Report of the ICES\NAFO Joint Working Group on Deep-water Ecology (WGDEC), 11–15 March 2013, Floedevigen, Norway.

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11–15 March 2013

Floedevigen, Norway

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

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Executive summary

On 11 February 2013, the joint ICES/NAFO WGDEC, chaired by Francis Neat (UK) and attended by ten members met at the Institute for Marine Research in Floedevigen, Norway to consider the terms of reference (ToR) listed in Section 2.

WGDEC was requested to update all records of deep-water vulnerable marine ecosystems (VMEs) in the North Atlantic. New data from a range of sources including multibeam echosounder surveys, fisheries surveys, habitat modelling and seabed imagery surveys was provided. For several areas across the North Atlantic, WGDEC makes recommendations for areas to be closed to bottom fisheries for the purposes of conservation of VMEs.

Within the NEAFC regulatory area the following areas were considered;

- **N-W Rockall.** New data further support the boundary revision proposed by WGDEC in 2012. WGDEC therefore reiterates its recommendation from 2012, i.e. to modify the existing boundary to better protect VMEs.
- **S-W Rockall**. New data suggest the presence of VMEs outside the current closures in this area. Two closures to bottom fisheries are recommended.
- **The Hatton-Rockall Basin**. New data suggest significant aggregations of deep-sea sponges in this area. A closure to bottom fishing is recommended. Notice is also drawn to a potential cold-seep VME, but due to uncertainty in location and extent of the ecosystem, no closure to bottom fisheries is recommended at present.
- **The Hatton Bank.** Although no new information on VMEs were available, new information on bottom fishing vessel activity was provided allowing for better definition of the area in the SW of the bank that was proposed for closure in 2012. Two closures to bottom fisheries for protection of VMEs in this area are recommended.
- **The Josephine Seamount**. This is a NEAFC existing fishing area and an OSPAR MPA site. Although no new VME indicator data were available to the group, WGDEC considers that VMEs are very likely to be present in this area. A closure to bottom fishing for their protection is recommended.

Within the EEZs of various countries the following areas were considered;

- **Rosemary Bank** (EU EEZ). New information on trawl bycatch of deep-sea sponges was available. A closure to bottom fisheries for protection of VMEs in this area is recommended.
- **Faroese Waters** (Faroe Islands EEZ). New information from longline and trawl bycatch of coral and gorgonians were available. Significant amounts of coral indicate the presence of VMEs in two areas. Two closures to bottom fisheries for protection of VMEs in this area are recommended.
- **North Shetland-Tampen ground** (EU EEZ). New information on a significant trawl bycatch of deep-sea sponges was available. The record is close to other historical records of deep-sea sponges suggesting a wider area of this VME. A closure to bottom fisheries for protection of VMEs in this area is recommended.

- **Hebridean Terrace Seamount** (EU EEZ). New information from ROV surveys indicates the presence of coral gardens on the steep slopes of this seamount. A closure to bottom fisheries around the steep flanks for protection of VMEs is recommended.
- **Whittard Canyon, Irish Margin/Bay of Biscay** (EU EEZ). New information from ROV surveys suggested the presence of VMEs in this area. A closure to bottom fisheries for protection of VMEs in this area is recommended.
- **Porcupine Seabight** (EU EEZ). New information was available suggesting deep-sea sponge aggregations in this area. A closure to bottom fisheries is recommended.

Within the Northwest Atlantic (NAFO regulated) the following areas were considered;

- **The Grand Banks and Flemish Cap**. New Russian records of bycatch levels of VME indicators were presented but they were very low (not exceeding 1 kg of VME indicator species). No recommendations are made for closures to bottom fisheries.

WGDEC was asked if buffer zones around areas closed to bottom fishing are appropriate and to explain the criteria used to apply buffer zones. In the past WGDEC has drawn closure boundaries inclusive of a buffer zone and thus considers that current and proposed closure boundaries are appropriately delineated. The 'rule-of-thumb' for applying a buffer zone is to horizontally extend the closure around the records of VME indicator species by two to three times the depth of the water. The outer extents of these points are then joined to form the boundary. In some situations boundaries are drawn according to geomorphological features or 'VME elements', rather than actual records of VME indicators, in which case a precise buffer zone cannot be defined. Buffer zones adopted in new recommendations will be illustrated.

WGDEC was asked to assess the list of VME indicator species with a view to whether it is exhaustive and can be harmonized with the NAFO list of VME indicator species. WGDEC did not think an exhaustive list of species associated with VMEs in the NEAFC RA was necessary. Instead a list of VME types that encompass those species was thought to be more useful. Such a list was developed and it is described how those species on the NAFO list be integrated and harmonized.

WGDEC mapped VME elements (i.e. geomorphological features) in the NEAFC RA at depths <2000 m. The Mid-Atlantic Ridge is highlighted as one contiguous VME element. VME elements within the Rockall-Hatton area are mapped and those without current protection measures are highlighted. An analysis of all isolated seamounts with summits <2000 m in the NEAFC area was undertaken and a map is presented. Attention is drawn to six areas. In addition all known hydrothermal vents in the NEAFC RA were mapped. It was clear that most are too deep to be at risk from bottom fishing impacts. The few that are at depths <2000 m are highlighted as they are potentially at risk.

WGDEC was asked to assess whether the regulations for longline fishing as adopted by SEAFO and CCMLAR would be appropriate to vessels operating in the NEAFC RA. WGDEC concluded that the CCAMLR regulations are appropriate to the large industrialized longline vessels operating in the NEAFC area. If adopted by NEAFC these regulations would result in improved VME conservation objectives. The success, however, of the CCAMLR regulations appears to be contingent upon observer coverage which at present in NEAFC only applies to exploratory fisheries.

WGDEC was requested to incorporate data on known hydrothermal vents and cold-seeps in the North Atlantic into the ICES VME database. This was done and the sites are described together with a list of the associated fauna. The chapter concludes with an appraisal of potential threats from anthropogenic pressures.

WGDEC generated cumulative bycatch curves for sponges, sea-pens, and *Lophelia pertusa* (stony coral) using a subset of survey data from the ICES VME database. These analyses are discussed in relation to similar work undertaken by NAFO Scientific Council. While informative for WGDEC in defining VME encounters during scientific surveys, it was not possible to extrapolate this to generate confident estimates of VME thresholds for commercial vessels.

WGDEC reviewed the ecosystem section of the area overviews that WGDEEP uses in its reports. A suggestion for standardization of content and restructuring is made and it is emphasized that specific attention should be given to the occurrence of VMEs in each area.

1 Opening of the meeting

WGDEC began discussions at 09.00 on February 11th, 2013, at the Institute of Marine Research in Floedevigen, Norway. Deliberations primarily focused on what was being asked of the group by NEAFC. Following introductions, the opening discussion focused on new data sources available to the group, assignments of Terms of Reference, identification of key issues for group discussion and a timetable of events for the week. From 12th through 14th February a representative from the European Commission's DGMARE joined the meeting in a purely observational capacity.

2 Adoption of the agenda

The ICES/NAFO Joint Working Group on Deep-water Ecology (WGDEC), Chaired by Francis Neat, UK, met 11–15 February 2013 at IMR, Floedevigen, Norway to:

a) Provide all available new information on distribution of VMEs in the North Atlantic and update maps with a view to advising on any boundary modifications of existing closures to bottom fisheries (NEAFC request[1]).

b) Evaluate whether buffer zones applied in the current bottom fishing closures are appropriate. Additionally, ICES is requested to include, specify and illustrate buffer zones in its future advice on closures in the Regulatory Area as appropriate (NEAFC request).

c) Assess whether the list of VME indicator species is exhaustive and suggest possible addition to that list. The basis for the assessment should be the FAO Guidelines specifying taxa and habitats that may be relevant. ICES should focus on taxa (species or assemblages of species) that tend to form dense aggregations of assumed particular functional significance. NAFO SC has in 2012 conducted a similar assessment and revision and to the extent scientifically valid harmonization with NAFO lists would be beneficial. ICES is furthermore asked to map VME elements (i.e. geomorphological features) in the NEAFC RA. This would include seamounts and knolls at fishable depths (with summits shallower than 2000 m), canyons, and steep flanks. Also in this exercise, harmonization with NAFO SC evaluations would be beneficial. ICES is specifically requested to advice NEAFC on the occurrence of hydrothermal vents and measures applicable to protect hydrothermal vents and associated communities in the RA (NEAFC request).

d) Advice on the appropriateness of applying the threshold levels for VME indicator species for longline fishing as adopted in the SEAFO, and CCMLAR, in the NEAFC RA (NEAFC request).

e) Incorporate data on known hydrothermal vents and seeps in the ICES area into the ICES WGDEC VME database and maps and review the associated fauna and potential threats from anthropogenic pressures.

f) Explore the use of survey data from the ICES VME database to address by-catch thresholds in different regions, e.g. NAFO and NEAFC RA's.

g) Review and, if necessary, update the ecosystem section of the area overviews in the WGDEEP report in advance of WGDEEP so that WGDEEP can take greater account of ecosystem aspects (WGDEEP recommendation).

WGDEC will report by 14 April for the attention of the Advisory Committee.

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[1] "to provide all available new information on distribution of vulnerable habitats in the NEAFC Convention Area and fisheries activities in and in the vicinity of such habitats."

3 Provide all available new information on distribution of VMEs in the North Atlantic and update maps with a view to advising on any boundary modifications of existing closures to bottom fisheries

3.1 Introduction

New data that indicate the presence of VMEs were submitted to ICES WGDEC in 2013 and these were incorporated into the ICES VME database. These data were from across the North Atlantic including the NEAFC and NAFO regulatory areas as well as areas within the EEZs of the EC, Norway and other countries. No actual data were made available to the group on fishing activity (VMS data) in the North Atlantic. However some graphic outputs of VMS data were provided by Spain for the Hatton Bank area.

This chapter is split according to areas within the NEAFC RA, those areas within the EEZ's of the EC or other countries and those within the NAFO RA. Where new data suggested the presence of VMEs in areas outside current closed areas, revisions to closure boundaries or new proposals for area closures to bottom fisheries have been made.

Areas considered within the NEAFC RA include;

- Northwest Rockall Bank;
- Southwest Rockall Bank;
- Hatton-Rockall Basin;
- Hatton Bank;
- Josephine Seamount.

