed as well as human consumption (e.g. Grimaldo et al. 2020). Mesopelagic species are critical in marine food webs, and play a connecting role via diel vertical migrations, thus such fisheries would require careful consideration and could pose significant ecological threats, and possibly to carbon cycles. However, these fisheries currently remain exploratory given economic realities at this time and the potential ecological and biological impacts of such fisheries.

Activity/Pressure	Physical seabed disturbance[3]	Introduction of contaminating compounds	Introduction of non-indigenous species (NIS)	Marine Litter*	Noise	Light	Selective extraction of species (incl. bycatch)
Fishing	x	x	x	x	x	x	x
Shipping		x	x	x	x	x	
Telecommunications	x		x		x		
Bioprospecting							x
Marine litter[4]	x	x	x				
Deep-sea mining	x	x			x	x	
Oil and gas	x	x			x	x	
Renewable energy	x		x		x	x	

Table 3.1. Pressures associated with the current and potential future activities occurring within NEAFC RA 1, 2 and 3. Pressures listed are taken from ICES, 2023

---

[3] Physical seabed disturbance can occur via abrasion (the scraping of the substrate), resuspension of the substrate (siltation), removal of the substrate, and deposition (smothering) (ICES, 2023)

[4] Marine litter could be both the source of multiple pressures, and a pressure itself.

3.3 Pressures and likely threats from fishing activities affecting or expected to affect the areas and the biodiversity attributes

Fishing will have impacts on the environment which vary between types of gears and how they are used; i.e. individual or repeated damages to vulnerable bottom habitats, accidental catches of endangered or sensitive species, unaccounted mortality of escaping fish, catches of juvenile fish and ghost fishing due to lost and abandoned fishing gears. Fishing gears are commonly categorized as active/mobile e.g. trawling and seining, and passive/stationary (longlines, gillnets, pots and traps).

Physical seabed disturbance

Active fishing gears with bottom contact are considered to have the greatest impact on bottom sediments and benthic ecosystems (Eigaard et al., 2016, Løkkeborg et al. 2023). While passive fishing gears do not affect the demersal habitat to the same degree as active gears, they pose a threat in vulnerable areas with e.g. coral reefs. The gears can snag on corals, breaking them or ripping out an entire colony, and/or cause the gear to be difficult to retrieve. As the trawl is towed along the seabed, four trawl components have bottom contact; the doors, sweeps, centre weight and the ground gear. The doors and centre weight are heaviest and dig deepest to the sediment, but at the same time give the narrowest footprint (smallest area). Hiddink et al. (2017) give an overview of 18 studies showing tracks from trawl doors, varying in depth from 0.2 to 30 cm (median = 5.5 cm), where the deepest tracks are observed on muddy bottom. Video observations on hard bottom, mostly gravel with particle size < 6,5 cm (Freese et al., 1999), showed that the groundgear (rubber wheels of 65 cm diameter) left tracks of 1 to 8 cm depth and moved 19% of the largest boulders (> 75 cm). The sweeps affect the greatest area. The only study assessing the penetration depth for sweeps reports 2.2 cm penetration depth (Hiddink et al., 2017). For how long the tracks from trawling remain depends on how extensive they are, the sediment type, depth, and currents. Accordingly, it is distinguished between surface (0-2 cm) and subsurface impact (deeper than 2 cm) of bottom contacting gear.

Recovery time for habitats affected by trawling depends on fishing intensity (times trawled per year and intervals), surface and subsurface impact, type of fauna with regards to sediment composition, and degree of natural disturbance (currents and waves). A soft-bottom ecosystem will recover much more quickly than a coral reef, and studies have shown that while recovery from moderate impact can take less than a year, it can take decades for vulnerable habitats comprised of slow growing and long-lived organisms like corals, sponges, and sea pens. While studies on effects of bottom trawling on the seabed have been limited to shelf fisheries, damaging effects of towed demersal gear on vulnerable habitats occur independent of depth.

Marine litter and ghost fishing

Abandoned, lost and discarded fishing gear (ALDFG) constitutes a worldwide problem. This is partly due to direct polluting effects (estimated to be about 10% of waste in the oceans) but also due to ghost fishing, when ALDFG continue to catch and kill organisms (Gilman et al. 2015). The greatest potential for ghost fishing is from passive gears such as gillnets, trammel nets, pots and longlines. Gilman et al. (2015) lists several reasons for gear losses. In addition to intentional discarding of gear, there may be interactions with other gear, cutting of marker buoys, tracking gear malfunction, snagging on submerged features, damage by marine organisms, improper gear design and material, setting in areas where likely to snag bottom features, inclement weather, and strong currents. In offshore, deep areas, the risk of losing gear and not being able to retrieve it increases due to the harsh conditions, compared to coastal areas.

Biomass removal

Most obviously, fishing impacts target stocks via the removal of biomass, which has indirect effects on the ecosystem and biodiversity. That is, the harvesting of target stocks has indirect effects via life history outcomes, predator-prey relationships, competition, etc., and these cascade beyond management boundaries and via bentho-pelagic coupling. Additionally, such effects will interact with climate change to potentially exacerbate consequences, which is likely to worsen in the future. In this region, some pelagic stocks are currently fished above recommended targets, as discussed previously. The current impact of VME closures on demersal species is unclear as not all have fishing history data, and research on the potential for biomass to spill over beyond currently closed areas is needed.

Bycatch

Size- and species selection in fisheries is obtained by choice of location and gear specification such as mesh sizes, codend dimensions, mouth opening and position in the water column. Demersal fisheries are often multi-species, meaning that bycatches of organisms other than the target species are usually retained. While catches in pelagic fisheries, targeting fish schools are usually “cleaner” (less bycatch per volume of catch), there are known incidents of bycatches, including sharks, bluefin tuna and marine mammals. In the blue whiting fishery west of Ireland, a cruise conducted by IMR in 2021 (Breen et al. 2021) confirmed anecdotal evidence that there is a potential problem with bycatch of large species, for example: porbeagle (Lamna nasus) (IUCN status [NE Atlantic]: critically endangered) and bluefin tuna (Thunnus thynnus) (IUCN status [Europe]: near threatened). As for hook-and-line fisheries, deep-water sharks continue to be commonly caught as bycatch in the Azorean demersal and deep-sea fisheries (Fauconnet et al. 2023). Amongst them are several deep-water shark species categorized as threatened in the European IUCN Red List.

In NEAFC RA1, bycatch in demersal trawl fisheries is about 9 % in terms of total catch, while in benthic fisheries with long-line and bottom set gill nets the proportion is higher, but very variable with on average 20 % in the recent period. In RA 2, little information is explicitly available for the area while most of the bycatch information applies to waters in the Norwegian EEZ. In RA 3, no bycatch information is available.

3.4 Cumulative impacts assessments

Human activities can exert multiple pressures simultaneously, which may have additive, synergistic or antagonistic impacts on an ecosystem component. The severity of these impacts can ideally be altered through management measures if the multiple pressures are considered in combination.

In OSPAR ecosystem assessments, the bow-tie approach is applied (Figure 3.7), allowing for a mainly qualitative approach to cumulative impact assessments. Graphically, the ecosystem component considered is the tie, and pressures (cause) and impact (consequence) each represent one bow. ICES (2021b) has further elaborated this model as a risk-based model, defining the impact as a product of overlap and consequence, with one such risk assigned to each of the pressures for the ecosystem component under consideration. Thus, spatial and temporal overlap between pressures and ecosystem components (i.e. exposure) is a key element of cumulative risk assessments (ICES, 2021 c), and each impact can be weighted by the degree of exposure. In risk –based models, the risk also results from combining the exposure with differential ecosystem component vulnerabilities, where VMEs are, by nature, components showing the most vulnerable traits.

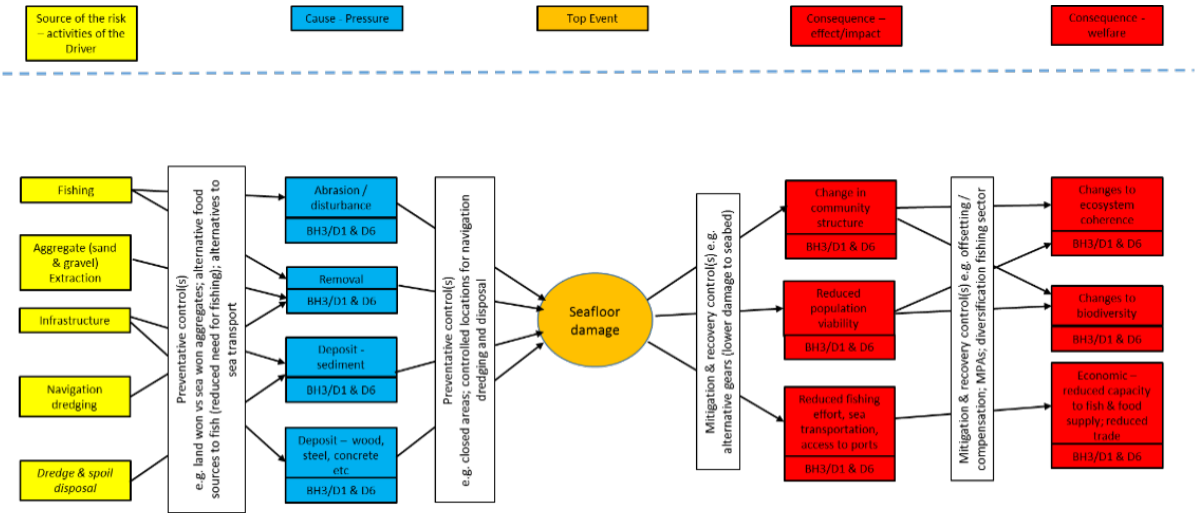


Figure 3.7: OSPAR bow-tie approach as a methodology to assess cumulative impacts on ecosystem components (= "Top Event"). See ICES 2021c for more explanation.

3.5 Conclusions

The evidence available on current, historic and potential future activities indicates that fishing is the most prevalent activity occurring across NEAFC RA1, 2 and 3, with the greatest potential threats from associated pressures. Within the existing fishing footprint, pressures will include physical seabed disturbance, selective extraction of species (including bycatch), and marine litter resulting in ghost fishing. Within the areas restricted to bottom fishing and VME closure areas, the threats from fishing are limited to impacts from pelagic gears, and are thus mainly selective extraction of species (incl. bycatch) and marine litter (incl. ghost fishing). The risk of impact to benthic and demersal biodiversity attributes is minimised within these areas, compared to the existing bottom fishing footprint, due to the lack of bottom contacting gear.

Additional activity within NEAFC RA1, 2 and 3 is mainly limited to shipping, and threats from associated pressures are mostly from the introduction of contaminating compounds. This is more likely to impact foodwebs in the pelagic environment, but could impact seabed sediments and associated infaunal and epifaunal communities.

There is wider threat from climate change and marine litter, however, these are unlikely to be threats that can be easily prevented, removed or eliminated, at the NEAFC RA scale.

Future activities are uncertain but may include deep-sea mining on the extended continental shelf of Norway, and possibly Portugal, renewable energy development, oil and gas activity, and mesopelagic fisheries. None of these present an imminent threat to the regions and thus associated risk to the biodiversity attributes is currently low.

4 Evaluation of the NEAFC management measures and if they mitigate the threats to the biodiversity attributes

WKECOVME agreed to use the CBD OECM criterion C (CBD 2018) as a guidance to address ToR A(iii) on the evaluation of the NEAFC management measures as to whether they achieve, or are expected to achieve, positive and sustained outcomes for the *in situ* conservation of biodiversity, and the likelihood or their potential effectiveness in mitigating the threats to the biodiversity attributes. Participants noted however that all the other OECM criteria (A (not a protected area), B (governed and managed), and D (associated ecosystem functions and services and cultural, spiritual, socio-economic and other locally relevant values), as well as the further guidance contained in CBD decision 14/8 (2018) would be essential for the full assessment of specific NEAFC's area-based management measures to be identified as OECMs. Considering the specific NEAFC's request to ICES, this full assessment would fall outside the scope of the workshop. In light of this, the evaluation contained in this section only focuses on how the measures for bottom fishing closures (VME closures) and restricted areas contained in NEAFC Recommendation 19:2014 align with OECM Criterion C (see table x below). Any further steps on the identification of these areas as OECMs by NEAFC would take the OECM criteria (annex III of decision 14/8 (2018)), as a whole, into full consideration. It was also noted that several other competent bodies and authorities play an important role in the conservation and sustainability of marine biodiversity attributes in the North-east Atlantic. Addressing biodiversity threats collectively and in a coherent manner can prevent marine biodiversity loss more effectively. Therefore the continued co-operative efforts between NEAFC and other competent authorities is of utmost importance.

4.1 VME closures

This section addresses the VME closures contained in NEAFC Recommendation 19:2014. The VME closures and other fisheries closures in NEAFC's Regulatory Area 1 can be found in figure 4.1 below (in green and brown).

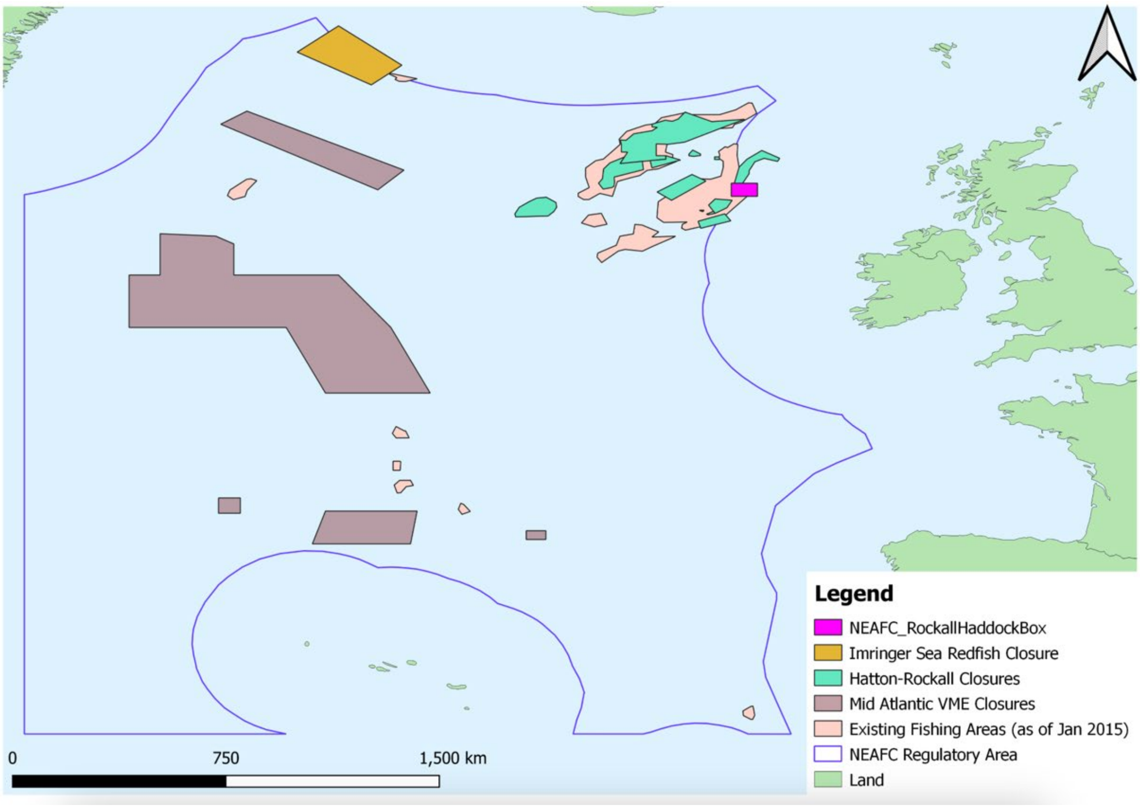


Figure 4.1: NEAFC fisheries and VME closures in RA 1.

Table 4.2. Evaluation of the measures for the VME closures contained in NEAFC Recommendation 19:2014 against OECM Criterion C.

CBD OECM Criteria C (CBD decision 14/8 (2018), Annex III)	NEAFC VME closures
Effective (i) The area achieves, or is expected to achieve, positive and sustained outcomes for the in situ conservation of biodiversity. (ii) Threats, existing or reasonably anticipated ones are addressed effectively by preventing, significantly reducing or eliminating them, and by restoring degraded ecosystems. (iii) Mechanisms, such as policy frameworks and regulations, are in place to recognize and respond to new threats. (iv) To the extent relevant and possible, management inside and outside the other effective area-based conservation measure is integrated.	VME closures NEAFC Recommendation 19:2014 adopted bottom fishing closures to protect VMEs. Bottom fishing is defined as “the use of fishing gear that is likely to contact the seafloor during the normal course of fishing operations” (Art. 2(a)). These closures are reviewed every five years (Art 10(1)). The current closures are in place until 31 December 2027 (Art.10(2)). In a recent review of the appropriateness of the closures, ICES (2022a) advised that “the current NEAFC bottom-fishing closure areas are still appropriate to protect VMEs, based on cumulating evidence of VME occurrence within these areas”, and that the “reopening of such closures to bottom fishing would present a risk of significant adverse impacts to VMEs, in particular as evidenced for mobile bottom-contacting gear.” (pp 1). Therefore, and in light of the findings of ToR A(i), the VME closures achieve and is expected to continue to achieve

CBD OECM Criteria C (CBD decision 14/8 (2018), Annex III)	**NEAFC VME closures**
	positive and sustained in situ biodiversity conservation outcomes (criterion (i), as long as these closures remain in place (criterion (iii), see also FAO 2022, at 18). In this case, the threats from bottom fishing are therefore addressed (see Garcia et al 2022). While other human activities can pose a threat to these benthic and demersal biodiversity attributes, the main current and anticipated pressures to these VME closed areas are bottom fishing, climate change and ocean acidification (see section 2 on threats and pressures above). The continued protection of these cold-water areas ecosystems from bottom fishing by NEAFC as the competent authority aligns with criterion (ii). Continued cooperation with other competent bodies remains important so as to ensure that other activities and cumulative pressures do not undermine the protection offered by the VME closures to biodiversity (criteria (ii) and (iv)). Other relevant closures in the vicinity Rockall Haddock Box (NEAFC Recommendation 4:2023): is not a closure to protect VMEs and falls outside the scope of this evaluation, which is based on the VME closures contained in Recommendation 19:2014. Further information is contained in the WKTOPS report (ICES 2021d).
Sustained over long term (i)The other effective area-based conservation measures are in place for the long term or are likely to be. (ii)“Sustained” pertains to the continuity of governance and management and “long term” pertains to the biodiversity outcome.	VME closures The current prohibition of bottom fishing in the VME closures and the effectiveness of such closures (Recommendation 19:2014, Article 5) are revised every five years in light of new scientific information (Art 10). Scientific evidence points to the need to maintain these closures to ensure the long-term maintenance of biodiversity benefits. The reopening of such closures to bottom fishing would present a risk of significant adverse impacts to VMEs, in particular as evidenced for mobile bottom-contacting gear (ICES 2022a). As per ICES advice, “any bottom-contact fishing on VME habitats using static or mobile bottom-contacting gears will result in damage to these habitats and poses a risk of significant adverse impacts” (ICES 2022b). Collectively, these confirm that VME closures are likely long-term measures for biological benefits, as long as they remain in place and as they relate to bottom-contacting gear. The longevity of the measure should also relate to the biodiversity attribute to be conserved (ICES 2021; Garcia et al 2021; IUCN-WCPA 2019), which in the case of VME indicator species are extremely long-lived (see section 1 on biodiversity attributes). The scientific review of VMEs under Art 10 is important, especially in light of climate change, hence the importance of continued clear scientific evidence in responding to such requests. Such evidence may include considerations on ecosystem ramifications, climate change and ocean acidification refugia sites (see sections 1 and 2 above; CBD 2016) the potential ongoing impacts of climate change, and other impacts to the region. Both Recommendation 19:2014 and the ICES advice speak to sustained governance, i.e. ICES advice (2022b) supports sustained prohibition of bottom-contacting gear. However, gaps in data and monitoring should be addressed to ensure effective governance and that biodiversity outcomes are

CBD OECM Criteria C (CBD decision 14/8 (2018), Annex III)	NEAFC VME closures
	maintained. ICES advice (2022b) regarding the need for gear codes in daily catch reports to clarify fishing effort in the region (see information and monitoring section below) may be especially important as effort can be concentrated along closure boundaries, as on Rockall Bank. These elements pertain only to bottom-contacting fishing gear, and do not address or monitor other stressors in the region, including those from other fishing activities (passive gears) and sectors. To fully address long-term biodiversity benefits and sustained governance, measures from all competent bodies and sectors that could pose a threat to biodiversity need to be coordinated with a view to address the full range of potential impacts in the area. Other relevant closures in the vicinity: Rockall Haddock Box: This area is managed outside the regime for VME protection under Recommendation 19.2014, and therefore falls outside the scope of this evaluation. However, since it is location (Rockall Hattom region), which focuses on VME protection, this area will be briefly mentioned herein (albeit not analysed). This measure was established to protect juvenile haddock for stock recruitment (ICES 2021). Regulations currently restrict all fisheries except longlines and its objectives could be considered long-term since it has been in place for over 20 years. The Haddock Box closure is up for revision annually, and focuses on haddock for which there is no formally agreed management plan in place (ICES 2021). ICES advises NEAFC to keep the closure in place and evidence for VME indicators species exist (see section 1 above). VME closures under decision 19:2014 are not in place.
In situ conservation of biological diversity[5] (i)Recognition of other effective area-based conservation measures is expected to include the identification of the range of biodiversity attributes for which the site is considered important (e.g. communities of rare, threatened or endangered species, representative natural ecosystems, range restricted species, key biodiversity areas, areas providing critical ecosystem functions and services, areas for ecological connectivity).	VME closures A list of VME habitats and representative taxa (known as VME indicators) and VME elements are provided within Table 1 of the NEAFC recommendation 19:2014. Updates to the list of VME indicators were also identified in ICES (2020a) Annex 5. Each VME closure has been put in place for the protection of VME habitats, with associated indicator species. The definitions of VME link to the OECM biodiversity attribute definitions (see ToR ai), and therefore VME closure areas will likely meet the requirements of this criterion. Note that it is also important to clearly understand coupling between benthic and pelagic waters, including if it exists, to truly consider biodiversity outcomes for the ecosystem. For example, certain pelagic activities have consequences for benthic or demersal species, and vice versa. Doing so is important for articulating full biodiversity benefits, as well as for identifying where human activities may be permissible in other areas of the water column. The spatial analysis of pelagic fisheries (figure 4.1) reveals that there is very little overlap between VMEs and pelagic fisheries at this time.