Areas considered within the EEZ's of various countries include;

- Hebrides Terrace Seamount;
- Rosemary Bank;
- Porcupine Sea Bight;
- Faroe-Shetland Channel and Tampen Area;
- Faroese waters;
- Irish Margin and Bay of Biscay;
- Gulf of Cadiz.

Areas considered within the NAFO RA include;

- Flemish Cap and Grand Banks.

3.2 Areas within the NEAFC regulatory area

3.2.1 Northwest Rockall Bank

Rockall Bank is a large plateau that lies some 250 km to the west of the UK and Ireland surrounded on all sides by deep water. It lies partly in the EC EEZ and partly in international waters regulated by NEAFC. An area in the NW of Rockall Bank has been closed to bottom fishing since 2007. That same closed area was submitted to the

European Commission as a candidate Special Area of Conservation (cSAC) under the EC Habitats Directive in 2010, and has since been approved by the European Commission as a Site of Community Importance (SCI). In 2012 WGDEC recommended a boundary modification to the area based on several sources of new information.

There was new research undertaken in the NW Rockall closed area in 2012. Six towed video transects within the NW Rockall closure were completed by Marine Scotland (Figure 3.1). The video footage revealed some of the most extensive patches of *Lophelia pertusa* reefs seen to date. Most coral occurred between depths of 240 and 270 m in the centre of the current NW Rockall closure. However, in a part of the proposed closure to bottom fishing recommended by WGDEC in 2012 (to the northeast) that is currently open to bottom fishing, a video transect revealed new observations of *Lophelia pertusa* reefs reaffirming that the extension is required.

Recommendation: The extension of the closure to bottom fishing proposed by WGDEC in 2012 is recommended.

The boundary modification recommended by WGDEC in 2012 is shown in Figure 3.1 and the coordinates of the closure boundary are given in Table 3.1.

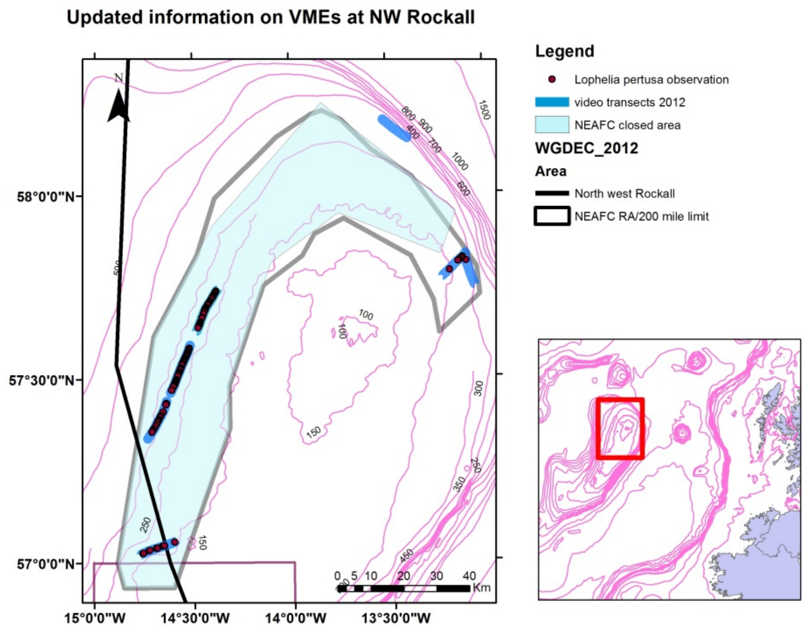


Figure 3.1. Map of NW Rockall showing locations of video transects (blue lines) undertaken by Marine Scotland in 2012 with point locations of coral observations (dots). The closure boundary recommended by WGDEC in 2012 is shown as the grey polygon. The current NEAFC closure is shown in pale blue. NEAFC RA boundary (200 miles) is shown as black line. Note the coral observed in the NE corner that lies outside the NEAFC closure (but inside the WGDEC (2012) recommended closure).

Table 3.1. Coordinates of points for recommended closure to bottom fishing in NW Rockall Bank.

Point Number	Latitude (N) (Degrees Minutes Seconds)	Longitude (W) (Degrees Minutes Seconds)	Latitude (decimal)	Longitude (decimal)
1	58 02 49.20	13 22 25.96	58.04700	-13.37388
2	57 51 35.92	13 07 30.14	57.85998	-13.12504
3	57 47 50.42	13 02 59.42	57.79734	-13.04984
4	57 43 22.15	13 02 17.37	57.72282	-13.03816
5	57 37 15.49	13 14 55.75	57.62097	-13.24882
6	57 42 33.62	13 16 28.56	57.70934	-13.27460
7	57 49 48.97	13 23 09.02	57.83027	-13.38584
8	57 56 05.67	13 43 26.11	57.93491	-13.72392
9	57 53 37.50	13 52 28.16	57.89375	-13.87449
10	57 50 05.13	13 56 22.56	57.83476	-13.93960
11	57 45 18.43	14 08 24.00	57.75512	-14.14000
12	57 28 59.98	14 19 00.01	57.48333	-14.31667
13	57 22 00.01	14 19 00.01	57.36667	-14.31667
14	56 55 59.98	14 36 00.00	56.93333	-14.60000
15	56 55 59.98	14 51 00.00	56.93333	-14.85000
16	57 00 00.00	14 52 59.98	57.00000	-14.88333
17	57 37 00.01	14 42 00.00	57.61667	-14.70000
18	57 50 15.79	14 28 44.22	57.83772	-14.47895
19	57 50 42.00	14 28 25.86	57.84500	-14.47385
20	57 59 35.30	14 23 11.18	57.99314	-14.38644
21	58 09 29.55	14 03 48.85	58.15821	-14.06357
22	58 13 05.91	13 53 17.88	58.21831	-13.88830
23	58 13 43.32	13 49 41.37	58.22870	-13.82816
24	58 12 14.22	13 43 52.32	58.20395	-13.73120
25	58 07 11.71	13 34 29.10	58.11992	-13.57475

3.2.2 Southwest Rockall Bank

In the SW section of the bank often referred to as the 'Empress of Britain bank' a closure to bottom fisheries has been in effect since 2007 to protect *Lophelia* reefs. In 2012 ICES recommended a boundary revision for the SW Rockall closed area based on two large bycatch records of *Lophelia pertusa*. Two small areas (with buffer zones of twice the depth) around the actual trawl paths were closed to bottom fishing by NEAFC in 2013.

This year, new data were available from towed video transects (Figure 3.2). As the positions reported are the ship's position (rather than the actual position of the towed video camera) an estimated maximum uncertainty of around 500 m (twice the wire length between vessel and camera) must be taken into account. *Lophelia pertusa* reefs were recorded across the area as were extensive stretches of seabed without *Lophelia pertusa* reefs (Figure 3.2). Most of the *Lophelia pertusa* reefs recorded were inside the current closed area (Figure 3.2) but there were also records from outside the currently closed area.

Recommendation: SW Rockall closure boundaries be revised.

Two revised areas are recommended for closure to bottom fisheries;

1) Extend the boundary of the closure in the western corner to incorporate the new video records (and the 2012 bycatch record). The boundary is drawn around the positions of the records according to the estimated uncertainty of the data (500 m) and includes a buffer zone of three times the water depth (Figure 3.2).

2) Extend the boundary in the southern corner to encompass new video records and the 2012 bycatch records. The boundary is drawn around the positions of the records according to the estimated uncertainty of the data (500 m) and includes a buffer zone of three times the water depth (Figure 3.2).

The geographic coordinates for the above closures are provided in Tables 3.2a and 3.2b.

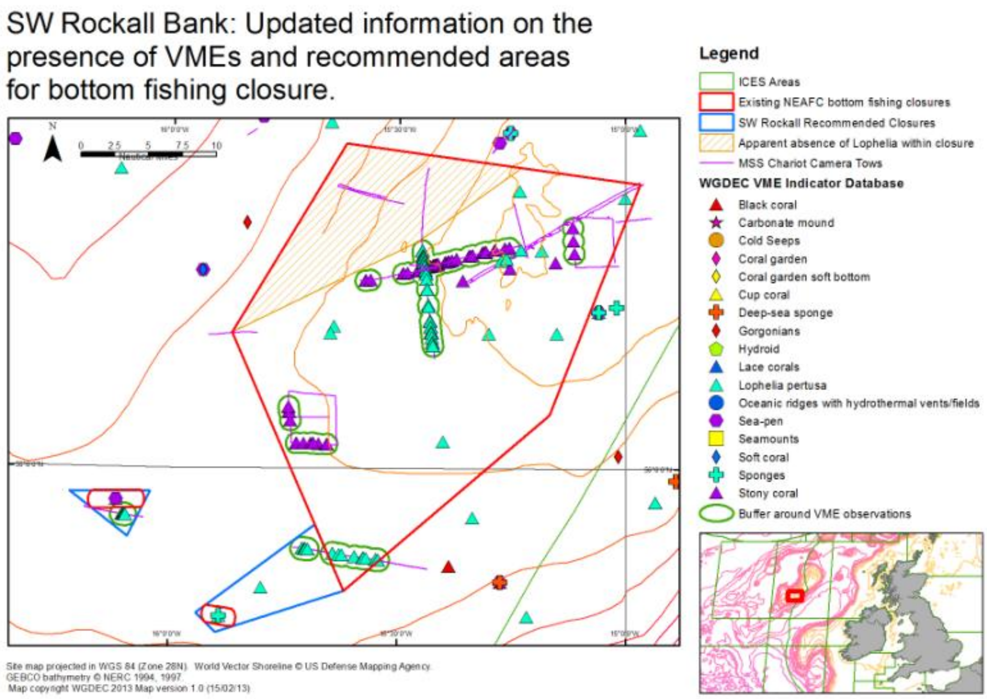


Figure 3.2. SW Rockall bottom fishing closure boundary modifications (blue polygons).

Table 3.2a. Geographic coordinates for the SW Rockall western closure extension.

Latitude (decimal degrees)	Longitide (decimal degrees)	Latitude (DMS)	Longitude (DMS)
55.9694	-16.2196	55° 58' 10" N	16° 13' 11" W
55.9706	-16.0427	55° 58' 14" N	16° 2' 34" W
55.9144	-16.0925	55° 54' 52" N	16° 5' 33" W

Table 3.1b. Geographic coordinates for the SW Rockall southern corner closure extension.

Latitude (decimal degrees)	Longitide (decimal degrees)	Latitude (DMS)	Longitude (DMS)
55.9310	-15.6806	55° 55' 52" N	15° 40' 50" W
55.8500	-15.6167	55° 51' 0" N	15° 37' 0" W
55.7977	-15.8968	55° 47' 52" N	15° 53' 48" W
55.8215	-15.9399	55° 49' 17" N	15° 56' 24" W

WGDEC notes that in the northern part of the SW Rockall closed area (orange shaded area in Figure 3.2) there is now substantial video evidence that *Lophelia pertusa* reefs are absent. The original basis for closure of this area was precautionary (ICES WGDEC 2007) and based on Russian information on patches of coral that were joined together to form a boundary. Should further research continue (including analysis of fishing data) and demonstrate there are no *Lophelia pertusa* reefs likely to be present in this area there may be a strong case that this part of the current closure could be reopened to bottom fishing in future.

3.2.3 Hatton–Rockall Basin

The Hatton-Rockall basin is an expanse of deep-water sedimentary habitat at depths of between 1100–1500 m between the slopes of Rockall Bank and Hatton Bank.

In a research survey in 2012 a benthic sampling net attached to a fishing trawl was found to contain species of chemosymbiotic clams (Bivalvia: Vesicomyidae and Thyasiridae). There were two species completely new to science among the sample as well as previously known species. To date species of this genus have only been found in association with active cold seeps. This is the first indication of an active cold seep ecosystem at Rockall. Cold seeps are considered to be VMEs under the FAO guidelines and since the site is at approximately 1200 m and within a NEAFC existing fishing area some protection from bottom contact fishing is likely to be needed. The exact position of the seep is not known because the trawling operation was aborted due to problems with the fishing gear, but estimates from the Ship's log and sensors attached to the net give an approximate position with an uncertainty of around 3 km; a position of 57.953 latitude, -15.545 longitude has been used. The position is shown in Figure 3.3. Further research should be able to confirm the existence of the cold seep and a more precise location and estimate of extent of the ecosystem at which point a closure will almost certainly be recommended.

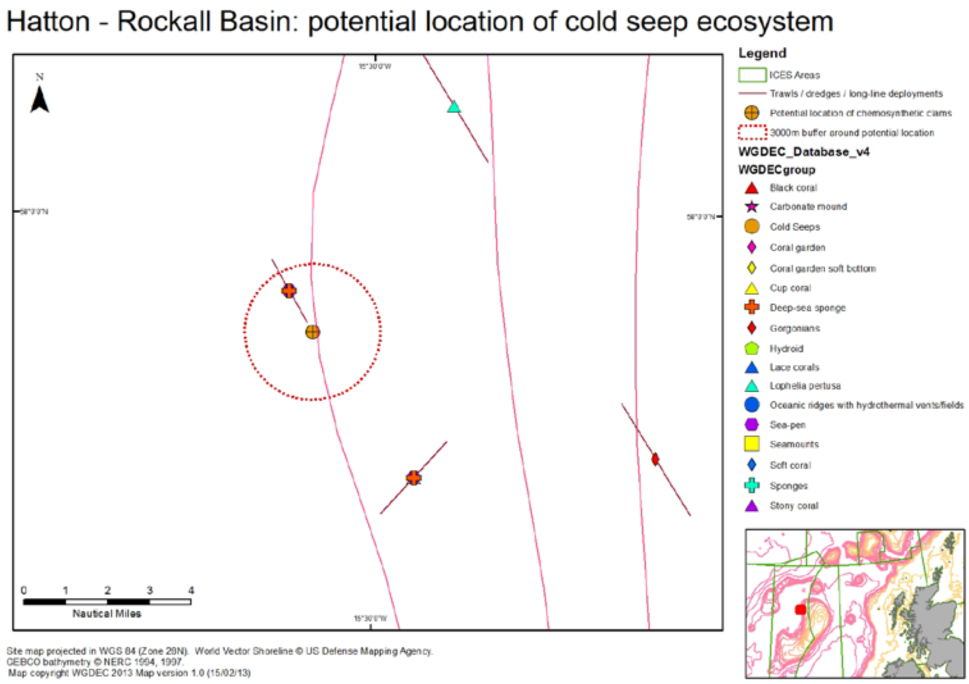


Figure 3.3. Approximate location (circled) of chemosynthetic clams collected in a benthic sampling net attached to a fishing trawl within the Hatton-Rockall Basin. The 3000 m perimeter shown takes into account the uncertainty in location estimated from the ships log and sensors on the trawlnet.

In the middle of the Hatton-Rockall basin new data were presented from a research survey (Huvenne *et al.*, 2011a) on the presence of an aggregation of deep-sea sponges (*Pheronema carpenteri* and *Hyalonema* stalked sponges) at approximately 1150 m water depth (Figure 3.4). The sponges were observed from ROV and drop-frame camera video and image footage (Howell *et al.*, 2013). A proposed closure to bottom gear is shown in Figure 3.3, with the geographic coordinates provided in Table 3.3.

Recommendation: A closure to bottom fishing around the sponge aggregation is proposed that corresponds to twice the water depth.

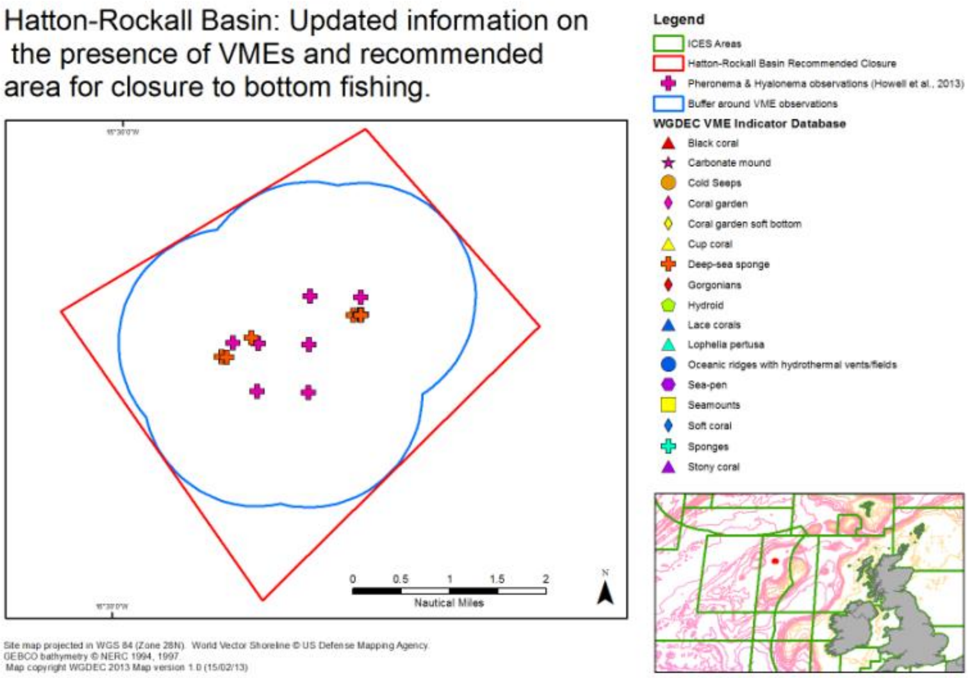


Figure 3.4. Recommendation for a closure to bottom fishing within the Hatton-Rockall Basin (red line). The blue line represents a buffer around the VME observations that corresponds to twice water depth.

Table 3.3. Geographic coordinates for the Hatton-Rockall Basin closure.

Latitude (decimal degrees)	Longitude (decimal degrees)	Latitude (DMS)	Longitude (DMS)
58.1840	-16.5190	58° 11' 2" N	16° 31' 8" W
58.2166	-16.4205	58° 12' 60" N	16° 25' 14" W
58.1832	-16.3624	58° 10' 59" N	16° 21' 45" W
58.1348	-16.4511	58° 8' 5" N	16° 27' 4" W

WGDEC notes that a recent predictive modelling study suggests this type of VME may be present throughout the Hatton-Rockall Basin (Ross and Howell, 2012); however as the science of predictive habitat modelling remains at a fairly coarse spatial resolution, ICES WGDEC does not feel able to yet recommend actions on the basis of this model.

3.2.4 Hatton Bank

Hatton Bank is a deep-water bank lying west of the Rockall plateau that is entirely within international waters and therefore regulated by the NEAFC. NEAFC closed a large portion of the upper bank to bottom fishing in 2007 to protect VMEs (NEAFC Recommendation IX-2007). There have been extensions to the boundary in 2008, 2010 and 2013 (NEAFC Recommendations IX-2008, VII-2010 and 9-2013), based on the new information provided by the UK and Spain.

In 2012 ICES proposed a boundary revision to the closure that consisted of three adjoining areas to the existing closure. Two of the areas were adopted by NEAFC, but one (area 3 in the SW of the bank, see Figure 3.5) was not. In 2012 ICES WGDEC used multibeam maps as well as records of VMEs indicators, but did not use information on fishing activity in the area because there was no recent VMS data available. No new VME data were available for the Hatton bank area, but new recommendations are made based on new information on fishing activity. Spanish VMS data for the period 2000–2011 (Durán Muñoz *et al.*, 2012a) was provided in graphical format (Figure 3.5). There is evidence of bottom-trawl activity in area 3 and therefore ICES WGDEC considers that area 3 requires modification to reflect this.