---

[5] 'In situ conservation of biodiversity', is defined under the CBD as "the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties." (1992 CBD, Art 2)

CBD OECM Criteria C (CBD decision 14/8 (2018), Annex III)	NEAFC VME closures
	Other relevant closures in the vicinity: Rockall Haddock Box: This management measure is for a single species, haddock, and data on wider biological benefits, including confirmation of VMEs, is limited. The closure is known to contain VME indicator species (439 VME indicator records were submitted to the ICES VME database in the years 2016–2019) (ICES, 2020b), but VME habitat presence has not yet been confirmed, due to the type of data collected within the region (mostly bycatch from scientific bottom trawl surveys). However, VME habitat presence has been confirmed within the vicinity of the closures (ICES, 2020b). It is likely that the lack of evidence on the specific VME habitats within the closure area means the closure may not meet this criterion.
Information and monitoring (i) Identification of other effective area-based conservation measures should, to the extent possible, document the known biodiversity attributes, as well as, where relevant, cultural and/or spiritual values, of the area and the governance and management in place as a baseline for assessing effectiveness. (ii) A monitoring system informs management on the effectiveness of measures with respect to biodiversity, including the health of ecosystems. (iii)Processes should be in place to evaluate the effectiveness of governance and management, including with respect to equity. (iv) General data of the area such as boundaries, aim and governance are available information.	VME closures Contracting parties provide vessel information to the NEAFC Secretariat each year, for vessels authorized to fish in the Regulatory Area in order to calculate the bottom fishing footprint. However, information on gear code is not always provided (ICES 2022b). When linking the vessel registry to the VMS, it is not possible to know which gear is being used. Furthermore, a vessel might use two gears in a year, e.g. pelagic gear in one trip and demersal on another. The daily catch report system thus could be adapted to have skippers report the gear used to catch the fish they are reporting. Therefore, the recommendation from ICES (2022b) on the inclusion of gear code in the daily catch reports with a view to greatly improve the VMS data and understanding of potential adverse impacts of bottom-fishing activity on VMEs continues to be relevant, including with respect to meeting criteria (iii) and (iv).

4.2 Restricted Bottom Fishing Areas

This section evaluates the restricted bottom fishing areas of Recommendation 19:2014 against the CBD OECM criterion C. NEAFC's restricted bottom fishing areas are those outside the existing fishing areas (in pink below) and outside the closures (see fig 4.2).

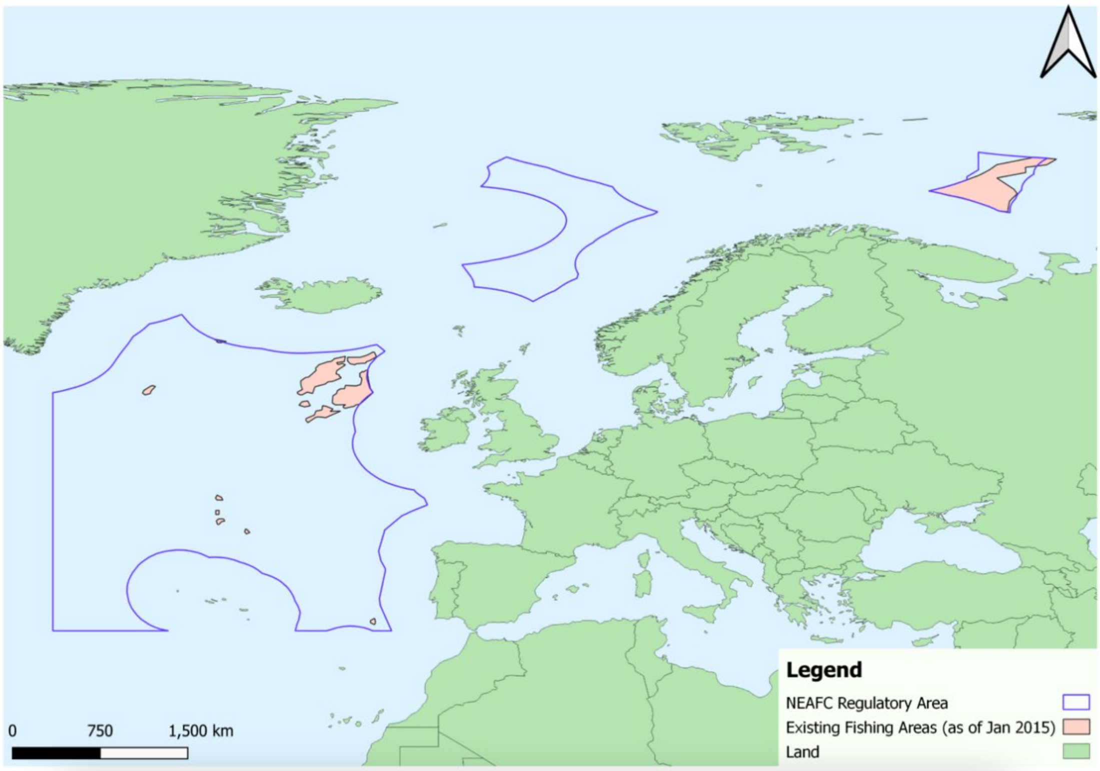


Fig 4.2 on NEAFC's existing fishing areas and its Regulatory Areas.

Table 4.2: Evaluation of the measures for the restricted areas contained in NEAFC Recommendation 19:2014 against OECM Criterion C

CBD OECM Criteria C (CBD decision 14/8 (2018), Annex III)	NEAFC's Restricted Bottom Fishing Areas (NEAFC Recommendation 19:2014)
Effective	
(i)The area achieves, or is expected to achieve, positive and sustained outcomes for the in situ conservation of biodiversity. (ii)Threats, existing or reasonably anticipated ones are addressed effectively by preventing, significantly reducing or eliminating them, and by restoring degraded ecosystems. (iii)Mechanisms, such as policy frameworks and regulations, are in place to recognize and respond to new threats. (iv)To the extent relevant and possible, management inside and outside the other effective area-based conservation measure is integrated.	In NEAFC, the restricted bottom fishing areas are defined as "areas outside closed areas and existing bottom fishing areas" (NEAFC Rec 19:2014, Art 2(f)). These areas can be subject to exploratory bottom fishing activities (NEAFC Rec 19:2014. Art 2(e)) if the requirements contained in Arts 6 and 7 of the same recommendation are fulfilled. The requirements for exploratory bottom fishing under these Articles include the submission to the Secretary of a Notice of Intent with documentation including: harvesting plan, mitigation plan (including those to prevent significant adverse impact (SAI) on VMEs, catch monitoring plan, catch recording/reporting system, data collection plan on distribution of tows/sets, plans for monitoring bottom fishing gear, data from seabed mapping programmes (Art 6, paras 1 and 2). In addition to the notice of intent, the Contracting Party should also submit to the Secretary an assessment of

CBD OECM Criteria C (CBD decision 14/8 (2018), Annex III)	NEAFC's Restricted Bottom Fishing Areas (NEAFC Recommendation 19:2014)
	known or anticipated impacts of the proposed activity as per Annex 4 of NEAFC Rec 19:2014 (Art 7). The requirements are similar to the impact assessment criteria contained in the FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas, which is applicable to existing and exploratory fishing areas alike (FAO, 2009, para 47).[6] If exploratory fishing is approved by the Commission and PECMAS, following the process stipulated in NEAFC Rec 19:2014, exploratory fishing can commence under certain conditions, including by having a scientific observer onboard, whom should collect VME data (Art 6 (6)). A report on the results of the activity shall be provided to the Secretary for ICES and CPs (Art 6(7)). After review of the impact assessments (under Art 7) and the results of the fishing protocols, based on the results of the exploratory fishing conducted in the past two years, the Commission may decide to authorise new bottom fishing, and these areas would then be defined as "existing bottom fishing areas" (Art 6(8)). No exploratory fisheries applications have been received to date, and hence the restricted areas are currently not subject to bottom fishing activities. The outcomes and effectiveness of the current measure regarding potential future fishing applications is still to be determined. New threats from bottom fishing would be addressed as per the provisions contained in NEAFC Rec 19:2014 with respect to the impact assessment criteria and process stipulated therein. Exploratory fisheries requirements are part of the precautionary approach to fisheries under the 1995 UN Fish Stocks Agreement, Article 6(6) (see also Caddell 2018). Environmental Impact Assessments (EIAs) have a crucial role in the protection of VMEs, as per the UN General Assembly Resolutions on Sustainable Fisheries (UNGA, 2006, 2009, 2011, 2016, 2022) and the FAO Guidelines (2009), but they differ from area-based management tools, such as VME closures, since EIAs and evaluation of EIAs will provide the basis for the establishment of future mitigation measures, which at the present cannot be evaluated because they have not yet been defined. Where VMEs are known to occur, closures provide the best response to potential threats from bottom fishing (NAFO SC 2013, at 40).

---

[6] Para 47 of the FAO Guidelines states that: "Flag States and RFMO/As should conduct assessments to establish if deep-sea fishing activities are likely to produce significant adverse impacts in a given area. Such an impact assessment should address, inter alia: (i) 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); (ii) 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; (iii) identification, description and mapping of VMEs known or likely to occur in the fishing area; (iv) 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; (v) 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; (vi) 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 (vii) 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."

CBD OECM Criteria C (CBD decision 14/8 (2018), Annex III)	NEAFC's Restricted Bottom Fishing Areas (NEAFC Recommendation 19:2014)
Sustained over long term	
(I)The other effective area-based conservation measures are in place for the long term or are likely to be. (ii)"Sustained" pertains to the continuity of governance and management and "long term" pertains to the biodiversity outcome.	These areas are open to exploratory fishing, and while there is guidance and requirements on VME considerations (Recommendation 19:2014, Articles 6 and 7, and Annex 4), the potential for fishing to occur precludes these areas from satisfying sustained governance for long-term biodiversity benefits. This measure likely has other benefits and may better fit under GBF targets 5 with respect to sustainable fishing, and 14 on mainstreaming biodiversity into economic sectors (CBD 2022).
In situ conservation of biological diversity	
(i) Recognition of other effective area-based conservation measures is expected to include the identification of the range of biodiversity attributes for which the site is considered important (e.g. communities of rare, threatened or endangered species, representative natural ecosystems, range restricted species, key biodiversity areas, areas providing critical ecosystem functions and services, areas for ecological connectivity).	There is no existing requirement to identify biodiversity attributes within the restricted bottom fishing areas, with the exception of areas where a Notice of Intent to undertake exploratory bottom fishing is provided (NEAFC recommendation 19:2014). Contracting Parties are then required to gather relevant data to facilitate assessments of exploratory bottom fishing, including a data collection plan to facilitate the identification of VMEs in the area fished. The definitions of VMEs link to the OECM biodiversity attribute definitions (see ToR ai). There will also be additional biodiversity attributes, aside from VMEs, that could be identified for the restricted bottom fishing area which are highlighted in Section 1 on biodiversity attributes. However, it is unlikely that the existing management measure (restricted bottom fishing area) sufficiently addresses this criterion in full because it doesn't set from the outset specific geographically delineated protective measures for the biodiversity attributes of the area.
Information and monitoring	
(i) Identification of other effective area-based conservation measures should, to the extent possible, document the known biodiversity attributes, as well as, where relevant, cultural and/or spiritual values, of the area and the governance and management in place as a baseline for assessing effectiveness. (ii) A monitoring system informs management on the effectiveness of measures with respect to biodiversity, including the health of ecosystems. (iii) Processes should be in place to evaluate the effectiveness of governance and management, including with respect to equity. (iv) General data of the area such as boundaries, aim and governance are available information.	NEAFC's recommendation 19:2014, which regulates exploratory bottom fishing, does not identify the biodiversity attributes in the restricted areas (as per criterion (i)). As noted above, the recommendation from ICES (2022b) on the inclusion of gear code in the daily catch reports with a view to greatly improve the VMS data and understanding of potential adverse impacts of bottom-fishing activity on VMEs continues to be relevant, including with respect to the sub-criteria (iii) and (iv). NEAFC's recommendation 19:2014 does not require that the exploratory fisheries assessments be made publicly available (as per criterion (iv), and FAO 2009, para 51). With respect to boundaries (criterion iv), the geographic delineation of the restricted areas are contained in NEAFC's Recommendation. However, any mitigation measure in the form of an area-based management tool as a result of the evaluation of the impact assessment/exploratory fishing requirements will have to be delineated on a case-by-case basis under the current regulations and they do not exist yet.

5 ToR B: Based on expert judgement (WGFTFB and WGSFD experts) as well as NEAFC VMS and catch report data analysis by WGSFD, provide a commentary on current and potential maximum depth on the use of mobile bottom contacting gear (trawls) and bottom contacting static gear in the NEAFC regulatory area.

5.1 Current maximum depth for bottom fishing

ICES have received vessel monitoring system data from NEAFC, along with catch reports, authorisation details, and vessel information from the NEAFC fleet registry for a number of years. These data have been analysed by the Working Group on Spatial Fisheries Data (WGSFD) to support a number of requests from NEAFC to ICES to provide information on the distribution of fisheries activities in and in the vicinity of VME habitats, and issues with data quality have been thoroughly documented over time. The principal challenge faced when using NEAFC VMS data to document the extent of bottom fishing is the lack of clarity around fishing gear inherent in the data. For many vessels, a description of gear type used is missing altogether, and for those where it is present, it is supplied once per year, leading to confusion should a vessel fish for both demersal and pelagic stocks (for example, redfish) within a year.

As a result, whilst NEAFC VMS data was explored in the early stages of this work, a decision was taken to focus on data received in response to the ICES VMS and logbooks data call, which passes through a robust quality assurance process, and can be subset by gear and target assemblage information (see Table XX). While the data itself may be more robust, a number of countries are not included in the dataset, (most notably Russia, Faroes and Norway). However, even with partial data coverage, it is still believed to be sufficiently representative of spatial fishing patterns in the NEAFC regulatory area to establish a maximum depth for fishing.

Table 5.1. Comparing two available sources of data to characterise the fishing footprint occurring in the NEAFC Regulatory Areas

Source	NEAFC Data	ICES Data
Temporal Extent	2004 – 2022 (quality poor until 2016)	2009 – 2022
Spatial Extent	NEAFC Convention Area	ICES Convention Area
Comprehensiveness	All vessels fishing in NEAFC RA	Vessels from ICES countries, but missing Norway, Russia, Faroes & Greenland
Data Type	Point data, with speed. Gear and engine power supplied annually (or not).	Gridded (0.05 degree cells) activity layers. Hours fished, KW hours fished, swept area ratio, by metier
Catch data	By species, by day (or week for EU)	Aggregated to total for all species

Source	NEAFC Data	ICES Data
Fishing activity	"Pings" at 1 – 6 knots	Assigned by national data submitters, based on analysis of speed profiles
How is fishing determined?	Speed profile	Assigned by data submitter
Where fishing is happening?	Precisely	Roughly
Who is fishing?	Not informed	Informed
How deep is fishing?	GEBCO 30" grid	Averaged over c-square (0.05° × 0.05°)
All activity captured?	Yes	No
Which gears are used?	Partial, and on an annual basis	Yes
Which species are caught?	Yes (daily or weekly)	No
How much is caught?	Yes	Yes

In order to provide a technical basis for a depth, below which fishing is unlikely to occur in the NEAFC Regulatory Area, gridded VMS data, submitted in response to the 2022 data call (ICES, 2022), was downloaded from the ICES database for vessels using bottom trawls, longlines and gillnets, in the years 2015 – 2021, in R, using the `icesVMS` library. This data is aggregated at a 0.05° × 0.05° scale, using the "c-square" indexing protocol (Rees, 2003). Global bathymetry data, at a 15-second resolution, was obtained from the General Bathymetric Chart of the Oceans (GEBCO, 2022) in a GeoTIFF format, which was then clipped to the Northeast Atlantic area (45°W – 40°E and 35° – 90°N). The VMS data was aggregated across countries and months to produce annual "footprints" for each gear type. To reduce the impact of artefacts caused by slow steaming, dodging weather and technical breakdowns, c-squares containing less than three hours of effort were filtered out. Average bottom depth in each fished c-square was calculated, and histograms produced showing the depth profile of the area fished by each gear and year in the Northeast Atlantic and fished by bottom trawl and year in the NEAFC regulatory area, to highlight the typical extent of fishing in the entire Northeast Atlantic and in the NEAFC regulatory area.

Results showed that while the majority of fished c-squares in the Northeast Atlantic are on the continental shelves, fishing activity continues down the slope for all gear types. For bottom trawling, 99% of c-squares containing fishing activity are shallower than 1000m, and 99.9% shallower than 1400m (Figure 5.1). For both the static gears, a slightly deeper profile is observed, however the fishing footprint is very limited in c-squares deeper than 1400m (Figure5.2; Figure 5.3), compared to the large surface area of marine space below 1400m in depth.

The histograms for the NEAFC regulatory area (Figure 5.4) show two peaks in the years 2015 to 2020. One between 200 and 400 m representing the bottom trawl fisheries on Rockall and Hatton banks and one at bottom depth of more than 800 m, representing the deep sea fisheries. For 2021 no deep sea fisheries were recorded.

These results were mapped spatially for the NEAFC regulatory area.

Figure 5.5 shows the distribution of bottom trawling on Rockall and Hatton banks, for each of the years between 2015 and 2021. The footprint is distributed, as would be expected, around the southern, western and northern slopes of Hatton bank, the eastern and western slopes of Rockall bank, and some fishing effort is regularly present in deeper waters to the west, on Lórien Knoll. In all of the years the footprint is contained by the 1400m isobath polygon. As there is substantially less data from static gear fisheries, longlines and gillnets have the footprints from 2015 to 2020 shown on single plots. Longlining in the Hatton/Rockall area is restricted to the top of the bank, around the area of the "haddock box". In the area around Josephine seamount the footprint is closely associated with the top of the mount, however some fishing takes place throughout the rest of the complex, in deeper waters. A further longline fishery is present in waters around the Pico fracture zone, to the southwest of Azores (Figure 5.6). Gillnet fishing is only tangentially present in the NEAFC regulatory area, on Rockall bank, along the border with the UK and Irish EEZs (Figure 5.7).

It could be argued that the current distribution of fisheries in the NEAFC regulatory area is only a reflection of the current management measures in place, however an analysis of bathymetry within the NEAFC existing fishing areas revealed that around 10% of the area has a bottom depth greater than 1400m, suggesting that fishers are not restricted from fishing deeper than they do currently by management measures, and that technical and economic considerations may be the limiting factors (Figure 5.8).

The NEAFC regulatory area is home to significant pelagic fisheries, both in deep (redfish, blue whiting) and shallower (mackerel, herring) waters. To allow a comprehensive view of fishing activities, these were also mapped. A large blue whiting fishery is known to take place in the deep waters to the west of Porcupine bank, which is clearly shown in Figure 5.9. Some pelagic fishing also takes place on the top of Rockall and Hatton banks, although catches from this area are much less extensive. It is interesting to note that vessels fishing with pelagic trawls appear to observe the VME closures present in this area, although technically they are only closed to demersal gears. In deep waters to the west of the mid-Atlantic ridge, to the southwest of the Icelandic EEZ, the distribution of a pelagic trawl fishery for redfish is shown in Figure 5.10.

To support discussions around a value for the maximum depth of fishing, the area of the NEAFC regulatory area, shallower than a set of depths between 1000m and 2000m, at 200m intervals, was calculated. Figure 5.11 shows the distribution of these across RA1, as well as close-up views of the Rockall/Hatton area, and the Mid-Atlantic ridge southwest of Iceland. Table 5.2 shows the areas circumscribed by each of these isobaths throughout the entire NEAFC regulatory area, while Figure 11 shows that the increase in area remains roughly linear with respect to increasing depth – there are few sharp discontinuities in depth within the NEAFC regulatory area, in contrast to the edge of the continental slope within national EEZs, so this result is perhaps to be expected.