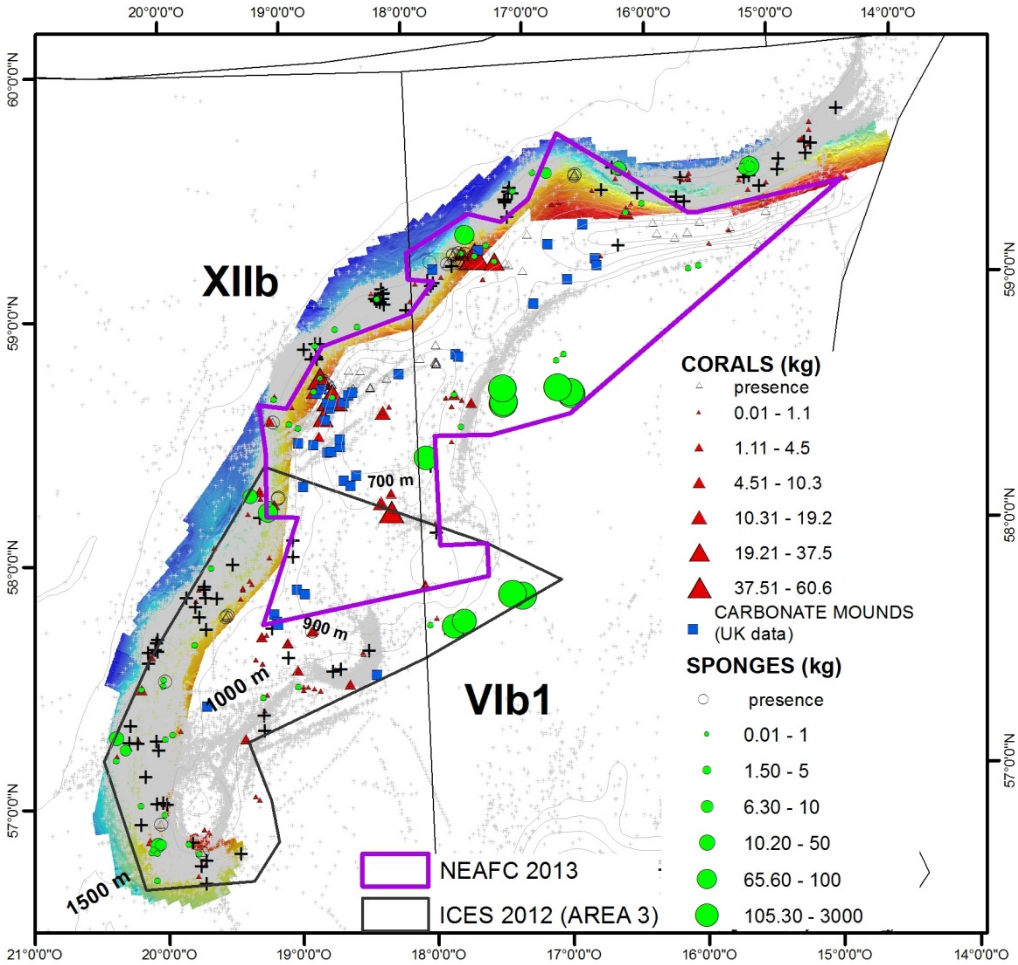


Figure 3.5. Fishery footprint for the Spanish bottom-trawl fishery (period 2000–2011) based on VMS data provided by the Spanish Government (modified from Durán Muñoz *et al.*, 2012a). Grey patches and points, VMS data (speed=2–4 knots); Black crosses, absence of VME indicator taxa records in the bycatch; Triangles, records of cold-water corals pooled; Circles, records of sponges pooled; Squares, carbonate mounds. (VME records from ICES database). The NEAFC Closed area is represented by the purple polygons. The area 3 in the ICES advice 2012 is indicated by the black polygon. Multibeam bathymetry map obtained by the Instituto Español de Oceanografía (IEO) along the western slope of the bank is also presented.

Multibeam surveys carried out by Spain revealed a sedimentary seabed that covers the much of the SW slopes of the Hatton Bank (Hatton Drift) mainly composed by muddy-sandy deposits (Sayago-Gil *et al.*, 2010). In addition analyses undertaken by NAFO in 2012 have for the first time given an indication of VME thresholds for seapens which were one of the VME indicator species prevalent in this area (Durán Muñoz *et al.*, 2011, 2012b). The NAFO analyses suggest that 7 kg of seapens is an appropriate threshold for encountering a seapen VME during commercial vessel fishing operation. As all of the VME indicator records of seapens in this area were well below 7 kg there is now a basis for considering these records not to represent VMEs. Likewise, a similar analysis on sponges suggests that only bycatches of over 400 kg should be considered indicative of a VME encounter. All of the VME indicator records of sponges in the SW slope were also well below that threshold. It is clear that although most fishing activity occurs on the western slopes, some fishing activity occurs to the east in areas that are not covered by multibeam surveys and therefore lack information on the seabed such as morphology, slope, etc.

Recommendation: WGDEC recommends that two areas, one to the southeast (Figure 3.6 and Table 3.4) and one to the southwest (Figure 3.6 and Table 3.5) of Hatton Bank be closed to bottom fishing.

In the delineation of the boundaries of the proposed closures, WGDEC was precautionary. The criteria used in construction of the boundary are as follows;

- The presence of carbonate mounds which classify as VME elements (area to southwest of Hatton Bank);
- The presence of large bycatch of sponges in the east (area to southeast of Hatton Bank);
- The presence of small bycatch of gorgonians in the area (area to southwest of Hatton Bank);
- A ‘knoll’ area to the southwest of Hatton Bank visible from the bathymetric data from the National Irish Seabed survey multibeam dataset (Dorschel *et al.*, 2010). Knolls are VME elements as defined by FAO guidelines. This feature has the topographical relief associated with the presence of VMEs and there are records of gorgonians from the summit at depths <1000 m;
- Two areas of outcropped rock (VME elements) on the western slope, visible on the Spanish multibeam data (Sayago-Gil *et al.*, 2010) which are also likely to be sites with VMEs;
- Evidence of fishing (trawling) activity in the sedimentary areas (Hatton Drift) of the western slope (see Figure 3.5).

Geographic coordinates of the two recommended closures are given in Tables 3.4 and 3.5.

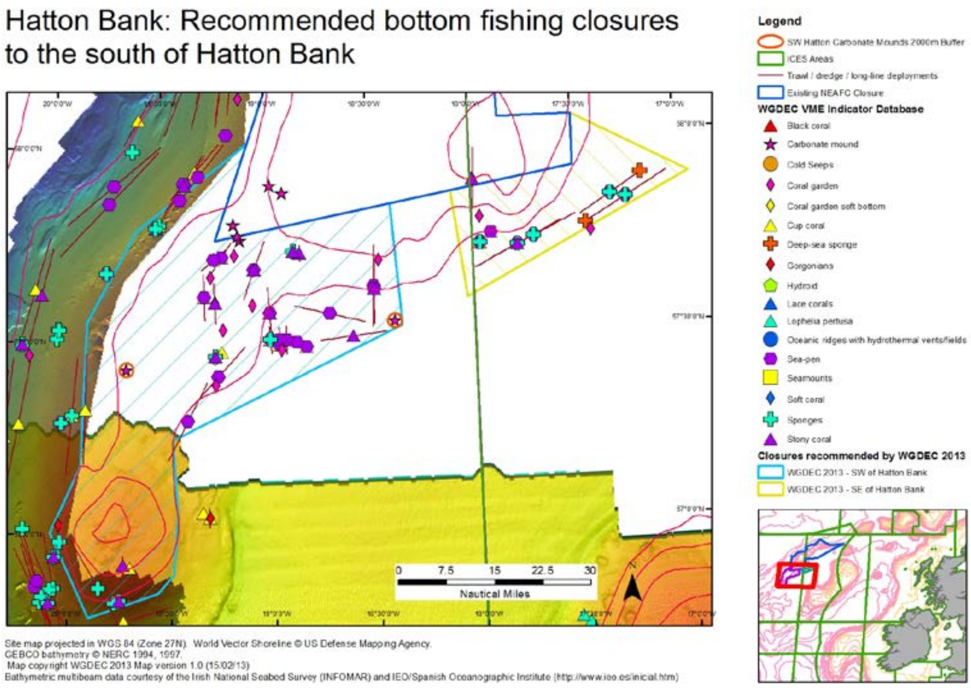


Figure 3.6. The two areas of Hatton Bank proposed to be closed to bottom fishing, one to the southeast (blue boundary) and one to the southwest (yellow boundary). Where the boundary was drawn around VME indicator species a buffer of twice the depth is included. Where the boundary is drawn around geomorphological or contour features a buffer is not included.

Table 3.4. Geographic coordinates for the recommended closure extension to the SE of Hatton Bank.

Latitude (decimal degrees)	Longitude (decimal degrees)	Latitude (DMS)	Longitude (DMS)
57.8626	-18.0978	57° 51' 45" N	18° 5' 52" W
57.9167	-17.5000	57° 54' 60" N	17° 29' 60" W
58.0500	-17.5000	58° 3' 0" N	17° 30' 0" W
57.8850	-16.9388	57° 53' 6" N	16° 56' 20" W
57.5851	-18.0335	57° 35' 6" N	18° 2' 0" W

Table 3.5. Geographic coordinates for the recommended closure extension to the SW of Hatton Bank.

Latitude (decimal degrees)	Longitude (decimal degrees)	Latitude (DMS)	Longitude (DMS)
57.9993	-19.0842	57° 59' 58" N	19° 5' 3" W
57.7500	-19.2500	57° 44' 60" N	19° 15' 0" W
57.8345	-18.3970	57° 50' 4" N	18° 23' 49" W
57.5188	-18.3547	57° 31' 8" N	18° 21' 17" W
57.2348	-19.4738	57° 14' 5" N	19° 28' 26" W
57.0368	-19.4588	57° 2' 12" N	19° 27' 32" W
56.8853	-19.4828	56° 53' 7" N	19° 28' 58" W
56.8370	-19.5604	56° 50' 13" N	19° 33' 37" W
56.7780	-19.8954	56° 46' 41" N	19° 53' 43" W
57.0007	-20.0704	57° 0' 2" N	20° 4' 13" W
57.1718	-19.9207	57° 10' 18" N	19° 55' 15" W
57.5445	-19.8773	57° 32' 40" N	19° 52' 38" W
57.7780	-19.6310	57° 46' 45" N	19° 37' 46" W

3.2.5 Josephine Seamount

Josephine Seamount lies just over 200 nm north of the Island of Madeira (Portugal) and is classed by NEAFC as 'an existing bottom fishing area' on the basis of documented bottom fishing activity in the area for at least two years within the period 1987–2007. According to OSPAR Decision 2010/5 a high seas MPA was established on the Josephine Seamount and the measure entered into force on 12 April 2011. In 2012 ICES WGDEC presented historical evidence provided from a database compiled by Yesson *et al*. (2012) showing concentrations of gorgonians (VME indicator species) on and around Josephine Seamount. The presence of gorgonian corals on the Josephine Seamount indicate that there is a high likelihood that the area has vulnerable marine ecosystems (VMEs) as defined in the FAO International Guidelines for the management of deep-sea fisheries in the high seas (FAO, 2009). Further, the summits and flanks of seamounts are listed amongst examples of geomorphological features that potentially support the species groups exemplified as VMEs (FAO guidelines, 2009).

WGDEC did not have access to recent data on fishing activity for this area, however, in view of the present status of the shallow parts of the seamount as an 'existing fishing area', WGDEC considers that there is a risk of significant adverse impacts on the likely VMEs from fishing with bottom-touching fishing gears.

Recommendation: a bottom fishing closure is established for the Josephine Seamount.

The boundary of the closure should correspond to the Josephine Seamount High Seas MPA established by OSPAR (OSPAR Decision 2010/5) (Figure 3.7 and Table 3.6). Such a closure would encompass the documented locations of recent VME indicator records as well as the adjacent flanks and slopes (VME elements) of the seamount and some surrounding deep areas of high topographic relief that are at present beyond fishing depths. The closure would protect VMEs on the Josephine seamount against adverse fisheries impacts.

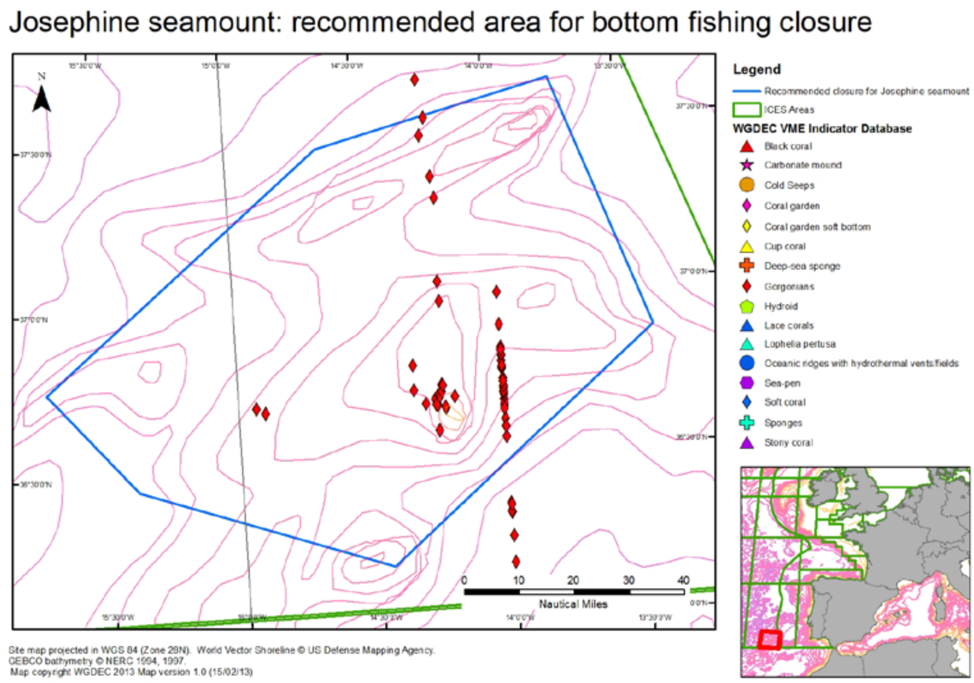


Figure 3.7. Map of Josephine Seamount showing the distribution of gorgonian corals and the proposed bottom fishing closure that corresponds precisely with the OSPAR High Seas MPA. The red square on the overview map shows the approximate location of the closure.

Table 3.6. Geographic coordinates for the proposed Josephine Seamount NEAFC bottom fishing closure.

Latitude (decimal degrees)	Longitude (decimal degrees)	Latitude (DMS)	Longitude (DMS)
37.460	-14.650	37° 27' 36" N	14° 39' 0" W
37.630	-13.750	37° 37' 48" N	13° 45' 0" W
36.860	-13.420	36° 51' 36" N	13° 25' 12" W
36.180	-14.450	36° 10' 48" N	14° 26' 60" W
36.450	-15.390	36° 27' 0" N	15° 23' 24" W
36.760	-15.720	36° 45' 36" N	15° 43' 12" W

3.3 Areas within EEZs of states or unions

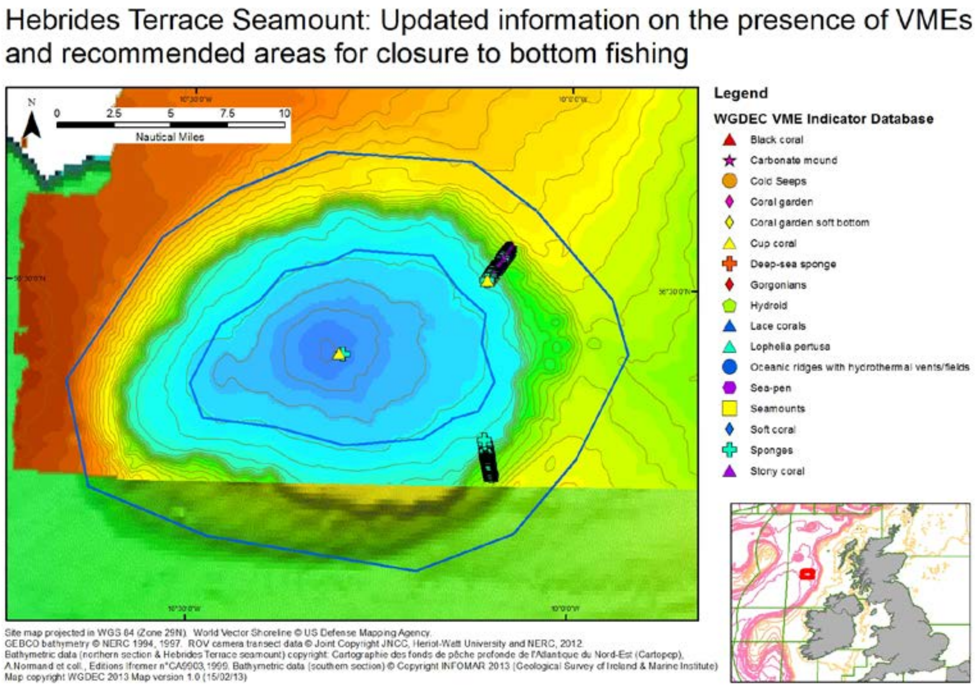
3.3.1 Hebrides Terrace Seamount

The Hebrides Terrace seamount lies to the west of the UK being partially joined to the continental slope. The summit is around 1000 m and its steep sided flanks descend to below 2000 m. In 2012 a research survey completed three ROV (Remotely Operated Vehicle) transects; two transects surveyed the steep flanks of the seamount the other was located across the summit (Roberts, 2013). On the seamount summit, only three ROV still images contained VME indicator species and none were at densities that would indicate actual VMEs. On the steep flanks, however, between the depths of

1200 m and 1700 m, a large number of VME indicator species were recorded at high densities indicating VMEs (Cross *et al*., 2013). The seamount is within fishable depths and a closure to bottom fishing would therefore be needed to protect these VMEs.

Recommendation: A closure to bottom fishing is proposed that encompasses the steep flanks of the seamount with a buffer around the records of VMEs corresponding to twice the water depth.

The resulting proposed closure is illustrated in Figure 3.8. The geographic coordinates of the closure can be seen in Tables 3.7 a (inner) and 3.7 b (outer).



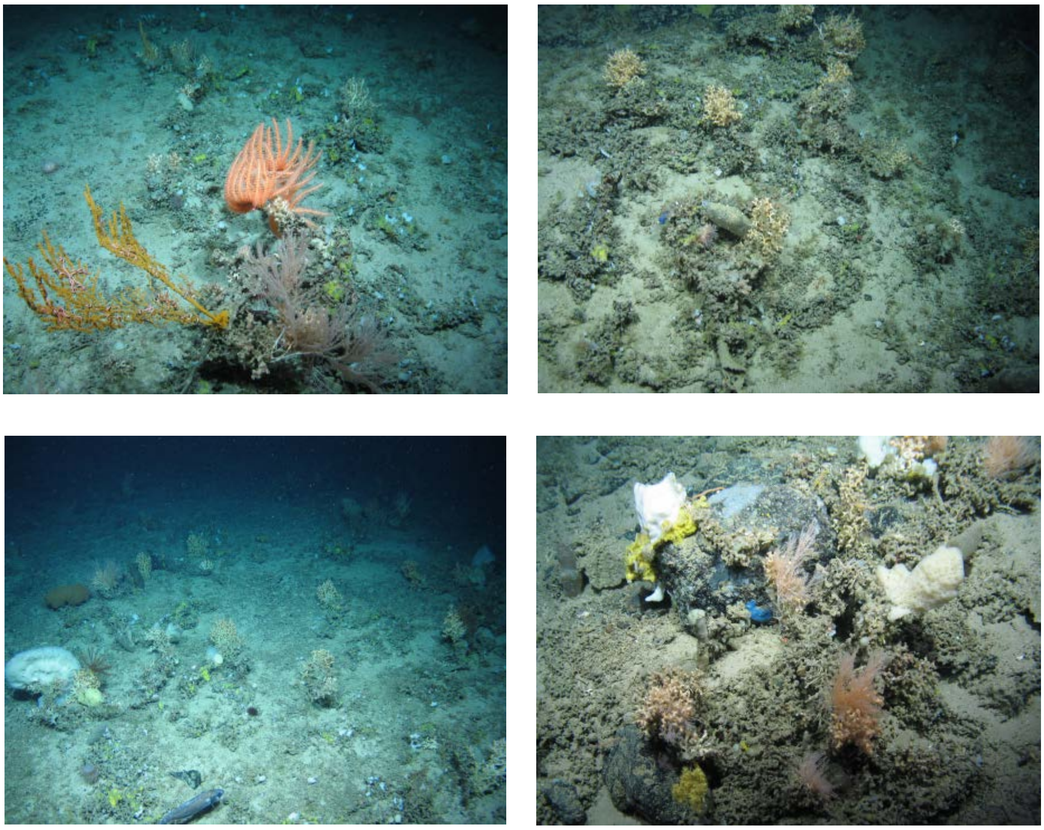


Figure 3.8. Map at top shows proposed closure (outer and inner boundaries delineated by a blue line) to bottom fishing to protect VMEs on the steep sided slopes of the Hebridean Terrace Seamount. Symbols indicate where VME indicators were observed on the ROV transects. The images below the map are examples of the habitats observed on the seamount flanks. Data/images joint copyright © JNCC, Heriot Watt University and NERC, 2012.

Table 3.7a. Geographic coordinates for the proposed Hebrides Terrace Seamount closure (inner boundary) to bottom fishing.