Table 5.1. Area of the NEAFC regulatory area circumscribed by isobaths at 200m intervals between 1000m and 2000m.

Depth (m)	Area (thousand km^2)
1000	150
1200	195
1400	260
1600	340
1800	414
2000	491

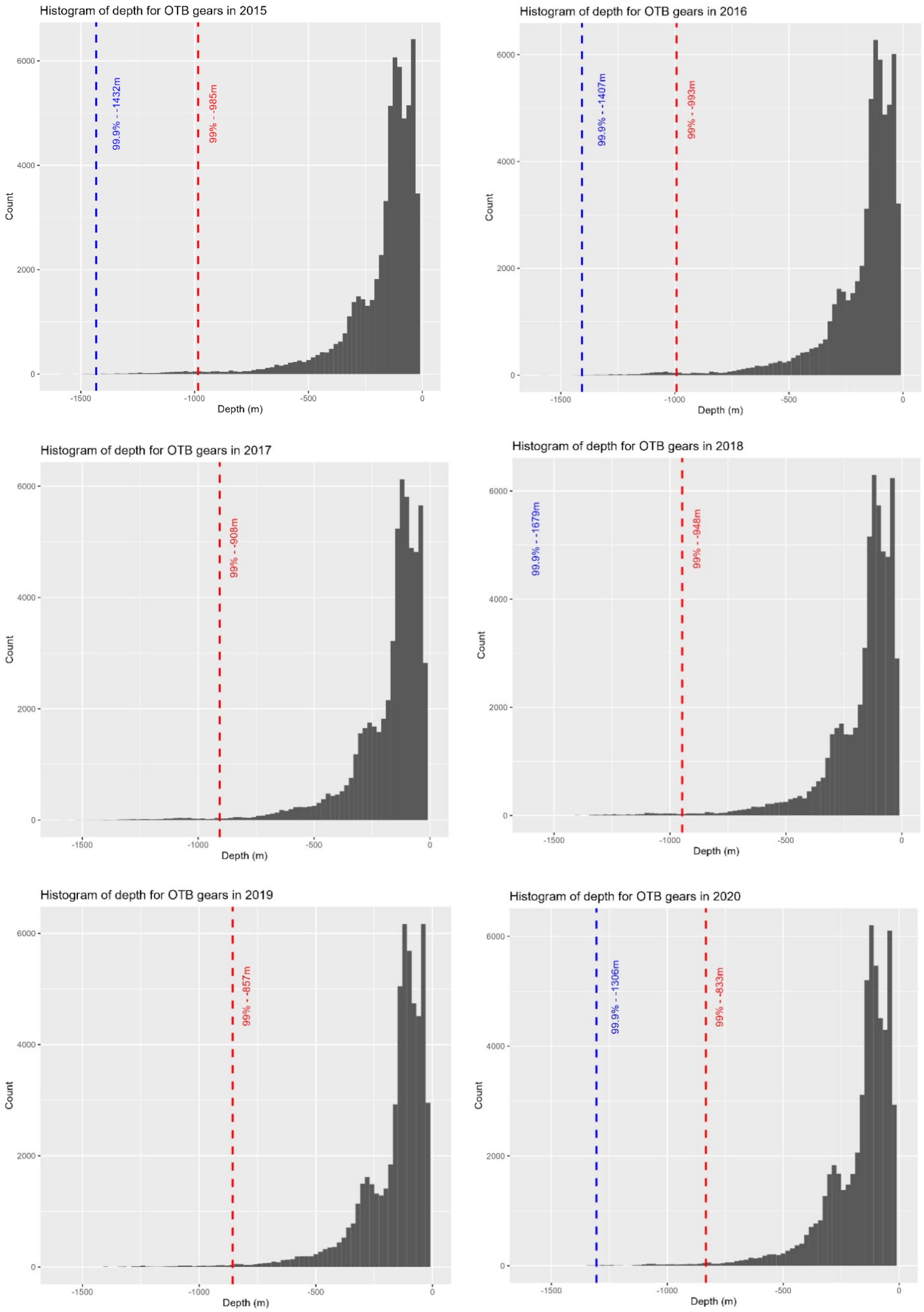


Figure 5.1. Histograms of mean depth of c-squares fished with bottom trawls, 2015 - 2020. Mean depths above which 99% of fished c-squares are shown with red lines, and 99.9% with blue.

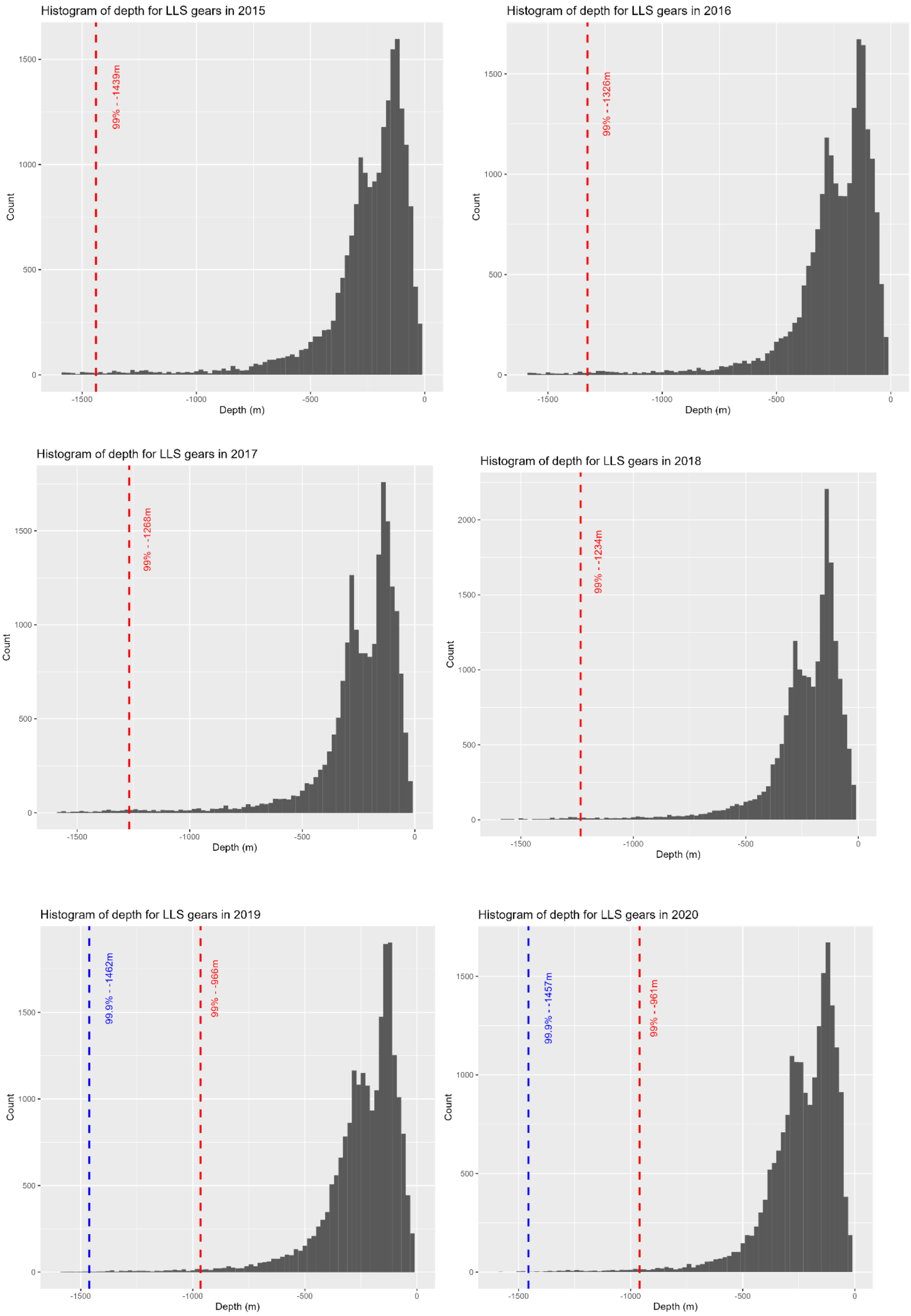


Figure 5.1. Histograms of mean depth of c-squares fished with longline gears, 2015 - 2020. Mean depths above which 99% of fished c-squares are shown with red lines, and 99.9% with blue.

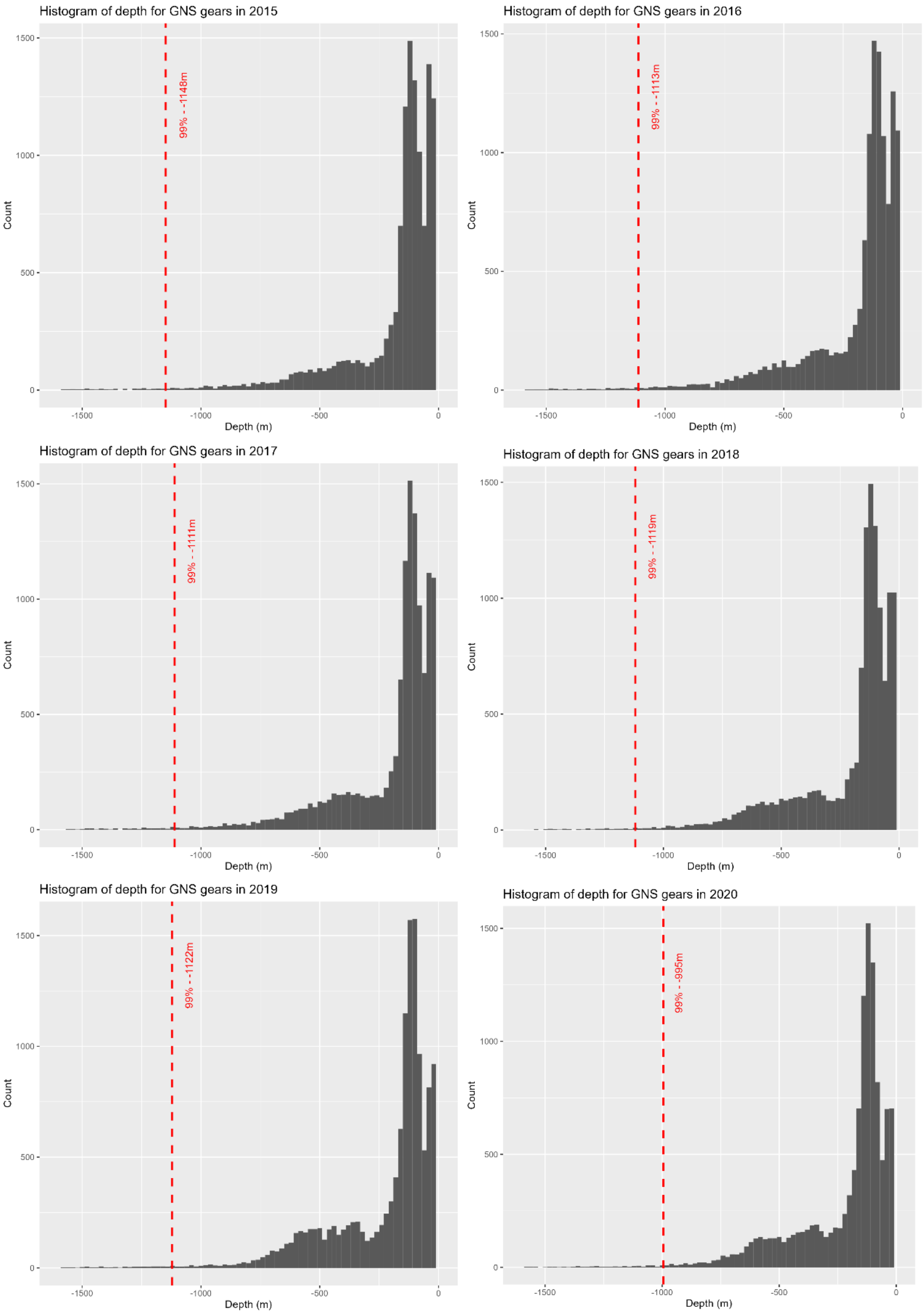
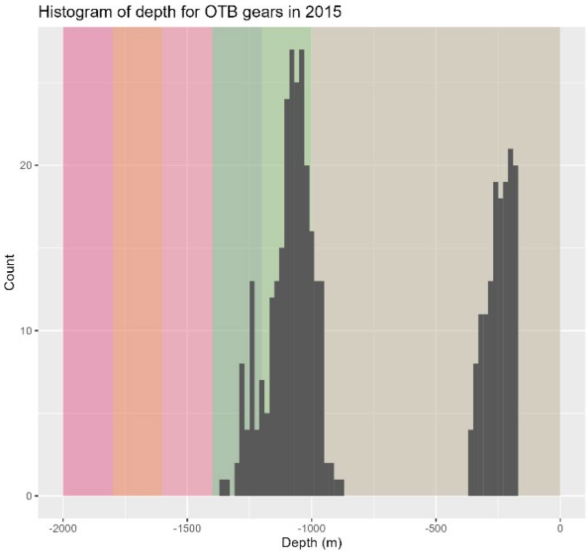
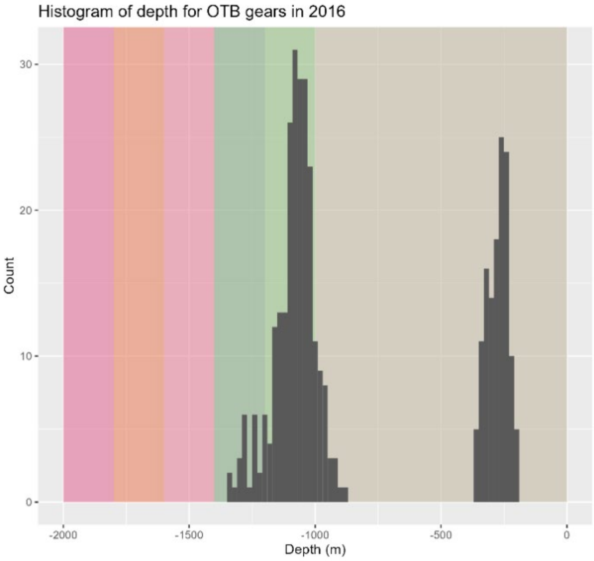
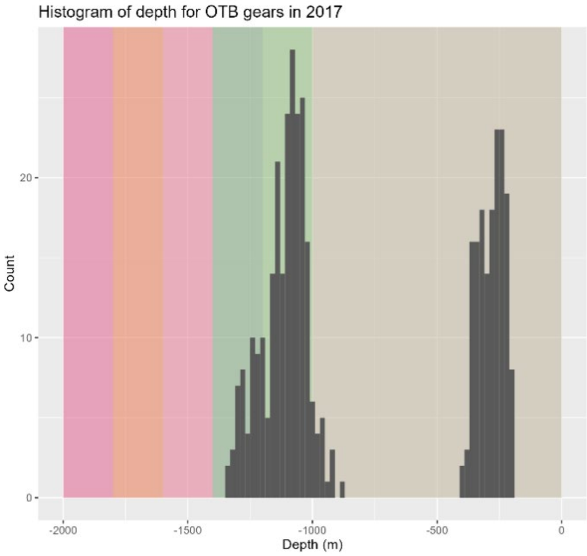
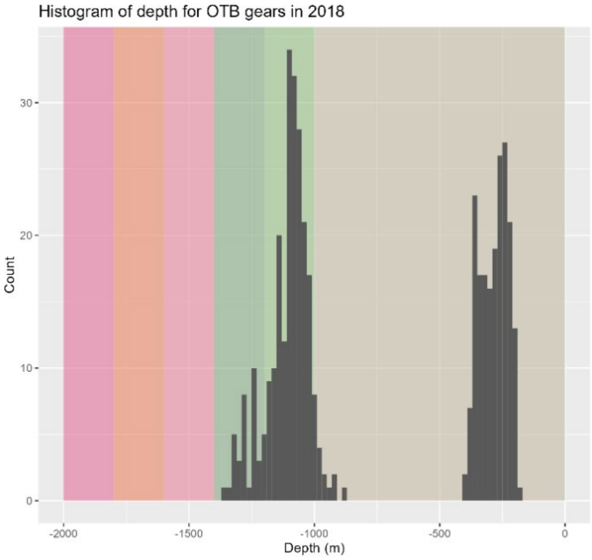


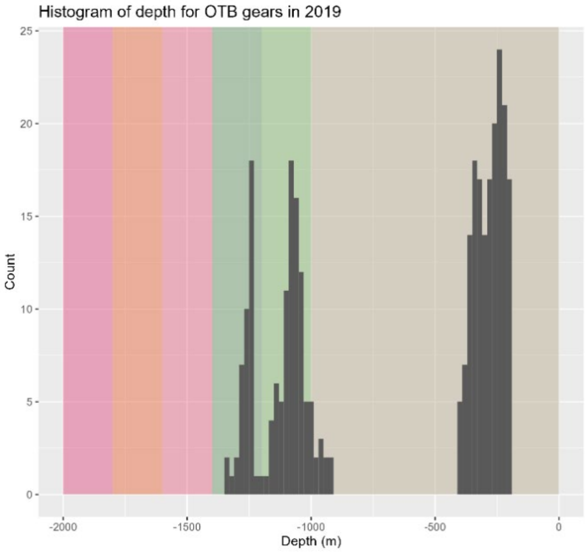
Figure 5.2. Histograms of mean depth of c-squares fished with set gillnets, 2015 - 2020. Mean depths above which 99% of fished c-squares are shown with red lines, and 99.9% with blue.

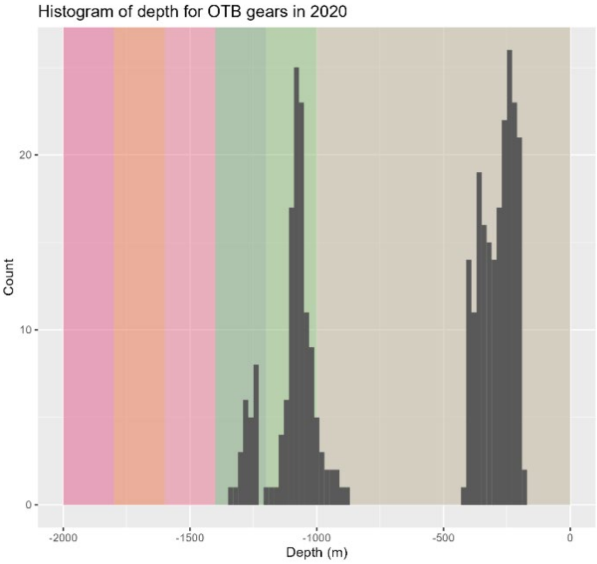

Histogram of depth for OTB gears in 2015


Histogram of depth for OTB gears in 2016


Histogram of depth for OTB gears in 2017


Histogram of depth for OTB gears in 2018


Histogram of depth for OTB gears in 2019


Histogram of depth for OTB gears in 2020

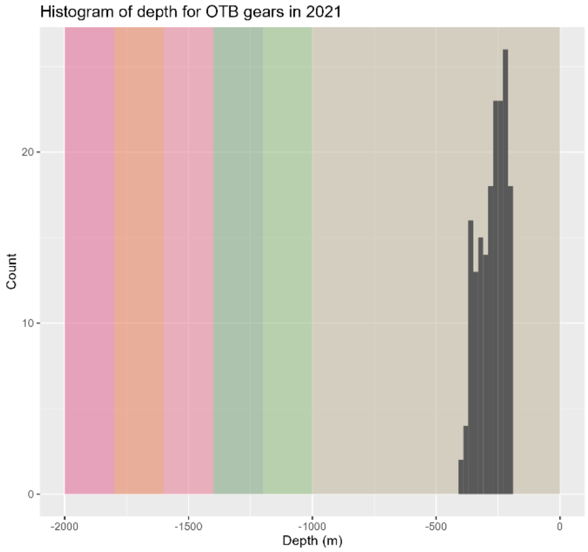


Figure 5.4. Histograms of mean depth of c-squares fished with set gillnets, 2015 - 2021. Bottom trawling with OTB in the NEAFC Regulatory Area.