Latitude (decimal degrees)	Longitude (decimal degrees)	Latitude (DMS)	Longitude (DMS)
56.4044	-10.1542	56° 24' 16" N	10° 9' 15" W
56.4102	-10.1191	56° 24' 37" N	10° 7' 9" W
56.4317	-10.0983	56° 25' 54" N	10° 5' 54" W
56.4600	-10.1162	56° 27' 36" N	10° 6' 58" W
56.4813	-10.1117	56° 28' 53" N	10° 6' 42" W
56.4989	-10.1482	56° 29' 56" N	10° 8' 53" W
56.5235	-10.1821	56° 31' 25" N	10° 10' 55" W
56.5266	-10.2859	56° 31' 36" N	10° 17' 9" W
56.5165	-10.3224	56° 30' 60" N	10° 19' 21" W
56.5100	-10.3775	56° 30' 36" N	10° 22' 39" W
56.4879	-10.4103	56° 29' 17" N	10° 24' 37" W
56.4703	-10.4614	56° 28' 13" N	10° 27' 41" W
56.4270	-10.5001	56° 25' 37" N	10° 30' 0" W
56.4016	-10.4825	56° 24' 6" N	10° 28' 57" W
56.3961	-10.3862	56° 23' 46" N	10° 23' 10" W
56.3836	-10.2950	56° 23' 1" N	10° 17' 42" W
56.3892	-10.1922	56° 23' 21" N	10° 11' 32" W
56.4034	-10.1543	56° 24' 12" N	10° 9' 16" W

Table 3.7b. Geographic coordinates for the proposed Hebrides Terrace Seamount closure (outer boundary) to bottom fishing.

Latitude (decimal degrees)	Longitude (decimal degrees)	Latitude (DMS)	Longitude (DMS)
56.5575	-10.0465	56° 33' 27" N	10° 2' 47" W
56.5924	-10.1334	56° 35' 33" N	10° 8' 0" W
56.5978	-10.3235	56° 35' 52" N	10° 19' 24" W
56.5669	-10.4532	56° 34' 1" N	10° 27' 11" W
56.5329	-10.5408	56° 31' 59" N	10° 32' 27" W
56.4273	-10.6631	56° 25' 38" N	10° 39' 47" W
56.3496	-10.6308	56° 20' 58" N	10° 37' 51" W
56.3154	-10.4737	56° 18' 55" N	10° 28' 25" W
56.2926	-10.1974	56° 17' 33" N	10° 11' 51" W
56.3209	-10.0704	56° 19' 15" N	10° 4' 14" W
56.3762	-9.9895	56° 22' 34" N	9° 59' 22" W
56.4530	-9.9226	56° 27' 11" N	9° 55' 21" W
56.4929	-9.9439	56° 29' 34" N	9° 56' 38" W
56.5570	-10.0457	56° 33' 25" N	10° 2' 45" W
56.5575	-10.0465	56° 33' 27" N	10° 2' 47" W
56.5924	-10.1334	56° 35' 33" N	10° 8' 0" W
56.5978	-10.3235	56° 35' 52" N	10° 19' 24" W
56.5669	-10.4532	56° 34' 1" N	10° 27' 11" W

3.3.2 Rosemary Bank Seamount

The Rosemary Bank Seamount lies at the north end of the Rockall Trough. Its summit is around 350 m. The upper summit is comprised of massive areas bedrock (Marine Scotland survey data) but this gives way to more gentle muddy slopes at around 800 m. There are small bycatch records of corals and sponges from the upper seamount. In 2012 a trawl sample was obtained from the lower muddy slope at a depth of around 1300 m. A large bycatch of Geodia sponges was taken (>1 tonne).

Recommendation: A closure to bottom fishing is proposed based on the trawl path plus a buffer of 2600 m (twice water depth).

The resulting proposed closure is illustrated in Figure 3.9. The geographic coordinates of the closure can be seen in Table 3.8.

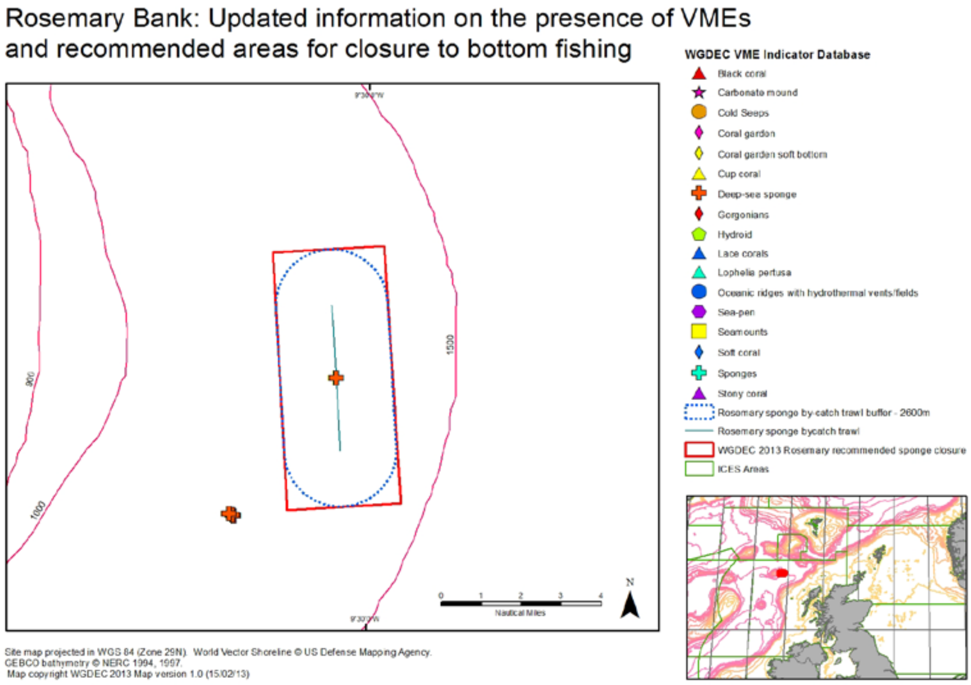


Figure 3.9. Recommended area for closure to bottom fishing to protect deep-sea sponge aggregations on the Rosemary Bank Seamount. The trawl line where a significant bycatch of Geodia sponges was taken is indicated, along with a 2600 m buffer (twice water depth of 1300 m). Observations of sponge records to SW of the trawl record were obtained in 2012 but have not yet been validated with respect to abundance, i.e. whether they represent deep-sea sponge aggregations or solitary occurrences (Axelsson *et al.*, 2012).

Table 3.8. Geographic coordinates for the proposed closure to bottom fishing.

Latitude (decimal degrees)	Longitude (decimal degrees)	Latitude (DMS)	Longitude (DMS)
59.298	-9.578	59° 17' 52" N	9° 34' 40" W
59.301	-9.487	59° 18' 2" N	9° 29' 14" W
59.194	-9.472	59° 11' 36" N	9° 28' 20" W
59.19	-9.564	59° 11' 24" N	9° 33' 51" W

3.3.3 Porcupine Sea Bight

New 'historic' records of deep-sea sponge aggregations (*Pheronema carpenteri*) were made available to WGDEC. These were collected during scientific trawl surveys reported from the Porcupine Sea Bight at depths between approximately 1000 and 1500 m (Rice *et al*., 1990).

Recommendation: As this was once and still may be an area of dense sponge aggregations that is within fishing depths, a bottom fishing closure is recommended.

The proposed closure is illustrated in Figure 3.10. The geographic coordinates of the closure can be seen in Table 3.9. The closure boundary has been drawn to encompass the aggregated records with an appropriate buffer of twice the water depth (2500 m) on all sides. WGDEC again notes that evidence from a recent predictive modelling study suggests this type of VME may also be present in an area on the southeastern flank of the Porcupine Sea Bight (Ross and Howell, 2012), however as stated previously we do not feel able to yet recommend actions on the basis of this model.

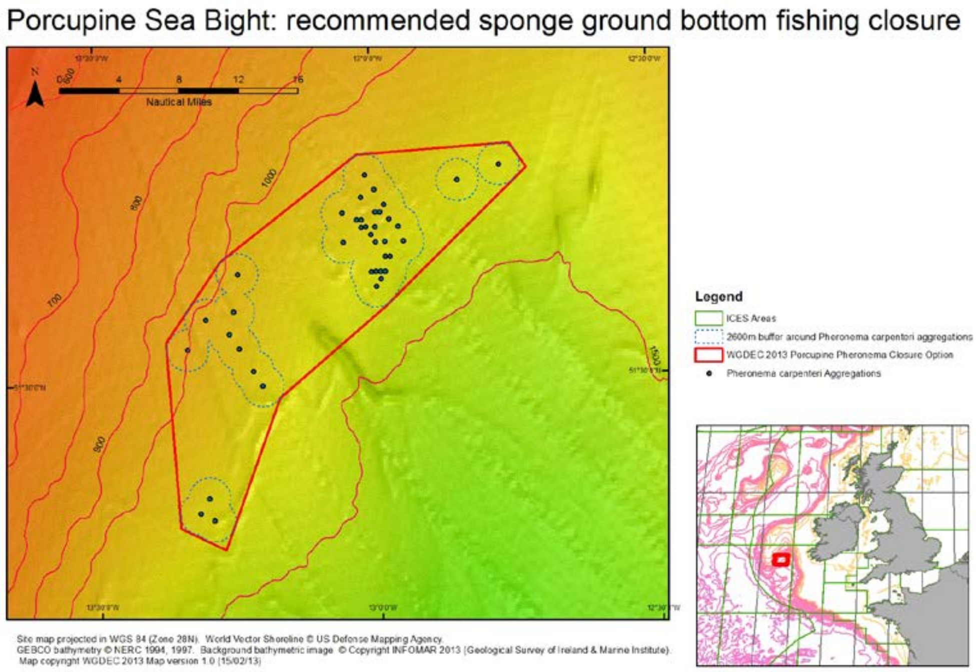


Figure 3.10. Proposed boundary of closure to bottom fisheries to protect deep-sea sponge aggregations in the Porcupine Sea Bight area.

Table 3.9. Geographic coordinates for the proposed closure to bottom fishing.