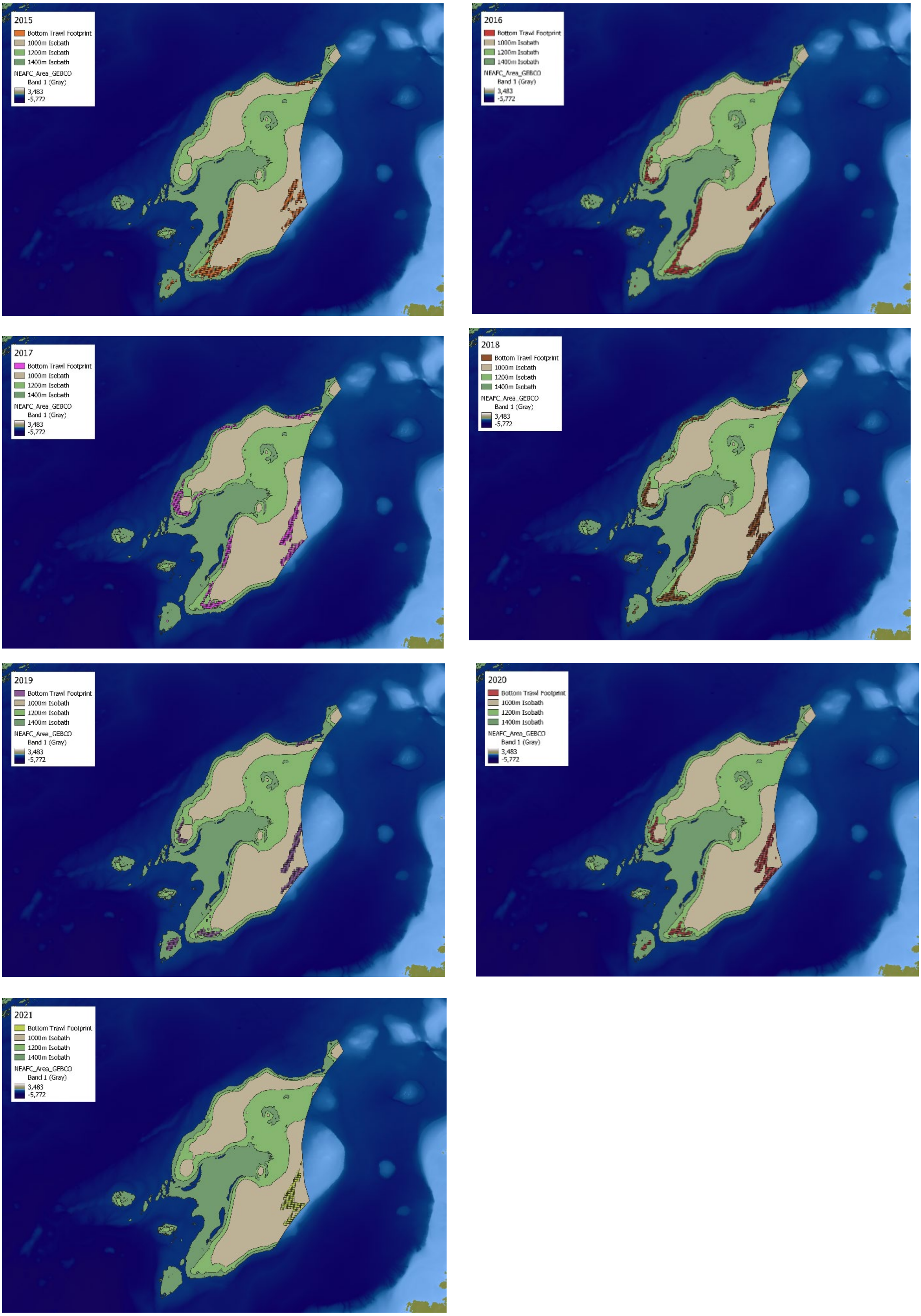


Figure 5.5. Bottom trawl footprints during 2015 - 2021, shown against the 1000m, 1200m and 1400m isobath areas at Rockall and Hatton Banks.

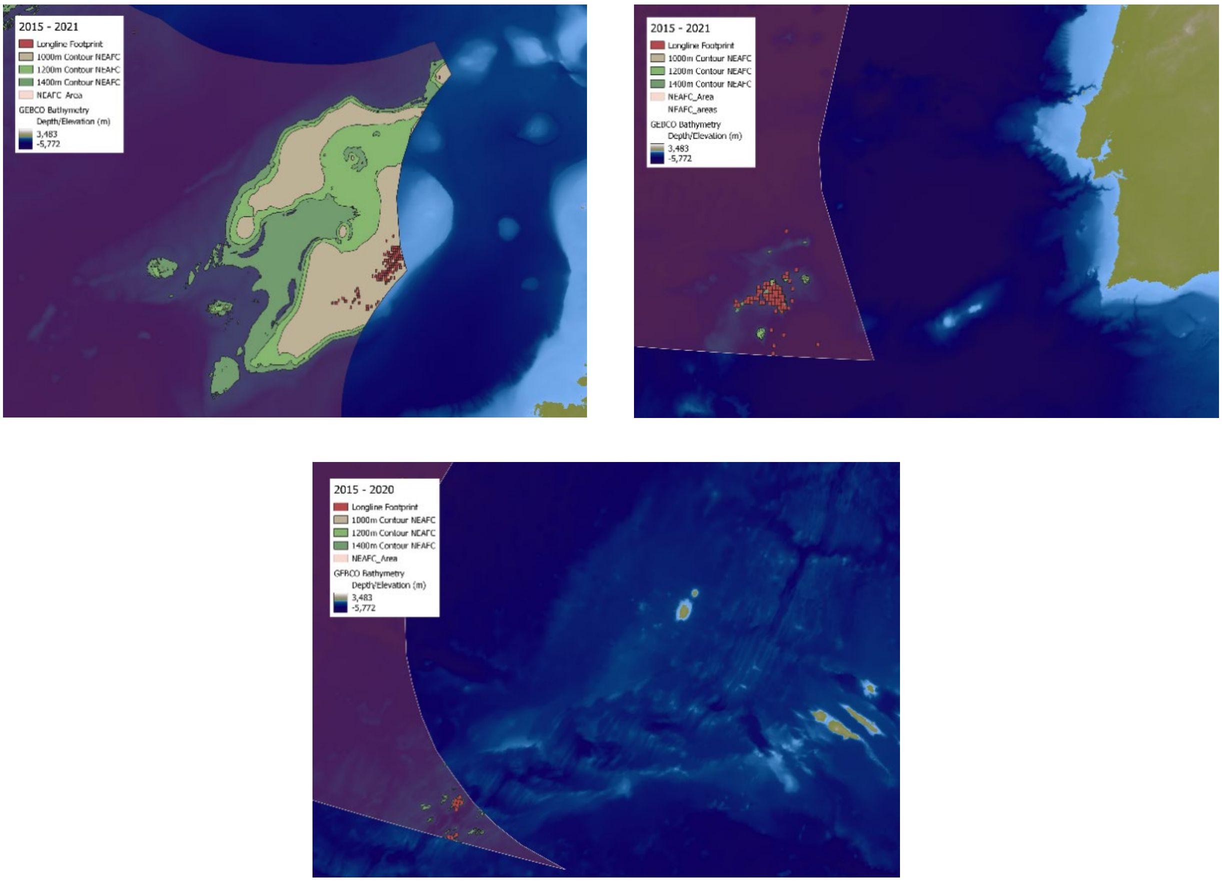


Figure 5.6. Longlining footprints during 2015 - 2021, shown against the 1000m, 1200m and 1400m isobath areas at Rockall and Hatton Banks.

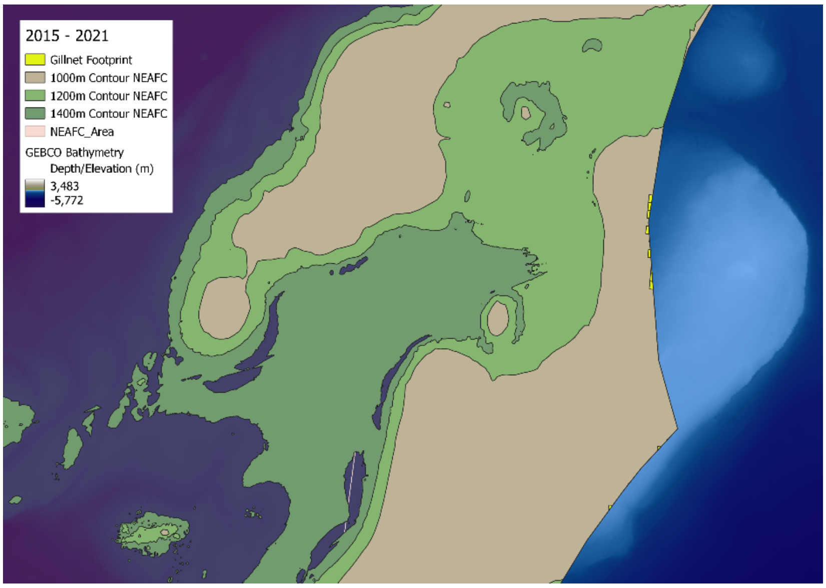


Figure 5.7. Gillnet footprints during 2015 - 2021, shown against the 1000m, 1200m and 1400m isobath areas at Rockall and Hatton Banks.

Figure 5.8. Areas within the NEAFC Existing Fishing Areas on Rockall and Hatton banks, shallower (light purple) and deeper (dark purple) than 1400m.

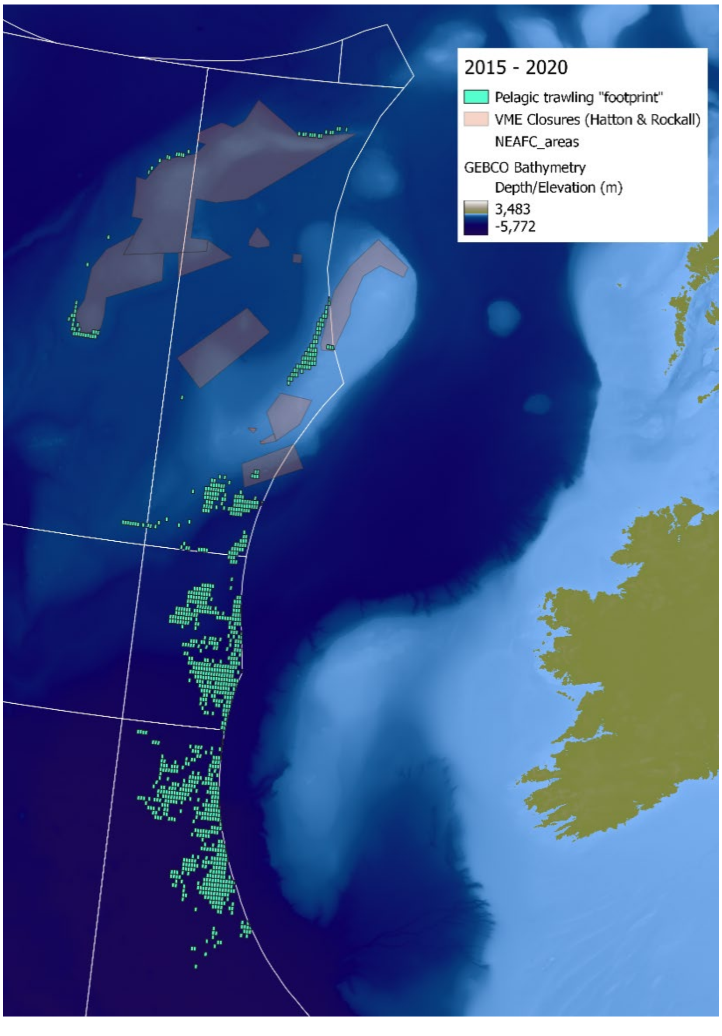


Figure 5.9. A "footprint" of pelagic trawling in the NEAFC regulatory area around Porcupine, Rockall and Hatton banks, 2015 - 2021.

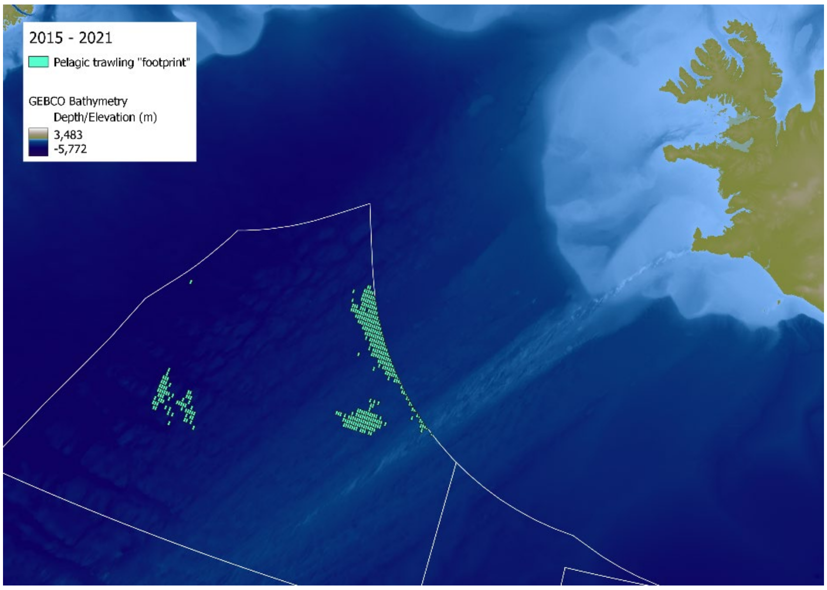


Figure 5.10. A "footprint" of pelagic trawling in the NEAFC regulatory area around the mid-Atlantic ridge, 2015 - 2021.

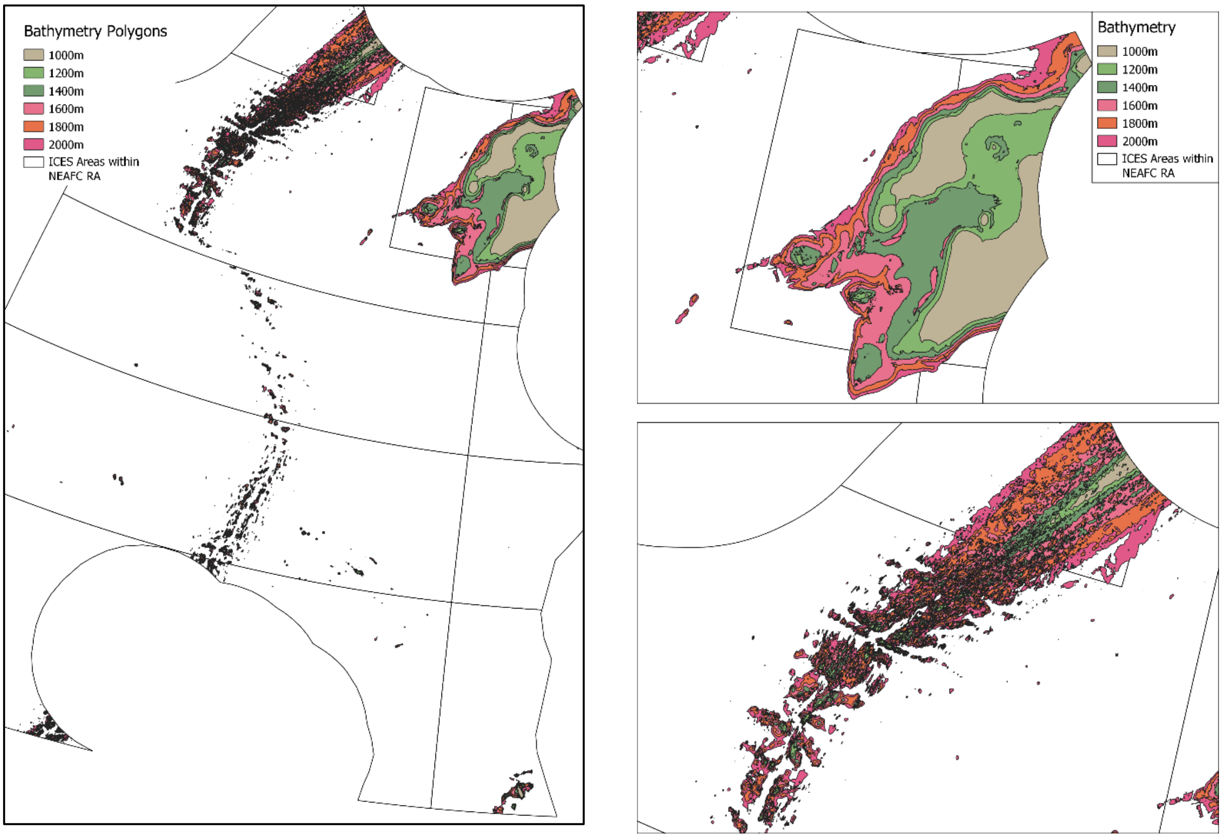


Figure 5.11. Polygons of areas within the NEAFC regulatory area between 1000m and 2000m, at 200m intervals. Left is a view of the entire RA1, top right a close up of the Rockall and Hatton banks, and bottom right the Mid-Atlantic Ridge north of the Charlie-Gibbs fracture zone.

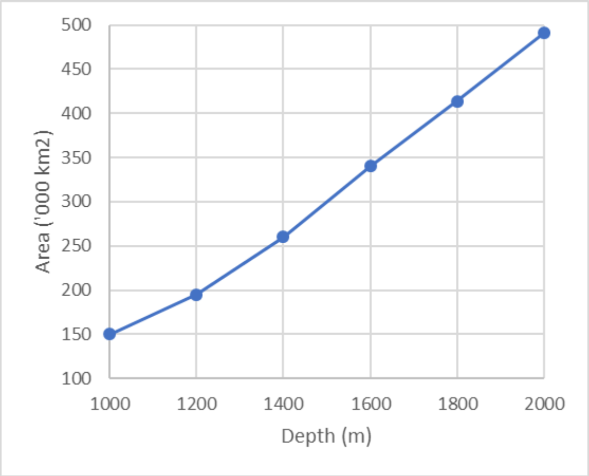


Figure 5.12. Graph of the area of the NEAFC regulatory area circumscribed by isobaths at 200m intervals between 1000m and 2000m.

5.2 Potential maximum depth for bottom fishing.

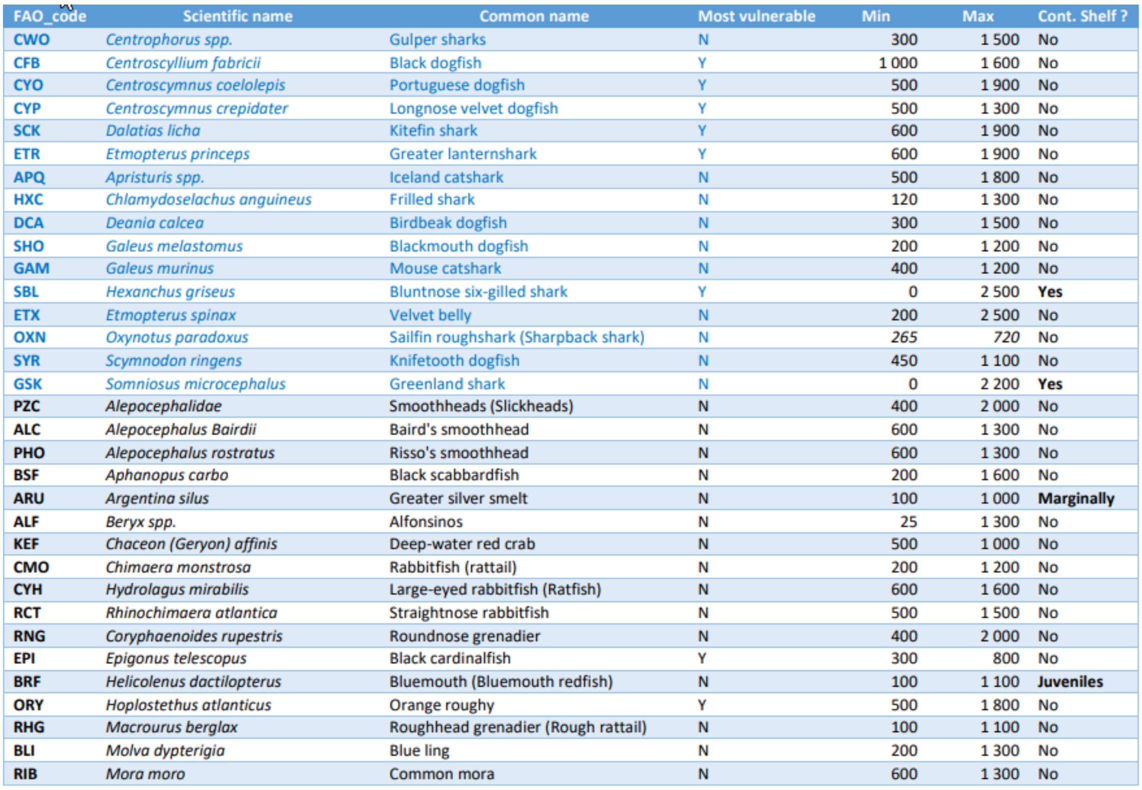
The bottom fishing areas in NEAFC RA1 includes bottom depth down to 3140 m. The current maximum fishing depth with mobile and passive bottom contacting gears is, as shown in section 5.1, around 1400 m in these areas.

The group has reflected on possible reasons for such a current maximum depth of fishing and what it suggests about a future potential depth for bottom contacting gears. Possible reasons include a lack of deep-sea resources, economic infeasibility (time constraints to reach the farther grounds, and in operating the fishing with longer warps, bridles and sweeps cables and the need for bigger winches to operate them vs. fish price and equipment costs) and technological limitations (dimensions of the warps and bridles, winches, space onboard and fuel consumption). Setting and hauling a trawl fishing deeper than 1000 m is time-consuming, and time is valuable on large ships, given their cost per hour. The limiting factor among those drivers (technical, economic, or resource distribution factors) is still unclear and prevents us from providing a precise estimate of potential maximal depth even if the lack of resources to exploit in deeper areas is likely the more determinant factor, according to expert judgement.

However, although it may be a challenge to fish with bottom contact gears at large depths especially with trawls, it is technically possible to conduct bottom fishing at depths greater than 1400 m. The absence of bottom fisheries below 1400 m is therefore likely related to the distribution of the resource (Table 5.2) and associated economic considerations rather than technical issues.

WKECOVME is not aware of any demersal fisheries resources in NEAFC RA that could support a commercial bottom fishery at depth of more than 1400 m and considers it unlikely that the maximum depth on the use of bottom contact gears observed in NEAFC RA will change with the current state of the resources.

Table 5.2. Extracted from EASME 2021 - Appendix 5 "Depth distribution of deep-sea species listed in Annex I of the EU Deep Sea Access Regulation (DSAR)" (doi:10.2826/464634)



FAO_code	Scientific name	Common name	Most vulnerable	Min	Max	Cont. Shelf ?
CWO	*Centrophorus spp.*	Gulper sharks	N	300	1 500	No
CFB	*Centroscyllium fabricii*	Black dogfish	Y	1 000	1 600	No
CYO	*Centroscymnus coelolepis*	Portuguese dogfish	Y	500	1 900	No
CYP	*Centroscymnus crepidater*	Longnose velvet dogfish	Y	500	1 300	No
SCK	*Dalatias licha*	Kitefin shark	Y	600	1 900	No
ETR	*Etmopterus princeps*	Greater lanternshark	Y	600	1 900	No
APQ	*Apristuris spp.*	Iceland catshark	N	500	1 800	No
HXC	*Chlamydoselachus anguineus*	Frilled shark	N	120	1 300	No
DCA	*Deania calcea*	Birdbeak dogfish	N	300	1 500	No
SHO	*Galeus melastomus*	Blackmouth dogfish	N	200	1 200	No
GAM	*Galeus murinus*	Mouse catshark	N	400	1 200	No
SBL	*Hexanchus griseus*	Bluntnose six-gilled shark	Y	0	2 500	**Yes**
ETX	*Etmopterus spinax*	Velvet belly	N	200	2 500	No
OXN	*Oxynotus paradoxus*	Sailfin roughshark (Sharpback shark)	N	*265*	*720*	No
SYR	*Scymnodon ringens*	Knifetooth dogfish	N	450	1 100	No
GSK	*Somniosus microcephalus*	Greenland shark	N	0	2 200	**Yes**
PZC	*Alepocephalidae*	Smoothheads (Slickheads)	N	400	2 000	No
ALC	*Alepocephalus Bairdii*	Baird's smoothhead	N	600	1 300	No
PHO	*Alepocephalus rostratus*	Risso's smoothhead	N	600	1 300	No
BSF	*Aphanopus carbo*	Black scabbardfish	N	200	1 600	No
ARU	*Argentina silus*	Greater silver smelt	N	100	1 000	**Marginally**
ALF	*Beryx spp.*	Alfonsinos	N	25	1 300	No
KEF	*Chaceon (Geryon) affinis*	Deep-water red crab	N	500	1 000	No
CMO	*Chimaera monstrosa*	Rabbitfish (rattail)	N	200	1 200	No
CYH	*Hydrolagus mirabilis*	Large-eyed rabbitfish (Ratfish)	N	600	1 600	No
RCT	*Rhinochimaera atlantica*	Straightnose rabbitfish	N	500	1 500	No
RNG	*Coryphaenoides rupestris*	Roundnose grenadier	N	400	2 000	No
EPI	*Epigonus telescopus*	Black cardinalfish	Y	300	800	No
BRF	*Helicolenus dactilopterus*	Bluemouth (Bluemouth redfish)	N	100	1 100	**Juveniles**
ORY	*Hoplostethus atlanticus*	Orange roughy	Y	500	1 800	No
RHG	*Macrourus berglax*	Roughhead grenadier (Rough rattail)	N	100	1 100	No
BLI	*Molva dypterigia*	Blue ling	N	200	1 300	No
RIB	*Mora moro*	Common mora	N	600	1 300	No

5.3 Use of a depth limit to define OECMs within the restricted fishing areas and VME closed areas.

5.3.1 Restricted fishing areas

The FAO handbook for Identifying, Evaluating and Reporting Other Effective Area-based Conservation Measures in Marine Fisheries states, on page 10 under the heading of gear restrictions: "gear restrictions applied to large jurisdictions are unlikely to qualify as Fisheries OECMs; however, discretely defined gear-restricted areas may have the potential to qualify" (FAO, 2022). In line with this, it seems appropriate for NEAFC to ring-fence the parts of the restricted bottom fishing areas that could potentially qualify as OECMs. WKECOVME recognises that a bottom-depth limit could be one way of setting OECM boundaries. As shown in section x, the increase in the area designated as a potential OECM applying a bottom-depth limit remains roughly linear with respect to increasing depth limit, meaning that the total size of the potential OECMs would increase with increasing depth limit.

If NEAFC wishes only to consider the parts of the restricted bottom fishing areas where bottom fisheries could potentially take place if there were no restrictions on bottom fishing a bottom depth limit of 1400 m would be appropriate.

However, the resulting areas may not necessarily include biodiversity attributes and may as such not contribute to the protection of them. An effective OECMs should target known significant biodiversity attributes with corresponding measurable biodiversity benefits at a spatial scale commensurate with the feature in question.

WKECOVME therefore considers that in discussing OECMs within the restricted bottom fishing areas the focus should be on areas containing biodiversity attributes. WKECOVME has in section 2 identified a number of areas within the restricted bottom fishing areas containing biodiversity attributes and suggest that these biodiversity attributes areas could be a good starting point for defining OECMs within the restricted fishing areas if effectively regulated through VME closures or equivalent measures.

5.3.2 VME closures.

ICES provided in 2022 in response to a request from NEAFC advice on the appropriateness of NEAFC bottom-fishing closures and advised that the current NEAFC bottom-fishing closure areas are appropriate to protect VMEs, and that reopening of such closures to bottom fishing would present a risk of significant adverse impacts to VMEs.

WKECOVME has no information on which to base a selection of parts of the VME closures as potential OECMs. As for the restricted bottom fishing areas the Workshop finds it difficult to justify the use of a bottom depth limit to designate OECMs within VME closures. The biodiversity attributes are well described in the VME closures and the Workshop considers that the VME closures as such could serve as a basis for defining OECMs.

6 References

Alt, C. H., Kremenetskaia, A., Gebruk, A. V., Gooday, A. J., Jones, D. O. 2019. Bathyal benthic megafauna from the Mid-Atlantic Ridge in the region of the Charlie-Gibbs fracture zone based on remotely operated vehicle observations. Deep Sea Res. I 145: 1-12.

Ashford, O., Kenny, A., Barrio Froján, C., Horton, t., Rogers, A. 2019. Investigating the envi-ronmental drivers of deep-seafloor biodiversity: a case study of peracarid crustacean assem-blages in the Northwest Atlantic Ocean. Ecology and Evolution., 9 (24), pp. 14167-14204, 10.1002/ece3.5852

Bamber, R.N., Thurston, M.H. 1995. The deep-water pycnogonids (Arthropoda: Pycnogonida) of the north-eastern Atlantic Ocean. Zool. J. Linnean Soc. 115: 117-162. https://doi.org/10.1111/j.1096-3642.1995.tb02325.x

Barnes, D.K.A, Galgani, F., Thompson, R.C., Barlaz, M. 2009. Accumulation and fragmentation of plastic debris in global environments. Philosophical Transactions of The Royal Society B, 364, 1985–1998.

Beattie, A.J., Hay, M., Magnusson, B., de Nys, R., Smeathers, J., Vincent, J.F. 2011. Ecology and bioprospecting. Austral Ecol. 36(3): 341-356. doi: 10.1111/j.1442-9993.2010.02170.x.

Beazley, L.I., Kenchington E.L., Murillo, F.J., Sacau, M. 2013. Deep-sea sponge grounds enhance diversity and abundance of epibenthic megafauna in the Northwest Atlantic. ICES J. Mar. Sci. 70: 1471–1490 https://doi.org/10.1093/icesjms/fst124

Bekiari, M. 2023. Marine Bioprospecting: Understanding the Activity and Some Challenges Related to Environmental Protection, Scientific Research, Ethics, and the Law. In: Garcia, M.d.G., Cortês, A. (eds) Blue Planet Law. Sustainable Development Goals Series. Springer, Cham. https://doi.org/10.1007/978-3-031-24888-7_19

Bell, J.B., Alt, C.H., Jones, D.O. 2016. Benthic megafauna on steep slopes at the northern mid-Atlantic ridge. Mar. Ecol. 37(6): 1290–1302.

Berndt, C., Jacobs, C. L., Evans, A. J., Gay, A., Elliot, G., Long, D. et al. 2012. Kilometrescale polygonal seabed depressions in the Hatton Basin, NE Atlantic Ocean: Constraints on the origin of polygonal faulting. Marine Geology 332/334: 126-133. DOI 10.1016/ j.margeo.2012.09.013.

Bett, B.J. 2001. UK Atlantic Margin Environmental Survey: introduction and overview of bathyal benthic ecology. Cont. Shelf Res. 21: 917-956.

Billett, D.S.M. 1991. Deep-sea holothurians. Oceanogr. mar. Biol. Ann. Rev. 29: 259-317.

Blasiak, R., Jouffray, J.-B., Wabnitz, C.C.C., Sundstrom, E., Osterblom, H. 2018. Corporate con-tral and global governance of marine genetic resources. Sci. Adv., 4(6): eaar5237. https://doi.org/10.1126/sciadv.aar5237

Blasiak, R., Kenchington, E., Arrieta, J.M., Bermudez, J.R., Calumpong, H., Garcia-Soto, C. et al. 2021. Developments in the exploration for and use of marine genetic rexources. In: The Second World Ocean Assessment, Volume II. Chapter 23. United Nations.

Boertmann D. 2011. Seabirds in the central North Atlantic, September 2006: Further evidence for an oceanic seabird aggregation area. Mar. Ornithol. 39(2): 183-188.

Boughet, P., Warén, A. 1979. The Abyssal molluscan fauna of the Norwegian sea and its relation to other faunas. Sarsia 64: 211-243.

Breen, M., Saltskår, J., Hannaas, J., Kvalvik, L., Ingólfsson, O.A., Lilleng, D. 2021. Research Cruise Report [2021825]: FV "Vikingbank" Catch Control in the Blue Whiting Pelagic Trawl Fishery. https://www.hi.no/resources/publikasjoner/toktrapporter/2021/Cruise-Report_VikingBank13-2021-English-1.pdf

Buhl-Mortensen, L., Buhl-Mortensen. P. 2017. Marine litter in the Nordic Seas: distribution composition and abundance. Marine Poll, Bull. 125 (1–2): 260-270, 10.1016/j.marpolbul.2017.08.048

Caddell, R. 2018. Precautionary management and the development of future fishing opportu nities: The international regulation of new and exploratory fisheries. Int. J. Mar. Coast. Law 33: 199-260.

Cárdenas, P., Rapp, H.T. 2015. Demosponges from the northern mid-Atlantic ridge shed more light on the diversity and biogeography of North Atlantic deep-sea sponges. J. Mar. Biol. Assoc. U.K. 95(7): 1475–1516.

Carreiro-Silva, M., Martins, I., Riou, V., Raimundo, J., Caetano, M., Bettencourt, R., et al. 2022. Mechanical and toxicological effects of deep-sea mining sediment plumes on a habitat-forming cold-water octocoral. Front. Mar. Sci, 9. https://doi.org/10.3389/fmars.2022.915650

Cathalot, C., van Oevelen, D., Cox, T.J., Kutti, T., Lavaleye, M., Duineveld, G. et al. 2015. Cold-water coral reefs and adjacent sponge grounds: hotspots of benthic respiration and organic carbon cycling in the deep sea. Front. Mar. Sci. 2 https://doi.org/10.3389/fmars.2015.00037

CBD. 1992. Convention on Biological Diversity. CBD Secretariat. https://www.cbd.int/convention/articles/?a=cbd-02

CBD. 2016. CBD decision XIII/11 on marine and coastal biodiversity, Annex II on the Voluntary specific workplan for biodiversity in cold-water areas within the jurisdictional scope of the Convention.

CBD. 2018. CBD decision 14/8 on protected areas and other effective area-based conservation measures.

CBD. 2022. CBD decision 15/04 on the Kunming-Montreal Global Biodiversity Framework.

CBD Secretariat. 2023a. Ecologically or Biologically Significant Areas (EBSAs). Charlie-Gibbs Fracture Zone. Published 17 Mar 2023. UNEP/CBD. https://chm.cbd.int/database/record?documentID=263492

CBD Secretariat. 2023b. Ecologically or Biologically Significant Areas (EBSAs). Hatton and Rockall Banks and Basin. Published 17 Mar 2023. UNEP/CBD. https://chm.cbd.int/database/record?documentID=263494

CBD Secretariat. 2023c. Ecologically or Biologically Significant Areas (EBSAs). Mid-North-Atlantic Frontal System. Published 17 Mar 2023. UNEP/CBD. https://chm.cbd.int/database/record?documentID=263491

CBD Secretariat. 2023d. Ecologically or Biologically Significant Areas (EBSAs). North Azores Plateau. Published 17 Mar 2023. UNEP/CBD. https://chm.cbd.int/database/record?documentID=263489

CBD Secretariat. 2023e. Ecologically or Biologically Significant Areas (EBSAs). Southern Reykjanes Ridge. Published 17 Mar 2023. UNEP/CBD. https://chm.cbd.int/database/record?documentID=263493

Chapman, E.C.N., Rochas, C.M.V., Piper, A.J.R., Vad, J., Kazanidis, G. 2023. Effect of electro-magnetic fields from renewable energy subsea power cables on righting reflex and physiolog-ical response of coastal invertebrates. Mar. Poll. Bull. 193: 115250. https://doi.org/10.1016/j.marpolbul.2023.115250.

Chen, Q., Allgeier, A., Yin, D. and Hollert, H. 2019. Leaching of endocrine disrupting chemi-cals from marine microplastics and mesoplastics under common life stress conditions. Environ. Int. 130: 104938.

Christophoridis, C., Bourliva, A., Evgenakis, E., Papadopoulou, L., Fytianos, K. 2019. Ef-fects of anthropogenic activities on the levels of heavy metals in marine surface sediments of the Thessaloniki Bay, Northern Greece: Spatial distribution, sources and contamination as-sessment. Microchem. J. 149: 104001.

Collins, P.C., Kennedy, R., Van Dover, C.L. 2012. A biological survey method applied to sea-floor massive sulphides (SMS) with contagiously distributed hydrothermal-vent fauna. Mar. Ecol. Progr. Ser. 452: 89-107.

Consoli, P., Romeo, T., Angiolillo, M., Canese, S., Esposito, V., Salvati, E., et al. 2019. Marine litter from fishery activities in the Western Mediterranean Sea: The impact of entanglement on marine animal forests. Environ. Poll. 249: 472-481.

Convention on the Conservation of Migratory Species of Wild Animals. 1979. UNEP/CMS Secretariat. https://www.cms.int/en/convention-text

Copping, A.E., Hemery, L.G., Overhus, D.M., Garavelli, L., Freeman, M.C., Whiting, J.M., et al. 2020. Potential Environmental Effects of Marine Renewable Energy Development—The State of the Science. J. Mar. Sci. Enginer. 8(11): 879. https://doi.org/10.3390/jmse8110879

Danovaro, R., Corinaldesi, C., Dell'Anno, A., Snelgrove., P.V. 2017. The deep-sea under global change. Current BIol., 27: R461-R465.

Davies, A.J., Guinotte, J.M. 2011. Global habitat suitability for framework-forming cold-water corals. PLoS ONE 6(4): e18483. https://doi.org/10.1371/journal.pone.0018483

Davies, A.J., Narayanaswamy, B.E., Hughes, D.J., Roberts, J.M. 2006. An introduction of the benthic ecology of the Rockall-Hatton Area (SEA 7). Scottish Association for Marine Science, Oban, p. 94. http://www.offshoresea.org.uk/.

de Goeij, J. M., Van Oevelen, D., Vermeij, M. J., Osinga, R., Middelburg, J. J., De Goeij, A. F., et al. 2013. Surviving in a marine desert: the sponge loop retains resources within coral reefs. Science 342 : 108–110. doi: 10.1126/science.1241981

Denisenko, N.V. 2022. Taxonomic structure and endemism of the bryozoan fauna of the Arctic region. Paleontol. J. 56 : 774-492. https://doi.org/10.1134/S003103012207005X

Desbruyères, D., Biscoito, M., Caprais, J.C., Colaço, A., Comtet, T., Crassous, P., et al. 2001. Variations in deep-sea hydrothermal vent communities on the Mid-Atlantic Ridge near the Azores plateau. Deep Sea Res. I 48(5): 1325-1346.

Diogo, H., Pereira, J. G., Higgins, R. M., Canha, Â., Reis, D. 2015. History, effort distribution and landings in an artisanal bottom longline fishery: An empirical study from the North Atlantic Ocean. Marine Policy 51: 75–85.

Doney, S.C., Mahowald, N., Lima, I., Feely, R.A., Mackenzie, F.T., Lamarque, J.F. et al. 2007. Impact of anthropogenic atmospheric nitrogen and sulfur deposition on ocean acidi-fication and the inorganic carbon system. Proc. Nat. Acad. Sci 104(37): 14580-14585.

Durán Muñoz, P., Murillo, F., Sayago-Gil, M., Serrano, A., Laporta, M., Otero, I., et al. 2011. Effects of deep-sea bottom longlining on the Hatton Bank fish communities and benthic ecosystem, north-east Atlantic. JMBA 91(4): 939-952. doi:10.1017/S0025315410001773

Durán Muñoz, P., Sayago-Gil, M., Cristobo, J., Parra, S., Serrano, A., Díaz del Rio, V., et al. 2009. Seabed mapping for selecting cold-water coral protection areas on Hatton Bank, Northeast Atlantic. ICES J. Mar. Sci. 66: 2013-2025.

Dutkiewicz, S., Rothstein, L., Rossby, T. 2001. Pathways of cross-frontal exchange in the North Atlantic Current. J. Geophys. Res. Oceans 106(C11): 26917-26928.

EASME 2021. Study supporting the evaluation of the Deep-sea Access Regulation - Final Report- Luxembourg publication

Ecorys. 2014. Study to investigate the state of knowledge of deep-sea mining. Case studies on national legislation relevant to deep-sea mining. Final Report under FWC MARE/2012/06 - SC E1/2013/04

Eigaard, O. R., Bastardie, F., Breen, M., Dinesen, G. E., Hintzen, N. T., Laffargue, P., et al. 2016. Estimating seabed pressure from demersal trawls, seines, and dredges based on gear design and dimensions. ICES J. Mar. Sci. doi:10.1093/icesjms/fsv099

Etnoyer, P. , Warrenchuk, J. 2007. A catshark nursery in a deep gorgonian field in the Mississipi Canyon, Gulf of Mexico. Bull. Mar. Sci. 81: 553–559.

European Commission, Directorate-General for Maritime Affairs and Fisheries, Joint Research Centre. 2020a. The EU blue economy report 2020. Publications Office of the European Union. https://data.europa.eu/doi/10.2771/363293

EUSeaMAP 2021. https://emodnet.ec.europa.eu/en/euseamap-2021-emodnet-broad-scale-seabed-habitat-map-europe

Falkowski, P.G., Barber, R.T., Smetacek, V. 1998. Biogeochemical controls and feedbacks on ocean primary production. Science 281: 200 – 206.

FAO. 2009. International Guidelines for the Management of Deep-sea Fisheries in the High Seas. Rome. 73pp.

FAO. 2022. A handbook for identifying, evaluating and reporting other effective area-based conservation measures in marine fisheries. Rome. https://doi.org/10.4060/cc3307en

Fauconnet, L., Catarino, D., Das, D., Giacomello, E., Gonzales-Irusta, J.M., Afonso, P. Et al. 2023. Challenges in avoiding deep-water shark bycatch in Azorean hook-and-line fisheries, ICES J. Mar. Sci. 80: 605–619. https://doi.org/10.1093/icesjms/fsac178

Fock, H., John, H-C. 2006. Fish larval patterns across the Reykjanes Ridge. Mar. Biol. Res. 2:191-199.

Fox, A. D., Henry, L.-A., Corne, D. W., Roberts, J. M. 2016. Sensitivity of marine protected area network connectivity to atmospheric variability R. Soc. open sci.3160494160494 https://royalsocietypublishing.org/doi/epdf/10.1098/rsos.160494

Frederiksen, R., Jensen, A., Westerberg, H. 1992. The distribution of the scleractinian coral *Lophelia pertusa* around the Faeroe Islands and the relation to internal tidal mixing. Sarsia 77: 157-171.

Freese, L., Auster, P.J., Heifetz, J., Wing, B.L. 1999. Effects of trawling on seafloor habitat and associated invertebrate taxa in the Gulf of Alaska. Mar. Ecol. Prog. Ser. 182: 119-126.

Galgani, F., Hanke, G., Maes, T. 2015. Global distribution, composition and abundance of marine litter. Marine Anthropogenic Litter, Springer International Publishing, 29–56. https://doi.org/10.1007/978-3-319-16510-3_2.