Latitude (decimal degrees)	Longitude (decimal degrees)	Latitude (DMS)	Longitude (DMS)
51.5463	-13.3768	51° 32' 47" N	13° 22' 37" W
51.6361	-13.2759	51° 38' 10" N	13° 16' 33" W
51.7522	-13.0271	51° 45' 8" N	13° 1' 38" W
51.7614	-12.7513	51° 45' 41" N	12° 45' 5" W
51.7339	-12.7221	51° 44' 2" N	12° 43' 20" W
51.5830	-12.9772	51° 34' 59" N	12° 58' 38" W
51.4819	-13.1736	51° 28' 55" N	13° 10' 25" W
51.3129	-13.2767	51° 18' 46" N	13° 16' 36" W
51.3379	-13.3559	51° 20' 16" N	13° 21' 21" W

3.3.4 Faroe-Shetland and Tampen area

There are several historic records of deep-sea sponge aggregations on the margin of the Faroe-Shetland Channel running SW–NE to an area known as Tampen (Bett, 2001; ICES 2007; Howell *et al*., 2007; Howell *et al*., 2010). These data suggest there may be a continuous narrowband of sponge aggregations on the UK continental slope north of the Wyville-Thompson Ridge, focused on the 500 m contour. A recent (2011) trawl bycatch record of a deep-sea sponge aggregation (estimated weight >1 tonne) confirms this area is still important deep-sea sponge habitat. A further research survey was conducted in this area in 2012; the seabed imagery is still in the process of being analysed and will be presented to WGDEC 2014. The resulting proposed closure is illustrated in Figure 3.11, complete with a buffer around the records of 1500 m, three times water depth. The geographic coordinates of the closure can be seen in Table 3.10.

Recommendation: A closure to bottom fishing is recommended around the recent record and nearby historical records.

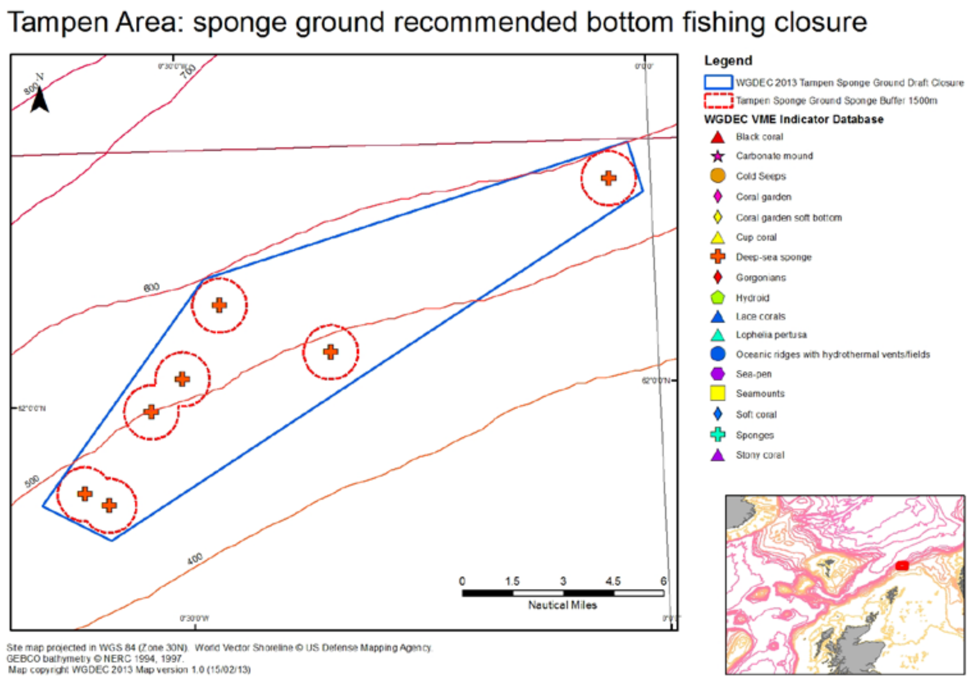


Figure 3.11. Proposed boundary for closure to bottom fisheries to protect deep-sea sponge aggregations in the Tampen area, north of Shetland.

Table 3.10. Geographic coordinates for the proposed closure to bottom fishing.

Latitude (decimal degrees)	Longitude (decimal degrees)	Latitude (DMS)	Longitude (DMS)
61.9507	-0.6565	61° 57' 3" N	0° 39' 23" W
62.0601	-0.4775	62° 3' 36" N	0° 28' 39" W
62.1195	-0.0229	62° 7' 10" N	0° 1' 22" W
62.0947	-0.0084	62° 5' 41" N	0° 0' 30" W
61.9322	-0.5845	61° 55' 56" N	0° 35' 4" W
61.9507	-0.6565	61° 57' 3" N	0° 39' 23" W

3.3.5 Faroese waters

New data were available from Russian bottom-trawl and longline fishing vessels with observers aboard in the southern part of the Faroese Fisheries Zone (Vinnichenko and Kanishchev, 2013; Vinnichenko *et al*., 2009). Fishing was conducted in three areas; Bill Bailey, Lousy and Faroe Banks and bycatch of VME indicators (gorgonians) was recorded by the trawl vessel at first two sites, but only at low levels (less than 1 kg) on both banks (Vinnichenko, 2013 Working Document). Data from the longline vessel suggested entanglement of gear and bycatch of VME indicator species (most likely *Lophelia pertusa*) in large quantities). Consequently, these areas need protection from bottom contact fishing operations. Historical data also suggests that *Lophelia pertusa* is found throughout this area (Figure 3.12). The proposed closures are illustrated in Figure 3.12. The geographic coordinates of the closures can be seen in Table 3.11a and b.

Recommendation: Two closures to bottom fisheries (Figure 3.12) are recommended around the areas where VME indicator species were encountered with a buffer zone of twice the depth.

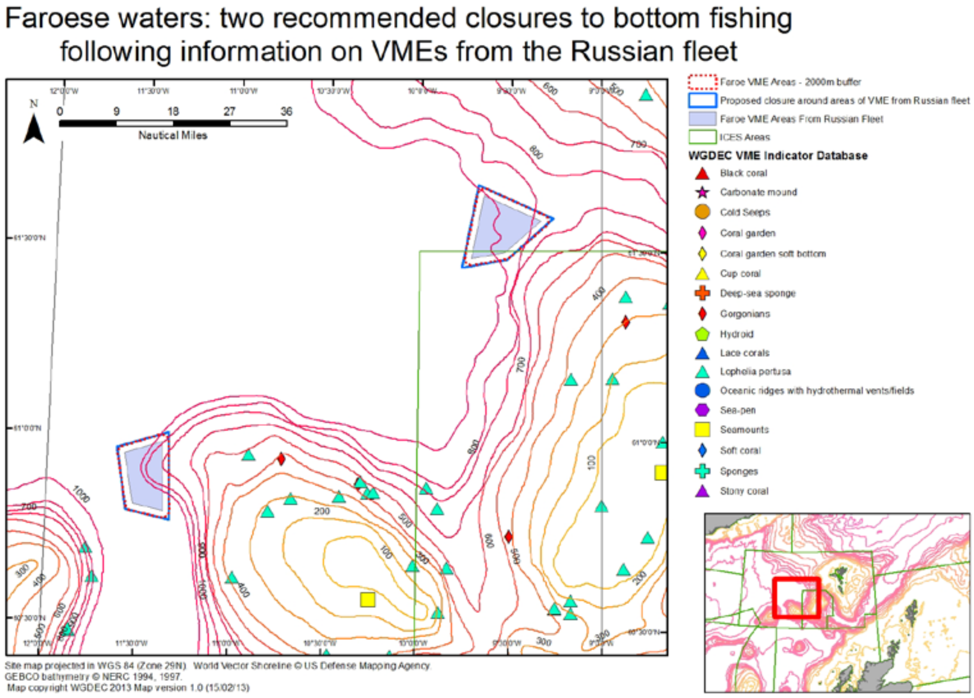


Figure 3.12. Two areas (blue polygons) recommended to be closed to bottom fishing to protect cold-water corals in Faroese waters on the basis of data from Russian observers. Also shown are historic records of VME indicator species from the ICES VME database and the OSPAR habitats database (see legend for details).

Table 3.11a. Geographic coordinates for the proposed (eastern) closure to bottom fishing.

LATITUDE (DECIMAL DEGREES)	LONGITUDE (DECIMAL DEGREES)	LATITUDE (DMS)	LONGITUDE (DMS)
-9.6798	61.6769	61° 40' 37" N	9° 40' 47" W
-9.2669	61.5892	61° 35' 21" N	9° 16' 1" W
-9.5206	61.4812	61° 28' 52" N	9° 31' 14" W
-9.7675	61.4583	61° 27' 30" N	9° 46' 3" W

Table 3.11b. Geographic coordinates for the proposed (western) closure to bottom fishing.

LATITUDE (DECIMAL DEGREES)	LONGITUDE (DECIMAL DEGREES)	LATITUDE (DMS)	LONGITUDE (DMS)
-11.6268	60.9645	60° 57' 52" N	11° 37' 36" W
-11.3475	61.0076	61° 0' 28" N	11° 20' 51" W
-11.3300	60.7769	60° 46' 37" N	11° 19' 48" W
-11.5674	60.8012	60° 48' 4" N	11° 34' 3" W

3.3.6 Whittard Canyon (Irish Margin)

In 2012, WGDEC reported data on VMEs for the upper Whittard Canyon along the Irish Margin/Bay of Biscay (Huvenne *et al.*, 2011b; Ingels *et al.*, unpublished data). That evidence indicated diverse cold-water coral reefs at water depths ranging 880–3300 m (Huvenne *et al.*, 2011b). Most corals were located on vertical cliffs and steep slopes although some occurred on relatively level ground (Huvenne *et al.*, 2011b). Other types of VMEs were also evident in the upper Whittard Canyon (Ingels *et al.*, in preparation) including seapen fields (particularly *Kophobelemnon* spp.), and *Lophelia* and *Madrepora* coral reef.

New data provided by the Marine Institute Ireland suggest the presence of VMEs in the head of the Whittard Canyon (Guinan and Leahy, 2010). Data from two short ROV transects, indicate the presence of VME indicators in new areas in the Whittard Canyon and the presence of dead coral rubble fields. New ROV video data provided by the National Oceanography Centre Southampton presents an extensive detailed analysis of all coral occurrences (>1600 records) observed along 13 ROV survey tracks (ca. 34 km of track; Morris *et al.*, under review). These data indicate the presence of significant amounts of VMEs in different branches of the Whittard Canyon. Substantial *Lophelia* reefs were observed and over 30 coral types were identified in reefs, coral garden environments and mixed soft sediment–hard bottom areas; high coral diversity was observed inside and away from the reefs. Coral communities occurred in great densities and maximum density observed was >800 coral colonies in a 100 m transect. VME indicator species observed belonged to the Schizopathidae, Carophyliidae, Gorgonacea, Alcyoniidae, Paragorgiidae, Chrysogorgiidae, Isididae, Stylasteridae, Primnoidae, and Pennatulacea.