Garcia, S.M., Rice, J., Himes-Cornell, A., Friedman, K.J., Charles, A., Diz, D., et al. 2022. OECMs in marine capture fisheries: Key implementation issues of governance, management, and biodiversity. Front. Mar. Sci. 9: 920051.

Garcia, S.M., Rice, J., Charles, A.,Diz, D. 2021. OECMs in Marine Capture Fisheries: Systematic approach to identification, use and performance assessment in marine capture fisheries (Version 2). Fisheries Expert Group of the IUCN Commission on Ecosystem Management, Gland, Switzerland. European Bureau of Conservation and Development, Brussels, Belgium: 87 p. Available at www.ebcd.org/feg.

García-Cárdenas, F. J., Drewery, J., López González, P. J. 2019. Resurrection of the sea pen genus *Ptilella* Gray, 1870 and description of *Ptilella grayi* n. sp. from the NE Atlantic (Octocorallia: Pennatulacea). Sci. Mar. 83 (3): 261-276. https://doi.org/10.3989/scimar.04845.26A.

García-Gómez, J.C., Garrigós, M., Garrigós, J. 2021. Plastic as a vector of dispersion for marine species with invasive potential. A review. Front. Ecol. Evol. 9: 629756.

GEBCO Compilation Group (2022) GEBCO_2022 Grid (doi:10.5285/e0f0bb80-ab44-2739-e053-6c86abc0289c)

Gebruk, A.V., Fabri, M.-C., Briand, P., Desbruyeres, D. 2010. Community dynamics over a decadal scale at Logatchev, 14@45′N, Mid-Atlantic Ridge. Cahiers de Marine Biologie 51: 383 – 388.

Gibson, C., Valenti, S.V., Fordham, S.V., Fowler, S.L. 2008. The Conservation of Northeast Atlantic Chondrichthyans. Report of the IUCN Shark Specialist Group Northeast Atlantic Red List Workshop. IUCN Species Survival Commission Shark Specialist Group. Newbury, UK. viii + 76pp.

Gilman, E., 2015. Status of international monitoring and management of abandoned, lost and discarded fishing gear and ghost fishing. Mar. Policy 60:225–239. https://doi.org/10.1016/j.marpol.2015.06.016.

Gilman, E., Musyl, M., Suuronen, P., Chaloupka, M., Gorgin, S., Wilson, J. et al. 2021. Highest risk abandoned, lost and discarded fishing gear. Sci. Rep. 11(1): 1-11.

Gofas, S. 2007. Rissoidae (Mollusca: Gastropoda) from northeast Atlantic seamounts. J. Nat. Hist. 41: 779-885. doi: 10.1080/00222930701298085.

Gollner, S., Colaco, A., Gebruk, A., Halpin, P.N., Higgs, N., Menini, E., et al. 2021. Application of scientific criteria for identifying hydrothermal ecosystems in need of protection. Marine Policy 132: 104641.

Gomes-Pereira, J.N., Carmo, V., Catarino, D., Jakobsen, J., Alvarez, H., Aguilar, R., et al. 2017. Cold-water corals and large hydrozoans provide essential fish habitat for *Lappanella fasciata* and *Benthocometes robustus*. Deep Sea Res. II 145: 33-48 https://doi.org/10.1016/j.dsr2.2017.09.015

Griffiths, JR, Kadin, M, Nascimento, FJA, Tamelander, T, Törnroos, A, Bonaglia, S, et al. 2017. The importance of benthic-pelagic coupling for marine ecosystem functioning in a changing world. Glob. Chang. Biol. 23(6): 2179-2196. doi: 10.1111/gcb.13642.

Grimaldo, E., Grimsmo,L., Alvarez, P., Herrmann, P., Møen Tveit, G., Tiller, R.., et al. 2020. Investigating the potential for a commercial fishery in the Northeast Atlantic utilizing mesopelagic species, ICES J. Mar. Sci. 77: 7-8, 2541–2556, https://doi.org/10.1093/icesjms/fsaa114.

Hardesty, B.D., Good, T., Wilcox, C. 2015. Novel methods, new results and science-based solutions to tackle marine debris impacts on wildlife. Ocean Coastal Manag. 115: 4-9.

Hardy, S.M., Smith, C.R., Thurnherr, A.M. 2015. Can the source-sink hypothesis explain macrofaunal abundance patterns in the abyss? A modelling test. Proc. Biol. Sci. 282(1808): 20150193. doi: 10.1098/rspb.2015.0193.

Hassellöv, I.M., Turner, D.R., Lauer, A., Corbett, J.J. 2013. Shipping contributes to ocean acidification. Geophys. Res. Lett. 40(11): 2731-2736.

Hawkes, N., Korabik, M., Beazley, L., Rapp, H. T., Xavier, J. R., Kenchington, E. 2019. Glass sponge grounds on the Scotian Shelf and their associated biodiversity. Mar. Ecol. Prog. Ser. 614:, 91–109. doi: 10.3354/meps12903

Heger, A., Ieno, E.N., King, N.J., Morris, K.J., Bagley, P.M., Priede, I.G. 2008. Deep-sea pelagic bioluminescence over the Mid-Atlantic Ridge. Deep-Sea Res. II 55: 126-136.

Hennicke, J., Blanchard, S., Chaniotis, P., Cornick, L., Hauswirth, M. Schellekens, T., et al. 2022. Report and assessment of the status of the OSPAR network of Marine Protected Areas in 2021. In: OSPAR, 2023: The 2023 Quality Status Report for the North-East Atlantic: 101. https://oap.ospar.org/en/ospar-assessments/committee-assessments/biodiversity-committee/status-ospar-network-marine-protected-areas/assessment-reports-mpa/mpa-2021/

Henry, L., Vad, J., Findlay, H., Murillo, J., Milligan, R., Roberts, J. 2014. Environmental variability and biodiversity of megabenthos on the Hebrides Terrace Seamount (Northeast Atlantic). Sci. Rep. 4: 5589.

Henry, L.-A., Navas, J. M., Hennige, S. J., Wicks, L. C., Vad, J., Roberts, J. M. 2013. Cold-water coral reef habitats benefit recreationally valuable sharks. Biol. Conserv. 161: 67–70.

Henry, L-A., Roberts, J.M. 2007. Biodiversity and ecological composition of macrobenthos on cold-water coral mounds and adjacent off-mound habitat in the bathyal Porcupine Seabight, NE Atlantic. Deep-Sea Res. I 54: 654-672.

Hensen, C., Duarte, J.C., Vannucchi, P., Mazzini, A., Lever, M.A., Terrinha, P., et al. 2019. Marine Transform Faults and Fracture Zones: A Joint Perspective Integrating Seismicity, Fluid Flow and Life. Front. Earth Sci. 7:39. doi: 10.3389/feart.2019.00039

Hiddink, J.G., Jennings, S., Sciberras, M., Szostek, C.L., Hughes, K.M., Ellis, N., et al. 2017. Global analysis of depletion and recovery of seabed biota after bottom trawling disturbance. Proc. Nat. Acad. Sci. USA 114(31): 8301-8306.

Howell, K., Billett, D.S.M., Tyler, P.A. 2002. Depth-related distribution and abundance of seastars (Echinodermata:Asteroidea) in the Porcupine Seabight and Porcupine Abyssal Plain, N.E. Atlantic. Deep-Sea Res. I 49: 1901-1920.

Howell, K.L., Davies J.S., Jacobs, C., Narayanaswamy, B.E. 2009. Broadscale Survey of the Habitats of Rockall Bank, and mapping of Annex I 'Reef' habitat. JNCC Report No. 422, JNCC, Peterborough.

Howell, K.L., Davies J.S., Narayanaswamy, B.E. 2010. Identifying deep-sea megafaunal epibenthic assemblages for use in habitat mapping and marine protected area network design. J. Mar. Biol. Ass. UK 90: 33-68.

Howell, K.L., Davies, J.S., Hughes, D.J., Narayanaswamy, B.E. 2007. Strategic Environmental Assessment / Special Area for Conservation Photographic Analysis Report. Department of Trade and Industry, Strategic Environmental Assessment Report, UK, p. 163. Unpublished report.

Howell, K.L., Huvenne, V., Piechaud, N., Robert, K., Ross, R.E. 2014. Analysis of biological data from the JC060 survey of areas of conservation interest in deep waters off north and west Scotland, JNCC Report No. 528. JNCC, Peterborough, ISSN 0963-8091.

Howell, K.L., Piechaud, N., Downie, A.L., Kenny, A. 2016. The distribution of deep-sea sponge aggregations in the North Atlantic and implications for their effective spatial management. Deep-Sea Res. I 115: 309-320.

Hunter Jr, M.L., Acuña, V., Bauer, D.M., Bell, K.P., Calhoun, A.J., Felipe-Lucia, M.R., et al. 2017. Conserving small natural features with large ecological roles: a synthetic overview. Biol. Conserv. 211:.88-95.

Huvenne, V.A.I. (ed.) 2011. RRS James Cook Cruise 60, 09 May-12 Jun 2011. Benthic habitats and the impact of human activities in Rockall Trough, on Rockall Bank and in Hatton Basin. National Oceanography Centre Cruise Report, No. 04. Southampton, UK: National Oceanography Centre, Southampton, 133 pp.

ICES. 2007. Report of the Working Group on Elasmobranch Fishes (WGEF). Copenhagen. 332 pp.

ICES. 2016. Report of the workshop on Vulnerable Marine Ecosystem database (WKVME), 10–11 December 2015, Peterborough, UK. ICES CM 2015/ACOM:62. 42 pp.

ICES. 2019. Oceanic Northeast Atlantic ecoregion – Ecosystem overview. *In* Report of the ICES Advisory Committee, 2019. ICES Advice 2019, section 13.1. https://doi.org/10.17895/ices.advice.5754

ICES. 2019b.ICES/NAFO Joint Working Group on Deep-water Ecology (WGDEC). ICES Scientific Reports. 1: 56. 119 pp.

ICES. 2019c. Workshop on ecological valuing of areas of the Barents Sea (WKBAR). ICES Scientific Reports. 1:39. 34 pp. http://doi.org/10.17895/ices.pub.5444.

ICES. 2020a. ICES/NAFO Joint Working Group on Deep-water Ecology (WGDEC). ICES Scientific Reports. 2:62. 188 pp. Available: https://doi.org/10.17895/ices.pub.7503

ICES. 2020b. Information on vulnerable habitats in subareas of the NEAFC Regulatory Area closed to fishing for purposes other than VME protection. ICES Advice on fishing opportunities, catch, and effort Ecoregions in the Northeast Atlantic and adjacent seas. Published 3 July 2020.

ICES. 2021a. Norwegian Sea ecoregion – fisheries overview. In Report of the ICES Advisory Committee, 2022. ICES Advice 2022, section 12.2. https://doi.org/10.17895/ices.advice.21640826

ICES. 2021b. ICES Ecosystem Overviews Barents Sea Ecoregion 5.1 Barents Sea Ecoregion-Ecosystem overview: 1–11.

ICES. 2021c. Working group on cumulative effects assessment approaches in management (WGCEAM). ICES Scientific Reports, 1: 26. http://ices.dk/sites/pub/Publication Reports/Expert Group Report/HAPISG/2019/Working Group on Cumulative Effects Assessment Approaches in Management (WGCEAM).pdf.

ICES. 2021d. ICES/IUCN-CEM FEG Workshop on Testing OECM Practices and Strategies (WKTOPS). ICES Scientific Reports. 3:42. 195 pp. https://doi.org/10.17895/ices.pub.8135IUCN-WCPA Task Force on OECMs. 2019. Recognising and reporting other effective area-based conservation measures. Gland, Switzerland: IUCN. https://doi.org/10.2305/IUCN.CH.2019.PATRS.3.en

ICES. 2022a. Working Group on Spatial Fisheries Data (WGSFD; outputs from 2021 meeting). ICES Scientific Reports. 4:92. 151 pp.https://doi.org/10.17895/ices.pub.21630236

ICES. 2022b. Oceanic Northeast Atlantic ecoregion – fisheries overview. In Report of the ICES Advisory Committee, 2021. ICES Advice 2021, section 13.2, https://doi.org/10.17895/ices.advice.21646910

ICES. 2022c. ICES Special Request Advice. NEAFC request on appropriateness of NEAFC bottom-fishing closures. Sr2022-13. Available: https://doi.org/10.17895/ices.advice.21261387

ICES. 2022d. Blue whiting (*Micromesistius poutassou*) in subareas 1-9, 12, and 14 (Northeast Atlantic and adjacent waters). In Report of the ICES Advisory Committee, 2022. ICES Advice 2022, whb.27.1-91214. https://doi.org/10.17895/ices.advice.21493974

ICES. 2022e. Barents Sea ecosystem – fisheries overview. In Report of the ICES Advisory Committee, 2022. ICES Advice 2022, section 5.2. https://doi.org/10.17895/ices.advice.2164081

ICES. 2022f. ICES Advice on fishing opportunities, catch, and effort Ecoregions in the Northeast Atlantic and adjacent seas, New information regarding vulnerable habitats in the NEAFC Regulatory Areas. Avalilable: https://doi.org/10.17895/ices.advice.21261369

ICES. 2022g. Alfonsinos (Beryx spp.) in subareas 1–10, 12, and 14 (the Northeast Atlantic and adjacent waters). In Report of the ICES Advisory Committee, 2022. ICES Advice 2022, alf.27.nea. https://doi.org/10.17895/ices.advice.19447742

ICES. 2022h. Mackerel (*Scomber scombrus*) in subareas 1-8 and 14 and division 9.a (the Northeast Atlantic and adjacent waters). In Report of the ICES Advisory Committee, 2022. ICES Advice 2022, mac.27.nea. https://doi.org/10.17895/ices.advice.7789

ICES. 2022i. Herring (Clupea harengus) in subareas 1, 2, 5 and divisions 4.a and 14.a, Norwegian spring-spawning herring (the Northeast Atlantic and Arctic Ocean). In Report of the ICES Advisory Committee, 2022. ICES Advice 2022, her.27.1-24a514a. https://doi.org/10.17895/ices.advice.19772380

ICES. 2022j. Barents Sea ecosystem – fisheries overview. In Report of the ICES Advisory Committee, 2022. ICES Advice 2022, section 5.2. https://doi.org/10.17895/ices.advice.2164081

ICES. 2023. ICES Ecosystem Overviews Technical Guidelines. Version 4. ICES Guidelines and Policies - Advice Technical Guidelines. 24 pp. https://doi.org/10.17895/ices.pub.22059803

ICES. 2023a. Workshop on sea Bird Bycatch monitoring in the NEAFC Regulatory Area (WKBB). ICES Scientific Reports. 5:78. 97 pp. https://doi.org/10.17895/ices.pub.23635305

ICES. 2023b. OSPAR request for review of the revised nomination proforma for the 'North Atlantic current and Evlanov seabasin' MPA in the OSPAR Maritime Area Item. ICES Advice: Special Requests. Report. https://doi.org/10.17895/ices.advice.22153610.v1

Jacobs, C.L. 2006. An Appraisal of the Surface Geology and Sedimentary Processes within SEA7, the UK Continental Shelf. National Oceanography Centre Southampton Research and Consultancy Report, No. 18, 62pp.

Jacobs, C.L., Howell, K.L. 2007. Habitat investigations within the SEA4 and SEA7 area of the UK continental shelf. MV Franklin Cruise 0206, 03-23 Aug 2006. Research and Consultancy Report No. 24. National Oceanography Centre, Southampton. UK. 95pp.

Johnson, D., Ferreira, M.A., Kenchington, E. 2018. Climate change is likely to severely limit the effectiveness of deep-sea ABMTs in the North Atlantic. Marine Policy 87: 111-122.

Kammann, U., Aust, M.O., Bahl, H., Lang, T. 2018. Marine litter at the seafloor–Abundance and composition in the North Sea and the Baltic Sea. Mar. Poll. Bull. 127: 774-780.

Kane, I.A., Clare, M.A., Miramontes, E., Wogelius, R., Rothwell, J.J., Garreau, P., et al. 2020. Seafloor microplastic hotspots controlled by deep-sea circulation. Science 368 (6495): 1140-1145.

Kenyon, N.H., Akhmetzhanov, A.M., Wheeler, A.J., van Weering, T.C.E., de Haas, H., Ivanov, M.K. 2003. Giant carbonate mud mounds in the southern Rockall Trough. Mar. Geol. 195: 5-30.

Keogh, P., Command, R.J., Edinger, E., Georgiopoulou, A., Robert, K. 2022. Benthic megafaunal biodiversity of the Charlie-Gibbs fracture zone: spatial variation, potential drivers, and conservation status. Mar. Biodivers. 52: 55. https://doi.org/10.1007/s12526-022-01285-1

Key Biodiversity Areas Partnership. 2023a. Key Biodiversity Areas factsheet: Evlanov Seamount and Basin. Extracted from the World Database of Key Biodiversity Areas. Developed by the Key Biodiversity Areas Partnership: BirdLife International, IUCN, American Bird Conservancy, Amphibian Survival Alliance, Conservation International, Critical Ecosystem Partnership Fund, Global Environment Facility, Re:wild, NatureServe, Rainforest Trust, Royal Society for the Protection of Birds, World Wildlife Fund and Wildlife Conservation Society. Downloaded from http://www.keybiodiversityareas.org/ on 11/08/2023.

Key Biodiversity Areas Partnership. 2023b. Key Biodiversity Areas factsheet: Atlantic, Northeast 2 - Marine. Extracted from the World Database of Key Biodiversity Areas. Developed by the Key Biodiversity Areas Partnership: BirdLife International, IUCN, American Bird Conservancy, Amphibian Survival Alliance, Conservation International, Critical Ecosystem Partnership Fund, Global Environment Facility, Re:wild, NatureServe, Rainforest Trust, Royal Society for the Protection of Birds, World Wildlife Fund and Wildlife Conservation Society. Downloaded from http://www.keybiodiversityareas.org/ on 11/08/2023.

Key Biodiversity Areas Partnership. 2023c. Key Biodiversity Areas factsheet: Evlanov Seamount and Basin. Extracted from the World Database of Key Biodiversity Areas. Developed by the Key Biodiversity Areas Partnership: BirdLife International, IUCN, American Bird Conservancy, Amphibian Survival Alliance, Conservation International, Critical Ecosystem Partnership Fund, Global Environment Facility, Re:wild, NatureServe, Rainforest Trust, Royal Society for the Protection of Birds, World Wildlife Fund and Wildlife Conservation Society. Downloaded from http://www.keybiodiversityareas.org/ on 11/08/2023.

Koslow, J. 1997. Seamounts and the ecology of deep-sea fisheries. Amer. Sci. 85: 168-176.

Kukuev, E.I., Pavlov, V.P. 2008. The first case of mass catch of a rare frill shark *Chlamydoselachus anguineus* over a seamount of the Mid-Atlantic Ridge. J. Ichthyol. 48: 676–678. https://doi.org/10.1134/S0032945208080158

Kunze, E., Llewellyn Smith, S. 2004. The role of small-scale topography in turbulent mixing of the global ocean. Oceanogr. 17(1): 55–64.

La Bianca, G., Rees, S., Attrill, M.J., Lombard, A.T., McQuaid, K.A., Niner, H.J., et al. 2023. A standardised ecosystem services framework for the deep sea. Front. Mar. Sci. 10:1176230. doi: 10.3389/fmars.2023.1176230

Large, P. A., Graham, N. G., Hareide, N-R., Misund, R., Rihan, D. J., Mulligan, M. C., et al. 2009. Lost and abandoned nets in deep-water gillnet fisheries in the Northeast Atlantic: retrieval exercises and outcomes. – ICES J. Mar. Sci. 66: 323–333.

Le Guilloux, E., Hall-Spencer, J.M., Söffker, M.K., Olu-Le Roy, K. 2010. Association between the squat lobster *Gastroptychus formosus* (Filhol, 1884) and cold-water corals in the North Atlantic. J. Mar. Biol. Ass. UK 90: 1363-1369.

Lincoln, S., Andrews, B., Birchenough, S. N., Chowdhury, P., Engelhard, G. H., Harrod, O., et al. 2022. Marine litter and climate change: Inextricably connected threats to the world's oceans. Sci Total Environ. 837: 155709.

Løkkeborg, S., Bakkeplass, K., Diesing, M., Gjøsæter, H., Gonzalez-Mirelis, G., Hvingel, C., et al. 2023. Compilation of knowledge about seabed impacts of trawl and Scottish seine in Norwegian waters (Effekter av bunntråling - Sammenstilling av kunnskap om bunnpåvirkning fra trål og snurrevad relevant for norske farvann). Rapport fra Hovforskningsinstituttet 2023-1 (In Norwegian).

Magalhães, M., Santos, R, Hamer, K. 2008. Dual-foraging of Cory's shearwaters in the Azores: feeding locations, behaviour at sea and implications for food provisioning of chicks. Mar. Ecol. Progr. Ser. 359: 283-293.

Magnusson, J., Magnusson, J.V. 1995. Oceanic redfish (*Sebastes mentella*) in the Irminger Sea and adjacent waters. Scien. Mar. 59: 241–254.

Maldonado, M., Aguilar, R., Bannister, R.J., Bell, J.J., Conway, K. W., Dayton, P. K., et al. 2015. Marine Animal Forests. Cham: Springer International Publishing; 2015. Sponge Grounds as Key Marine Habitats: A Synthetic Review of Types, Structure, Functional Roles, and Conservation Concerns; pp. 1–39.

Maldonado, M., Beazley, L., Lopez-Acosta, M., Kenchington, E., Casault, B., Hanz, U., et al. 2020. Massive silicate utilization facilitated by a benthic-pelagic coupled feedback sustains deep-sea sponge aggregations. Limnol. Oceanogr 66: 366-391. https://aslopubs.onlinelibrary.wiley.com/doi/10.1002/lno.11610

Marappan, S., Stokke, R., Malinovsky, M.P., Taylor, A. 2022. Assessment of impacts of the offshore oil and gas industry on the marine environment. In: OSPAR, 2023: The 2023 Quality Status Report for the North-East Atlantic. OSPAR Commission, London.

Matos, V. de, Braga Henriques, A., Serrao Santos, R., Ribeiro, P.A. 2014. New species of Heteropathes (Anthozoa:Antipatharia) expands genus distribution in the NE Atlantic. Zootaxa 3827(2): 293-300. Doi: 10.11646/zootaxa.3827.2.10

Merck, T., Wasserthal, R. 2009. Assessment of the environmental impacts of cables. OSPAR Biodiversity Series. 12, p. 437.

Miatta, M., Snelgrove, PV.R. 2022. Sea pens as indicators of macrofaunal communities in deep-sea sediments: Evidence from the Laurentian Channel Marine Protected Area. Deep Sea Res. I 182: 103702. https://doi.org/10.1016/j.dsr.2022.103702

Ministry of Petroleum and Energy of Norway. 2023. The government is facilitating a new ocean industry - seabed mineral activities. Government.no. https://www.regjeringen.no/en/aktuelt/the-government-is-facilitating-a-new-ocean-industry-seabed-mineral-activities/id2985941/

Molodtsova, T.N. 2013. Deep-sea mushroom soft corals (Octocorallia: Alcyonacea: Alcyoniidae) of the Norther Mid-Atlantic Ridge. Mar. Biol. Res. 9 (5 – 6): 488 – 515.

Molodtsova, T.N. 2016. New records of Heteropathes Opresko, 2011 (Anthozoa: Antipatharia) from the Mid-Atlantic Ridge. Mar. Biodiv. 47: 179–186.

Morato, T. , Pauly, D. 2004. Seamounts: Biodiversity and fisheries. Fisheries Centre, University of British Columbia.

Morato, T., Allain, V., Hoyle, S., Nicol, S. 2009. Tuna Longline Fishing around West and Central Pacific Seamounts. Information Paper. Scientific Committee, Fifth Regular Session, 10-21 August 2009, Port Vila, Vanuatu. WCPFC-SC5-2009/EB-IP-04. Western and Central Pacific Fisheries Commission, Palikir, Pohnpei.

Morato, T., Hoyle, S., Allain, V., Nicol, S. 2010. Seamounts are hotspots of pelagic biodiversity in the open ocean. Proc. Nat. Acad. Sci. 107(21): 9707–9711.

Morato, T., González-Irusta, J. M., Dominguez-Carrió, C., Wei, C. L., Davies, A., Sweetman, A. K., 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 Biol. 26(4): 2181-2202.

Morato, T., Juliano, M., Pham, C. K., Carreiro-Silva, M., Martins, I., Colaço, A. 2022. Model-ling the dispersion of seafloor massive sulphide mining plumes in the Mid Atlantic Ridge around the Azores. Front. Mar. Sci. 9. https://doi.org/10.3389/fmars.2022.910940

Moriarty, M., Pedreschi, D., Stokes, D., Dransfeld, L., Reid, D.G. 2016. Spatial and temporal analysis of litter in the Celtic Sea from groundfish survey data: lessons for monitoring. Mar. Poll. Bull. 103: 195-205.

Morozov, G., Sabirov, R., Anisimova, N. 2021. The hidden diversity of the endemic Arctic sponges (Porifera). J. Nat. Hist. 55: 571-596. https://doi-org.ezproxy.library.dal.ca/10.1080/00222933.2021.1913256

Mortensen, P., Buhl-Mortensen, L., Gebruk, A., Krylova, E. 2008. Occurrence of deep-water corals on the Mid-Atlantic Ridge based on MAR-ECO data. Deep-Sea Res. II 55(1-2): 142–152.

Myers, A.A., Hall-Spencer, J.M. 2004. A new species of amphipod crustacean, *Pleusymtes comitari* sp. nov., associated with Acanthogorgia sp. gorgonians on deep-water coral reefs off Ireland. J. Mar. Biol. Ass. UK 84: 1029-1032.

NAFO. 2013. Scientific Council Meeting Part B, SC 7-20 Jun 2013, Halifax, Canada.

Narayanaswamy, B.E., Howell, K.L., Hughes, D.J., Davies, J.S., Roberts, J.M, Black, K.D. 2006. Strategic Environmental Assessment Area 7 Photographic Analysis Report. 13. Department of Trade and Industry, Strategic Environmental Assessment Report, UK, p. 179. Unpublished report.

NEAFC Recommendation 19 2014 on area management measures for the protection of vulnerable marine ecosystems in the NEAFC Regulatory Area, as amended (2023)

Neat, F., Jamieson, A., Stewart, H., Narayanaswamy, B., Collie, N., Stewart, M., et al. 2019.Visual evidence of reduced seafloor conditions and indications of a cold-seep ecosystem from the Hatton–Rockall basin (NE Atlantic). J. Mar. Biol. Assoc. 99(2): 271-277. doi:10.1017/S0025315418000115

Nelms, S.E., Coombes, C., Foster, L.C., Galloway, T.S., Godley, B.J., Lindeque, P.K., et al. 2017. Marine anthropogenic litter on British beaches: a 10-year nationwide assessment using citizen science data. Sci. Total Environ. 579: 399-1409. https://doi.org/10.1016/j.scitotenv.2016.11.137.

Norwegian Petroleum Directorate (NPD) (2023). Seabed minerals: Substantial resources on the Norwegian shelf. https://www.npd.no/en/news/general-news/2023/seabed-minerals-substantial-resources-on-the-norwegian-shelf/

Nøttestad, L., Olsen, E. 2004. Whales and seals: top predators in the ecosystem. In: The 10 Norwegian Sea Ecosystem. Skjoldal, H.R. (Ed.) Tapir Academic Press, Trondheim, Norway pp. 395-434.

Oliveira, C. 2014. Behavioural ecology of the sperm whale (*Physeter macrocephalus*) in the North Atlantic Ocean. Departamento de Oceanografia e Pescas. [Horta]: Universidade dos Açores; 2014.

Oliver, P. G., Drewery, J. 2014. New species of chemosymbiotic clams (Bivalvia: Vesicomyidae and Thyasiridae) from a putative 'seep' in the Hatton–Rockall Basin, northeast Atlantic. J. Marine Biol. Assoc. UK. 94: 389–403.

Olsen, E., Budgell, P., Head, E., Kleivane, L., Nottestad, L., Prieto, R., et al. 2009. First satellite-tracked long-distance movement of a Sei Whale (*Balaenoptera borealis*) in the North Atlantic. Aquat. Mam. 35(3): 313-318.

Orlov, A., Cotton, C., Byrkjedal, I. 2006. Deepwater skates (Rajidae) collected during the 2004 cruises of R.V. "G.O. Sars" and M.S. "Loran" in the Mid-Atlantic Ridge area. Cybium 30(4) suppl: 35-48.

OSPAR. 2011. OSPAR Convention for the Protection of the Marine Environment of the NorthEast Atlantic Meeting of the OSPAR Commission (OSPAR) London: 20-24 June 2011.

OSPAR. 2012. Guidelines on Best Environmental Practice (BEP) in Cable Laying and Opera-tion. Agreement 2012-2. 12/22/1, Annex 14.

OSPAR. 2015. Historic dumping of low-level radiactive waste in the North-East Atlantic. Factsheet. https://www.ospar.org/site/assets/files/1173/factsheet_historic_dumping_final.pdf #

OSPAR. 2022. Status Assessment 2022 – Seamounts. https://oap.ospar.org/en/versions/2237-en-1-0-0-seamounts/

Oug, E., Bakken, T., Kongsrud, J.A., Alvestad, T. 2017. Polychaetous annelids in the deep Nordic Seas: Strong bathymetric gradients, low diversity and underdeveloped taxonomy. Deep Sea Res. I 137: 102-112.

Pham, C.K., Vandeperre, F., Menezes, G., Porterio, F., Isidro, E., Morato, T. 2015. The importance of deep-sea vulnerable marine ecosytems for demersal fish in the Azores. Deep Sea Res I 96: 80-88.

Piechaud, N., Downie, A., Stewart, H.A., Howell, K.L. 2015. The impact of modelling method selection on predicted extent and distribution of deep-sea benthic assemblages. Earth Env. Sci. T. R. So. 105: 251-261.

Pitcher, T., Morato, T., Hart, P., Clark, M., Haggan, N., Santos, R. 2007. Seamounts: Ecology, Fisheries, and Conservation, Blackwell Fisheries and Aquatic Resources Series, Vol. 12, Blackwell Publishing, Oxford, 527 pp.

Prieto, R., Silva, M.A., Waring, G., Gonçalves, J. 2014. Sei whale movements and behavior in the North Atlantic inferred from satellite telemetry. Endangered Species Res. 26: 103-113. DOI: https://doi.org/10.3354/esr00630.

Puerta, P., Johnson, C., Carreiro-Silva, M., Henry, L. A., Kenchington, E., Morato, T., et al. 2020. Influence of water masses on the biodiversity and biogeography of deep-sea benthic ecosystems in the North Atlantic. Front. Mar. Sci: 239.

Ramirez-Llodra, E., Hilario, A., Paulsen, E., Costa, C.V., Bakken, T., Johnsen, G., et al. 2020. Benthic communities on the Mohn's Treasure Mound: Implications for management of seabed mining in the Arctic Mid-Ocean Ridge. Front. Mar. Sci. 7:490. doi: 10.3389/fmars.2020.00490

Read, J., Pollard, R., Miller, P., Dale, A. 2010. Circulation and variability of the North Atlantic Current in the vicinity of the Mid-Atlantic Ridge. Deep Sea Res. I 57(3): 307-318.

Rees, T. 2003. "'C-squares', a new spatial indexing system and its applicability to the description of oceanographic datasets". Oceanogr. 16 (1): 11–19. doi:10.5670/oceanog.2003.52

Rex, M.A., McClain, C.R., Johnson, N.A., Etter, R.J., Allen, J.A., et al. 2005. A source-sink hypothesis for abyssal biodiversity. Am Nat. 165(2): 163-78. doi: 10.1086/427226

Robert, K., Jones D.,.Roberts, J. M., Huvenne, V A.I. 2016. Improving predictive mapping of deep-water habitats: Considering multiple model outputs and ensemble techniques. Deep Sea Res. I 113: 80–89.

Roberts, J.M. (ed.). 2013. Changing Oceans Expedition 2012. RRS James Cook cruise 073 Cruise Report. Heriot-Watt University. 224 pp.

Roberts, J.M., Long, D., Wilson, J.B., Mortensen, P.B., Gage, J.D. 2003. The cold-water coral Lophelia pertusa (Scleractinia) and enigmatic seabed mounds along the north-east Atlantic margin: are they related? Mar. Poll. Bull. 46: 7-20.

Roberts, J.M., Wheeler, A.J., Freiwald, A. 2006. Reefs of the deep: The biology and geology of cold-water coral ecosystems. Science 213: 543-547.

Roberts, J.M., Henry, L-A., Long, D., Hartley, J.P. 2008. Cold-water coral reef frameworks, megafaunal communities and evidence for coral carbonate mounds on the Hatton Bank, north east Atlantic. Facies 54: 297-316.

Robinson, N.M., Nelson, W.A., Costello, M.J., Sutherland, J. E., Lundquist, C.J. 2017. A systematic review of marine-based species distribution models (SDMs) with recommendations for best practice. Frontiers in Marine Science 4: 421, 11 pp.

Rogan, E., Cañadas, A., Macleod, K., Santos, M.B., Mikkelsen, B., Uriarte, A., et al. 2017. Distribution, abundance and habitat use of deep diving cetaceans in the North-East Atlantic. Deep Sea Res. II 141: 8-19.

Rogers, A., Clark, M., Hall-Spencer, J., Gjerde, K. 2008. The Science behind the Guidelines: A Scientific Guide to the FAO Draft International Guidelines (December 2007) for the Management of Deep-sea Fisheries in the High Seas and Examples of How the Guidelines May Be Practically Implemented. IUCN, Switzerland.

Rovelli, L., Attard, K., Bryant, L.D., Flögel, S., Stahl, H.J., Roberts, J.M., et al. 2015. Benthic O_2 uptake of two cold-water coral communities estimated with the non-invasive eddy-correlation technique. Mar. Ecol. Prog. Ser. 525: 97-104.

Santos, M. A., Bolten, A. B., Martins, H. R., Riewald, B., Bjorndal, K. A. 2008. Air-Breathing Visitors to Seamounts: Sea Turtles. Seamounts: Ecology, Fisheries & Conservation, 239-244.

Shor, A., P.Lonsdale, C.D.Hollister, D.Spencer 1980. Charlie-Gibbs fracture zone: bottom-water transport and its geological effects. Deep Sea Res. A. 27: 325-338, IN1-IN2, 339-345 https://doi.org/10.1016/0198-0149(80)90030-8

Silva, M.A., Prieto, R., Jonsen, I., Baumgartner, M.F., Santos, R.S. 2013. North Atlantic Blue Fin Whales Suspend Their Spring Migration to Forage in Middle Latitudes: Building up Energy Reserves for the Journey? PLoS ONE 8(10): e76507. https://doi.org/10.1371/ journal.pone.0076507.

Skov, H., Gunnlaugsson, T., Budgell, W.P., Horne, J., Nøttestad, L., Olsen, E., et al. 2008. Small-scale spatial variability of sperm and sei whales in relation to oceanographic and topographic features along the Mid-Atlantic Ridge. Deep-Sea Res. II 55: 254 – 268.

Skov, H., Gunnlaugsson, T., Budgell, W.P., Horne, J., Nøttestad, L., Olsen, E., et al. 2008. Small-scale spatial variability of sperm and sei whales in relation to oceanographic and topographic features along the Mid-Atlantic Ridge. Deep-Sea Research II 55: 254 – 268.

Soetaert, K., Mohn, C., Rengstorf, A., Grehan, A., van Oevelen, D. 2016. Ecosystem engineering creates a direct nutritional link between 600-m deep cold-water coral mounds and surface productivity. Sci. Rep. 6: 35057 (2016). https://doi.org/10.1038/srep35057

Söffker, M., Sloman, K.A., Hall-Spencer, J.M. 2011. In situ observations of fish associated with coral reefs off Ireland. Deep-Sea Res. I 58: 818-825.

Tabachnick, K.R., Collins, A.G. 2008. Glass sponges (Porifera, Hexactinellidae) of the northern Mid-Atlantic Ridge. Mar. Biol. Res. 4: 25 – 47.

Tabachnick, K.R., Menshenina, L 2013. New data on glass sponges (Porifera, Hexactinellida) of the northern Mid-Atlantic Ridge. Part 2. Aphrocallistidae, Euretidae, Euplectellidae and Rossellidae (with descriptions of two new species of Sympagella). Mar. Biol. Res. 9 (5 – 6), 469 – 487.

Taboada, S., Whiting, C., Wang, S., Ríos, P., Davies, A.J., Mienis, F. et al. 2023. Long distance dispersal and oceanographic fronts shape the connectivity of the keystone sponge *Phakellia ventilabrum* in the deep northeast Atlantic. Front. Mar. Sci. 10:1177106. doi: 10.3389/fmars.2023.1177106

Tempera, F., Carreiro-Silva, M., Jakobsen, K., Porteiro, F.M., Braga-Henriques, A., Jakobsen, J. 2015. An Eguchipsammia (Dendrophylliidae) topping on the cone. Mar. Biodiv. 45 (1): 3-4.

Thornburg, C.C., Zabriskie, T.M., McPhail, K.L. 2010. Deep-Sea Hydrothermal Vents: Potential Hot Spots for Natural Products Discovery? J. Nat. Prod. 73: 489–499. https://doi.org/10.1021/np900662k

Thorrold, S.R., Afonso, P., Fontes, J., Braun, C.D., Santos, R.S., Skomal, G.B., et al. 2014. Extreme diving behaviour in devil rays links surface waters and the deep ocean. Nature Comm. 5(1): 4274.

Thushari, G.G.N. and Senevirathna, J.D.M. 2020. Plastic pollution in the marine environment. Heliyon, 6(8), p.e04709.

UNEP, (2021). From Pollution to Solution: a global assessment of marine litter and plastic pollution. United Nations Environment Programme, Nairobi (2021).

United Nations 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, 8 September 1995, ATS 8 (entered into force 11 December 2001). Also referred to as the UN Fish Stocks Agreement.

United Nations General Assembly.2006. Resolution 61/105 on 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.

United Nations General Assembly. 2009. Resolution 64/72 on 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.

United Nations General Assembly. 2011. Resolution 66/68 on 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.

United Nations General Assembly. 2016. Resolution 71/123 on 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

United Nations General Assembly. 2022. Resolution 77/118 on 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.

van Andel, Tj. H., Bowin, C.O. 1968. Mid-Atlantic Ridge between 22º and 23º north latitude and the tectonics of mid-ocean rises. J. Geophys. Res. 73: 1279-1298.

Van Dover, C.L., Arnaud-Haond, S., Gianni, M., Helmreich, S., Huber, J.A., Jaeckel, A.L., et al. 2018. Scientific rationale and international obligations for protection of active hydrothermal vent ecosystems from deep-sea mining. Marine Policy 90: 20-28.

Van Dover, C.L., German, C.R., Speer, K.G., Parson, L.M., Vrijenhoek, R.C. 2002. Evolution and biogeography of deep-sea vent and seep invertebrates. Science. 295(5558): 1253-7. doi: 10.1126/science.1067361.

Vasilescu, V.F., Dinu, D. 2021. Installation of submarine cables in the offshore wind industry and their impact on the marine environment. Journal of Marine Technology and Environment. 1, pp. 43–51. https://doi.org/10.53464/JMTE.01.2021.07

Vinnichenko, V. I., Khlivnoy V. N. 2004. Distribution and biological characteristics of young roundnose grenadier (*Coryphaenoides rupestris*) in the northeast Atlantic (by data of Russian investigations in 2003). ICES Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources Working Document, 2004.

Volkov, D. L. 2005. Interannual variability of the altimetry-derived eddy field and surface circulation in the extratropical North Atlantic Ocean in 1993–2001. J. Phys. Oceanogr. 35(4): 405-426.

Watling, L., Guinotte, J., Clark, M.R., Smith, C.R. 2013. A proposed biogeography of the deep ocean floor. Progr. Oceanogr. 111: 91-112.

Weaver, P.P.E., Boschen-Rose, R. E., Dale, A.C., Jones, D.O.B., Billett, D.S.M., Colaço, A., et al. 2019. Regional Environmental Assessment of the Northern Mid-Atlantic Ridge. 229 p.

Wheeler, A. J., Murton, B., Copley, J., Lim, A., Carlsson, J., Collins, P. et al. 2013. Moytirra: Discovery of the first known deep-sea hydrothermal vent field on the slow-spreading Mid-Atlantic Ridge north of the Azores. Geochem. Geophys. Geosyst. 14: 4170–4184. doi:10.1002/ggge.20243.

Wilson, J.B. 1979. The distribution of the coral *Lophelia pertusa* (L.) [*L. prolifera* (Pallas)] in the North-East Atlantic. J. Mar. Biol. Ass. UK 59: 149-164.

Wisshak, M., Neumann, C., Jakobsen, J., Freiwald, A. 2009. The 'living-fossil community' of the cyrtocrinid Cyathidium foresti and the deep-sea oyster Neopycnodonte zibrowii (Azores Archipelago). Palaeogeogr. Palaeoclim. Palaeoecol. 271 (1-2): 77-83.

WWF. 2001. Implementation of the EU Habitats Directive Offshore: Natura 2000 sites for reefs and submerged seabanks. Vol. II. Northeast Atlantic and North Sea, 87pp. World Wildlife Fund.

Xavier, J., Magalhães, M., Mendonça, A., Antunes, M., Carvalho, N., Machete, M., et al. 2011. Changes in diet of Cory's Shearwaters *Calonectris diomedea* breeding in the Azores. Mar. Ornithol. 39: 129-134.

Yesson, C., Taylor, M.L., Tittensor, D.P., Davies, A.J., Guinotte, J., Baco, A., et al. 2012. Global habitat suitability of cold-water octocorals! J. Biogeogr. 39: 1278-129

Annex 1: List of participants

Name	Institute	Country (of institute)	Email
Catarina Abril	Sciaena	Portugal	cabril@sciaena.org
Francois Bastardie	DTU Aqua	Denmark	fba@aqua.dtu.dk
Neil Campbell	ICES		Neil.campbell@ices.dk
Ana Colaço	University of the Azores	Portugal	maria.aa.colaco@uac.pt
Daniela Diz	Heriot-Watt University	UK	D.Diz@hw.ac.uk
Heino Fock	Thuenen Institute	Germany	heino.fock@thuenen.de
Laura Grady	JNCC	UK	Laura.Grady@jncc.gov.uk
Ellen Kenchington	Fisheries and Oceans Canada	Canada	ellen.kenchington@dfo-mpo.gc.ca
Andrew Kenny	CEFAS	UK	andrew.kenny@cefas.gov.uk
Emily Klein	Pew Trusts	UK	eklein@pewtrusts.org
Eskild Kirkegård (chair)			kirkegaardeskild@gmail.com
Olafur Arnar Ingolfsson	HELCOM	Norway	olafur.arnar.ingolfsson@hi.no
Rebecca Langton	Marine Scotland	UK	Rebecca.Langton@gov.scot
Liam Matear	JNCC	UK	Liam.Matear@jncc.gov.uk
Monika Szynaka	University of Algarve	Portugal	mjszynaka@gmail.com
Sebastian Valanko	ICES		sebastian.valanko@ices.dk

Annex 2: Resolutions

ICES Workshop to evaluate long-term biodiversity/ ecosystem benefits of NEAFC closed and restricted areas (WKECOVME)

2020/OT/HAPISG02 The Workshop to evaluate long-term biodiversity/ ecosystem benefits of NEAFC closed and restricted areas (WKECOVME) chaired by Eskild Kirkegaard (DK), will be at ICES HQ and online, 7-11 August 2023 to:

a) Review and consolidate information on effectiveness of NEAFC's 1) areas restricted to bottom fishing, and 2) closed areas according to the VME Recommendation (19:2014) in relation to long-term biodiversity/ecosystem benefits. Collated information should include an:
    i. evaluation of the biodiversity attributes of the areas concerned
    ii. list potential threats resulting from pressures, and specifically evaluate the pressures and likely threats from fishing activities affecting or expected to affect the areas and the biodiversity attributes
    iii. evaluation of the NEAFC management measures as to whether they achieve, or are expected to achieve, positive and sustained outcomes for the *in situ* conservation of biodiversity. This should also include the likely or potential effectiveness in mitigating the threats to the biodiversity attributes.
b) Based on expert judgement (WGFTFB and WGSFD experts) as well as NEAFC VMS and catch report data analysis by WGSFD, provide a commentary on current and potential maximum depth on the use of mobile bottom contacting gear (trawls) and bottom contacting static gear in the NEAFC regulatory area.

A core group of experts (Daniela Diz, Ellen L. Kenchington, Laura Grady, and Eskild Kirkegaard) will prepare material and help run the workshop. WKOECMVME will report by 22 August 2023 for the attention of the ACOM Committee.

Supporting information

Priority	The current activities of this Group will enable ICES to respond to advice requests from a number of clients (NEAFC/EC). Consequently, these activities are considered to have a high priority.

Scientific justification	ToR [a] this work should be done to be able to demonsate how relevant NEAFC measures (in particular the concepts of "closed areas" and "restricted bottom fishing areas" under the NEAFC VME Recommendation) correlated to the concepts "Marine Protected Area", MPA, and "Other Effective Area Based Conservation Measure", OECM. The work should provide eveidence base on current or potential evidence sources to provide further support to the OECM biodiversity benefits narrative. With regard to the VME closed areas and restricted bottom fishing areas is, if there is sufficient evidence that the pressure of bottom fisheries has largely been removed in these areas, what are the monitored biodiversity benefits? In the absence of sufficient monitoring is the workshop able to extrapolate from other evidence that the removal of bottom fishing pressure will have long term biodiversity benefits and describe these? What is the likely (minimal) biodiversity monitoring required or already available to optionally substantiate compliance evidence in terms of ongoing assessment of benefits in the future. ToR [b] In advance of the workshop, ICES working groups WGFTFB/WGSFD will provide a commentary based on expert judgement as well as NEAFC VMS and catch report data analysis on maximum depth on the use of mobile bottom contacting gear (trawls) and bottom contacting static gear in the NEAFC regulatory area. In the context of setting up OECMs, NEAFC will require infomation on areas that may be fished in the future. As such, an analysis of current NEAFC fishing practices in terms of maximum depth and in terms of general bathymetric features is rquired to inform the likely future extent by depth of fishing. VME/OECM closed area coordinates should be provided according to its advised depth limit as an option for consideration.
Resource requirements	Some support will be required from the ICES Secretariat.
Participants	The worksop will likely be attended by some 15–20 esxperts online and physically.
Secretariat facilities	None, apart from WebEx and SharePoint site provision
Financial	No financial implications.
Linkages to advisory committees	ACOM is the parent committee and specific ToRs from WKECOVME provide information fo the Advice Committee to respond to specific requests from clients.
Linkages to other committees or groups	While there are currently no direct linkages to other groups, WKECOVME should develop stronger links WGFTFB, WHMHM, WGSFD, WGDEC,and WGDEEP.
Linkages to other organizations	WKECOVME will provide the evidence base for ICES to base it advice to NEAFC. As such th working groups and experts under OSPAR and NAFO will be relavent.

Annex 3: Workshop Agenda

WKECOVME

7 – 11 August 2023

Draft Agenda v. 2 6/8

Monday 7 August	1400 – 1430 plenary	Welcome, Code of Conduct, adoption of agenda
	1430 – 1530 plenary	NEAFC's request to ICES and TOR for WKECOVME Discussion of background for the request. Presentation by Eskild Kirkegaard
	1530 – 1600 plenary	Background documents
	1600 - 1615	Comfort break
	1615 – 1715 plenary	TOR B: maximum depth on the use of bottom contacting gears. Presentation by Neil Campbell - available information - approach
	1715 – 1800 plenary	Forming of subgroups and planning the following days' work
Tuesday 8 August	1030 – 1100 plenary	TOR A i: evaluation of the biodiversity attributes of the areas concerned Presentation by Ellen L. Kenchington - available information - approach
	1100 – 1130 plenary	TOR A ii list potential threats resulting from pressures, and specifically evaluate the pressures and likely threats from fishing activities affecting or expected to affect the areas and the biodiversity attributes Presentation by Laura Grady - available information - approach
	1130 - 1145	Comfort break
	1145 – 1300 plenary	TOR A iii: evaluation of the NEAFC management measures and if they mitigate the threats to the biodiversity attributes Presentation by Daniela Diz - available information - approach

	1300 - 1400	Lunch
	1400 – 1600	Subgroups work
	1600 - 1615	Comfort break
	1615 - 1800	Subgroups work
Wednesday 9 August	1030 - 1100	Subgroups work
	1100 – 1115	Comfort break
	1115 – 1300 plenary	Feedback from subgroups
	1300 - 1400	Lunch
	1400 – 1600	Subgroups work
	1600 - 1615	Comfort break
	1615 – 1645 plenary	Advice template
	1645 - 1800	Subgroups work
Thursday 10 August	1030 – 1100	Subgroups work
	1100 – 1115	Comfort break
	1115 – 1300	Subgroups work
	1300 - 1400	Lunch
	1400 – 1600 plenary	Report and advice template
	1600 - 1615	Comfort break
	1615 – 1800 plenary	Report and advice template
Friday 11 August	1030 – 1130 plenary	Report and advice template
	1130 – 1145	Comfort break
	1145 – 1245 plenary	Report and advice template
	1245 – 1300 plenary	Close

Annex 4: Report from the review group of the work done by ICES working group on deep water ecology (WGDEC) in collaboration with the working group on spatial fisheries data (WGSFD) and of the workshop to evaluate long-term biodiversity/ecosystem benefits of NEAFC closed and restricted areas (WKECOVME)

Participants: Emanuela Fanelli and Pierre Pepin (Chair)

ICES Professional Officer: Sebastian Valanko

Meeting: By correspondence July-August 2023.

Request: Evaluate if the work has been done so that ICES can base its advice on it regarding two NEAFC requests:

1. NEAFC requests ICES to continue to all available new information on the distribution of vulnerable habitats (VMEs) in the NEAFC Convention Area and fisheries activities in and in the vicinity of such habitats and provide advice relevant to the Regulatory Area and the above-mentioned objectives. This should also include information on the distribution of vulnerable habitats in subareas of the Regula-tory Area that are closed to fishing for other purposes than VME protection, e.g. the haddock box at Rockall Bank. See last year's advice: see previous years advice.

2. NEAFC requests ICES to advise on Other Effective Area-Based Conservation Measures (OECMs) in relation to (existing) long-term biodiversity/ecosystem benefits of NEAFC's 1) areas restricted to bottom fishing, and 2) closed areas according to the VME Recommendation (19:2014).

Note on the process:

The reviewers' job is to evaluate the response from the working groups WGDEC and WGSFD, and the outcome of WKECOVME. We focused on commenting on the completeness of the advice, whether the groups missed important points relevant to the requests, and whether we agree with the conclusions.

The report combines the comments of two reviewers: Emanuela Fanelli and Pierre Pepin. The reviewers have different backgrounds, and each reviewer conducted their own assessments of the two reports before combining their evaluations and agree on the structure of the report and reach a consensus on the overall conclusions of our evaluation.

Review of the Report from the Working Group on Deep Water Ecology (WGDEC) 2023.

The Joint ICES/NAFO Working Group on Deep-water Ecology (WGDEC), chaired by Ana Colaço (PT), David Stirling (UK), Rui Vieira (UK) met online from 24-26 May 2023 to:

- ToR [A] Collate, validate and QA/QC-check new information on the occurrence and distribution of vulnerable marine ecosystems (VMEs), VME indicator taxa and VME elements in the North Atlantic and adjacent waters, archive appropriately using the ICES VME Database, and disseminate via the Working Group report and ICES VME Data Portal.
- ToR [B] Review, validate and update new information on the occurrence and distribution of VMEs, VME indicator taxa and VME elements in the NEAFC Convention Area, including subareas of the Regulatory Area that are closed to fishing for other purposes than VME protection.
- ToR [C] Provide and apply a mechanism to identifying a level of change/new VME submissions that should trigger an update of the EU VME advice to ensure the VMEs conservation objective is consistently achieved.

The reviewers noted that the report followed existing and approved procedures for the inclusion and analysis of data on Vulnerable Marine Ecosystems (VMEs), which therefore yielded advice in a manner consistent with prior outcomes from WGDEC. The reviewers note, however, that the work of WGDEC was potentially seriously affected by the very limited data submissions in which only two countries provided updated information from their data collection approaches. In 2023, 195 new VME presence records and 70 absence records were accepted into the ICES VME database. This contrasts with 2022, when 690 new VME presence records and 154 absence records were accepted into the ICES VME database. **The incomplete submission of data by ICES member countries for WGDEC's work is likely to have important consequences to the value of the updates to information and the subsequent advice that can be derived from the efforts of WGDEC in 2023**. **The report should include some explanation for the lack of submission to the ICES VME database.**

In the introduction of section 4, the reviewers note that the VME "confidence" index is no longer considered a good proxy for evaluating the reliability of the VME data used in the calculation of the VME Index, and that three recent ICES workshops (WKREG, WKEUVME, WKVMEBM) expressed concerns over the validity of the weighting terms applied to derive the confidence index. **The reviewers believe that for completeness, the WGDEC report should provide a summary of the concerns and the consequences to the provision of information for the formulation of advice**.

WGDEC's report provides a clear summary of the new data and presents the results of the analyses effectively. New information on VMEs were provided for two ICES ecoregions: Oceanic Northeast Atlantic ecoregion (Rockall Bank (including the Haddock Box)) and the Celtic Seas ecoregion (Rockall Bank, Porcupine Bank, Irish continental shelf). Outputs include maps of the new information from various sources and outputs from the weighting algorithm showing the likelihood of encountering VME in each grid cell for each area separately. **There are data within and outside the NEAFC regulatory areas, but it is unstated if application of the VME Index weighting algorithm for that area is based on all available data, which should be clarified in the text**.

The analysis of the 2022 VMS submission from NEAFC, provides information and maps on fisheries activities in the vicinity of vulnerable habitats (VMEs). The methods are clearly described and the approaches consistent with those used in the provision of advice in other jurisdictions (e.g., NAFO). Results are presented for Hatton Bank, Rockall Bank, South of Iceland, and Barents

Sea (no new data for the mid-Atlantic ridge seamounts). **The reviewers noted some inconsistencies in the presentation of the outcome of their analyses. There are clear statements about the adequacy of VME closures for Hatton Bank and the South of Iceland but not for Rockall Bank or the Barents Sea, despite comprehensive descriptions of the fishing activity, which represents an important gap in the information provided in the report.** Furthermore, because ToR C has been deferred to a later date, the reviewers note that the level of change/new VME submissions that should trigger an update of the EU VME advice is not evaluated in this report.

Because of there were relatively few additional data included in the 2023 WGDEC report, the reviewers conclude that the EU VME advice provided to NEAFC should at the very least be consistent with that previously provided by ICES.

Review of the Report from the Workshop to Evaluate Long-term Biodiversity/Ecosystem Benefits of NEAFC closed and restricted areas

The Workshop to evaluate long-term biodiversity/ ecosystem benefits of NEAFC closed and restricted areas (WKECOVME) chaired by Eskild Kirkegaard (DK), will be at ICES HQ and online, 7-11 August 2023 to:

- ToR [A] Review and consolidate information on effectiveness of NEAFC's 1) areas restricted to bottom fishing, and 2) closed areas according to the VME Recommendation (19:2014) in relation to long-term biodiversity/ecosystem benefits. Collated information should include an:
    i. evaluation of the biodiversity attributes of the areas concerned
    ii. list potential threats resulting from pressures, and specifically evaluate the pressures and likely threats from fishing activities affecting or expected to affect the areas and the biodiversity attributes
    iii. evaluation of the NEAFC management measures as to whether they achieve, or are expected to achieve, positive and sustained outcomes for the in situ conservation of biodiversity. This should also include the likely or potential effectiveness in mitigating the threats to the biodiversity attributes.
- ToR [B] Based on expert judgement (WGFTFB and WGSFD experts) as well as NEAFC VMS and catch report data analysis by WGSFD, provide a commentary on current and potential maximum depth on the use of mobile bottom contacting gear (trawls) and bottom contacting static gear in the NEAFC regulatory area.

After providing definitions of key terms contained in the report, WKECOVME proceeded to [1] evaluate the Biodiversity Attributes of the Areas Concerned; [2] list potential threats resulting from pressures, and specifically evaluate the pressures and likely threats from fishing activities affecting or expected to affect the areas and the biodiversity attributes; [3] evaluate the NEAFC management measures and if they mitigate the threats to the biodiversity attributes; and [4] based on expert judgement (WGFTFB and WGSFD experts) as well as NEAFC VMS and catch report data analysis by WGSFD, provide a commentary on current and potential maximum depth on the use of mobile bottom contacting gear (trawls) and bottom contacting static gear in the NEAFC regulatory area.

Each element, consisted of subsections detailing the information collated based on the Convention of Biological Biodiversity (CBD) in its guidance on Other Effective Conservation Measures (OECMs), provides examples of biodiversity attributes under Criterion C: "Achieves sustained and effective contribution to in situ conservation of biodiversity (Annex II in CBD 2018)". WKECOVME identified the following six biodiversity attributes for which it collated information in NEAFC's 1) areas restricted to bottom fishing, and 2) closed areas according to the NEAFC

Recommendation 19 : 2014 on area management measures for the protection of vulnerable marine ecosystems in the NEAFC Regulatory Area:

1. Communities of rare, threatened or endangered species,
2. Representative natural ecosystems,
3. Range restricted species,
4. Key biodiversity areas,
5. Areas providing critical ecosystem functions and services,
6. Areas for ecological connectivity.

WKECOVME also collated information for 14 VME closures associated with the Hatton Rockall Closures, excluding the Rockall Haddock Box which is considered separately for its transboundary position between national waters and the high seas, and which is targeted at managing impacts of fisheries on juvenile haddock. In addition, there is another closed area (Irminger Sea Redfish Closure) which was not part of the areas closed to protect VME but overlaps with Regulatory Area 1 (RA1, Reykjanes Ridge) and contains biodiversity attributes. Only benthic and demersal attributes were consistently considered under Biological Attributes, given that the focus was on fishing with bottom-contact gears (ToR A. ii, iii), but marine mammals and seabirds are considered where they are a prominent documented attribute for the area. Given the similarities between the biodiversity attributes and the EBSA and VME criteria, WKECOVME also reviewed the documentation for the five EBSAs located in the NEAFC region. WKECOVME recognized that the biodiversity attributes share similarities with those used by the CBD to identify EBSAs, and that the FAO VME criteria have strong linkages to the biodiversity attributes of 'key biodiversity areas' and 'areas providing critical ecosystem functions and services', and applied complimentary criteria from the FAO guidelines to identify areas at risk of biodiversity loss as a result of vulnerability to the nature of the fishery and whether significant adverse impacts of fishing have occurred.

Although the north Atlantic basin has the most extensive source of information for deep-water benthic invertebrates, data on the distribution of many organisms are still scarce. Despite the limitations, WKECOVME provided a comprehensive review of information pertaining to [1] communities of rare, threatened, or endangered species; [2] representative natural ecosystems; [3] range restricted species; [4] key biodiversity areas; [5] areas providing critical ecosystem functions; and [6] areas for ecological connectivity and their relevance to the NEAFC areas defined above. The information and their link with biodiversity criteria are effectively summarized at the end of section 2. **The reviewers agree with the conclusions that despite scarcity and patchiness of data in the deep sea for many benthic invertebrates, inferences about their distribution can be made by knowing something about known biodiversity attributes associated with nearby similar habitats and features. Furthermore, it is reasonable to infer that noteworthy biodiversity attributes or features are likely to be found in NEAFC restricted areas (NEAFC RA 1 – 3) as a result of the lack of or low level of human-induced disturbance or degradation.**

Existing and historic threats and associated pressures include fishing (including ghost fishing), shipping, telecommunications, radioactive waste dumping, bioprospecting of marine genetic resources, marine litter and climate change. These elements represent key factors that are most likely to have affected biodiversity in the NEAFC areas. For each activity, WKECOVME identified corresponding pressures, with fishing having the greater number of pressures associated with it. Shipping is second in terms of pressures, but evaluation of their impact is largely qualitative. Fishing will have impacts on the environment which vary between types of gears and how they are used. Physical seabed damage, marine litter, ghost fishing, biomass removal and bycatch can all impact biodiversity. The risk of impact to benthic and demersal biodiversity attributes is minimised within the areas restricted to bottom fishing and VME closure are. Potential future threats include deep-sea mining, oil and gas, renewable energy and mesopelagic fisheries.

At this time, the potential development of these threats is judged to be limited with no imminent risk. The review by the workshop was comprehensive and the rationale for the conclusions was appropriate throughout this section. **The reviewers agree with the conclusion that the evidence available on current, historic, and potential future activities indicates that fishing is the most prevalent activity occurring across NEAFC RA1, 2 and 3, with the greatest potential threats from associated pressures.**

In their evaluation of the NEAFC management measures and their ability to mitigate threats to biodiversity attributes, it is important to note that the meeting participants consider the use of the CBD OECM criterion C as guidance to address ToR [A]iii represents only a partial assessment of NEAFC management measures and that criteria A, B and D would be essential for the full assessment of OECMs. Furthermore, because there are several other competent bodies and authorities involved in the conservation and sustainability of marine biodiversity attributes in the North-east Atlantic, continued cooperation is essential. WKECOVME provided a comprehensive assessment of VME closures and restricted bottom fishing areas in terms of their effectiveness, whether they have been sustained over the long term, in situ conservation of biological diversity, and information and monitoring. **The reviewers consider that the workshop was limited in its capacity to assess the potential risk of bottom fishing impacts because information on gear code is not consistently being provided in the NEAFC provided data. This represents an important shortcoming that limits the accuracy if the scientific advice is based only on partial data. Until the issue is resolved, the reviewers recommend that all VMS data be considered as indicative of the bottom fishing footprint in order to minimise the risk of significant adverse impact and to ensure effectiveness of management measures.**

NEAFC data quality issues resulted in WKECOVME choosing the ICES VMS and logbook data, which passes through a robust quality assurance process, and can be subset by gear and target assemblage information, despite some benefits that could have been achieved using the NEAFC data, in their assessment of ToR [B]. The assessment of relative proportion of fishing activity in relation to depth and by métier provided a useful perspective in terms of the potential value of depth restrictions to limit the impact of bottom contacting gear in the NEAFC regulatory area. However, as WKECOVME correctly point out in their conclusions, if NEAFC wishes only to consider the parts of the restricted bottom fishing areas, the resulting areas may not necessarily include biodiversity attributes and may as such not contribute to the protection of them. **The reviewers view this as a critical element of the advice that should be stressed to the requesting agency that there is little justification to use bottom depth limits to designate OECMs. Furthermore, the reviewers agree with the WKECOVME conclusion concerning the appropriateness of NEAFC bottom-fishing closures and advised that the current NEAFC bottom-fishing closure areas are appropriate to protect VMEs, and that reopening of such closures to bottom fishing would present a risk of significant adverse impacts to VMEs.**

Overall, the reviewers conclude that WKECOVME has address the issues identified in the Terms of Reference based on the best available information and that the conclusions provided in this report provide a strong foundation of the development of advice to NEAFC.