There is substantial heterogeneity associated with canyon ecosystems and VME habitats are very likely to occur throughout the canyon branches. The potential impact of trawling in areas adjacent to steep flanks or slopes and canyon walls and the resulting gravity flows and resuspended sediments is considerable and hence buffer zones to protect the canyon VMEs from such impacts are of particular importance here (cf. ToR (b)). The areas around the Whittard Canyon head are fished (Huvenne *et al.*, 2011b) and trawling is likely in interfluvial areas between the branches of the Whittard Canyon as evidenced by high-resolution sidescan sonar imaging of trawl marks (Huvenne *et al.*, unpublished data). Fishing activity and intensity, however, need to be substantiated with VMS data.

Recommendation: WGDEC recommends that a closure to bottom fishing be put in place to protect the VMEs in this area.

The closure boundary is drawn to encompass not only the VME records (with buffer zones of twice the depth), but also to protect particular geomorphological elements such as the steep sides of the Canyon that are equally likely to harbour VMEs (Figure 3.13). The geographic coordinates of the closure can are presented in Table 3.12.

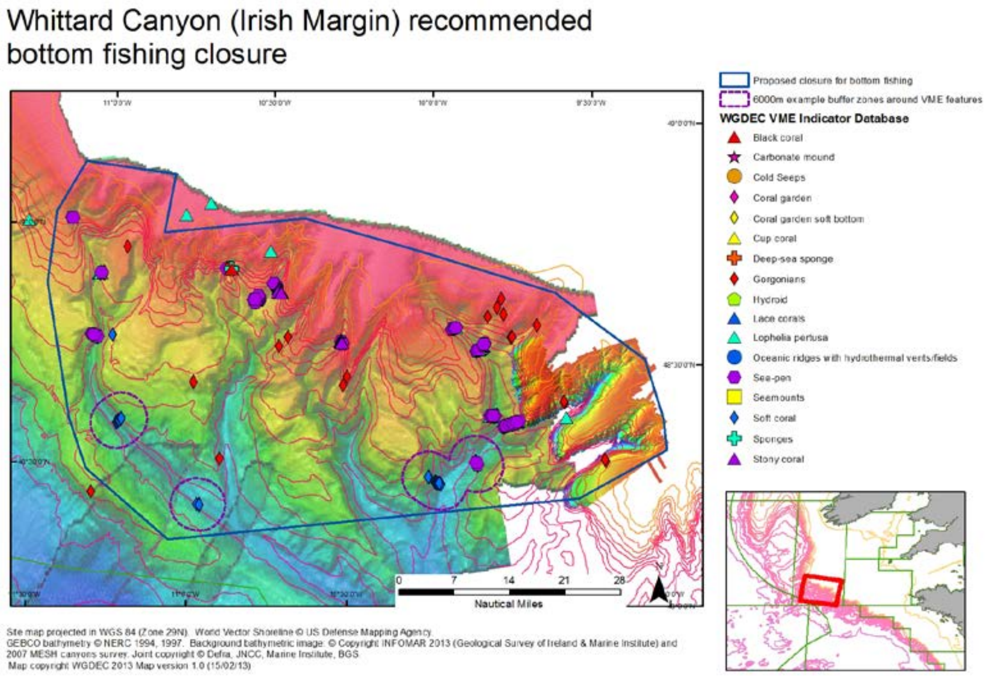


Figure 3.13. Boundary of proposed area to be closed to bottom fishing to protect VMEs in the Whittard Canyon area.

Table 3.12. Geographic coordinates for the proposed closure to bottom fishing.

Latitude (decimal degrees)	Longitude (decimal degrees)	Latitude (DMS)	Longitude (DMS)
48.8660	-11.3002	48° 51' 58" N	11° 18' 1" W
49.0119	-11.2402	49° 0' 43" N	11° 14' 25" W
49.1066	-11.1276	49° 6' 24" N	11° 7' 39" W
49.0543	-10.8496	49° 3' 15" N	10° 50' 59" W
48.9362	-10.9112	48° 56' 10" N	10° 54' 40" W
48.9256	-10.4624	48° 55' 32" N	10° 27' 45" W
48.8273	-10.1270	48° 49' 38" N	10° 7' 37" W
48.6957	-9.7119	48° 41' 45" N	9° 42' 43" W
48.5289	-9.4626	48° 31' 44" N	9° 27' 45" W
48.4018	-9.4335	48° 24' 6" N	9° 26' 1" W
48.3353	-9.4365	48° 20' 7" N	9° 26' 11" W
48.2616	-9.7331	48° 15' 42" N	9° 43' 59" W
48.2957	-11.0290	48° 17' 45" N	11° 1' 44" W
48.4678	-11.2559	48° 28' 4" N	11° 15' 21" W
48.5760	-11.2883	48° 34' 34" N	11° 17' 18" W

3.3.7 Bay of Biscay

The upper continental slope of the Bay of Biscay is targeted by bottom fisheries (Réveillaud *et al.*, 2008). In 2011 ICES WGDEC highlighted the area as being important for VMEs. Currently only one small area, situated in the southeastern part (Cap Breton canyon), is closed to bottom trawling, because of the high densities of deep-sea seapen and burrowing megafauna communities. For the remainder of the area, there is the risk of impact from bottom fisheries. In particular an area situated in the central part of the Bay of Biscay (cf. Figure 28 in ICES WGDEC Report of 2011) appears to be especially important for reef forming corals and ICES WGDEC advice in 2011 was that this area would benefit from protective measures from bottom contact fishing.

Rugged topography and high habitat heterogeneity (lie that observed at the Whittard Canyon) is typical for the entire Irish Margin/Bay of Biscay south of the Goban Spur, with over 130 deep canyons and interfluves, which makes the determination of appropriate closure zones difficult without more detailed and concise information on the distribution of VMEs in canyons along the whole margin. The development of terrain-based models could provide predictive information on the presence of VMEs in these less-accessible areas for which new data are obtained only sporadically.

The information gathered so far on the distribution of VMEs in the many canyon systems of the Irish Margin and the Bay of Biscay shows that many VMEs are present and that these are likely to be present in most areas along the geomorphologically complex Bay of Biscay.

3.3.8 Gulf of Cadiz (Spain)

Several records of cold-seep ecosystems and mud-volcanoes were obtained this year from the Gulf of Cadiz. Cold-seeps are recognized in the FAO guidelines as VMEs. These seeps are at depths of approximately 550 m and therefore potentially at risk from bottom fishing activity. A buffer of twice water depth (approximately 1000 m) has been applied; see Figure 3.14 and Table 3.13.

Recommendation: A closure to bottom fishing is proposed to protect them.

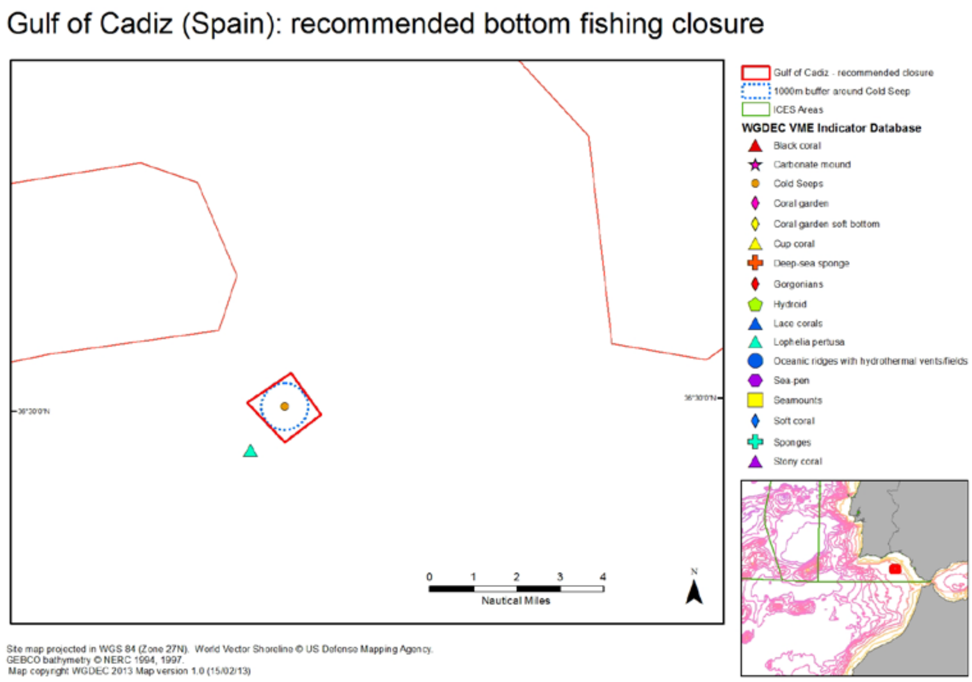


Figure 3.14. Boundary of proposed area (red polygon) around cold-seep ecosystem to be closed to bottom fishing in the Gulf of Cadiz.

Table 3.13. Geographic coordinates for the proposed closure to bottom fishing.

Latitude (decimal degrees)	Longitude (decimal degrees)	Latitude (DMS)	Longitude (DMS)
36.5018	-7.2679	36° 30' 6" N	7° 16' 4" W
36.5130	-7.2467	36° 30' 47" N	7° 14' 48" W
36.4966	-7.2327	36° 29' 48" N	7° 13' 58" W
36.4861	-7.2503	36° 29' 10" N	7° 15' 1" W

3.4 Areas within NAFO regulatory area

Data on VME indicator species were collected by Russian observers during five surveys of fishing vessels (Vinnichenko and Kanishchev 2013). The observations were conducted in the NAFO Regulatory Area (RA) on the Flemish Cap and the Grand Banks (Subareas 3LMNO) in January–July and December.

In the NAFO RA, bottom trawling was conducted in an area bounded by 42º50'–48º19' N and 44º30'–51º50' W in the depth range 200–1250 m (Figure 3.15). Cold-water corals were recorded mainly in the Sackville Spur Area between 48º06'–48º19' N, 46º31'–47º43' W in the catches from 800–1250 m depths. Corals were recorded on the eastern slope of the Grand Bank within 45º48'–47º44' N in the depth range 780–1050 m. A single catch of corals have been obtained on the "tail" of the bank (Figure 3.16). The amount per haul was small and did not exceed 1 kg overall. In the catches five species from orders Alcyonacea and Pennatulacea were found, among them *Anthoptilum* spp. and *Duva florida*. Single specimens of *Pennatula* spp., *Nephtheidae* spp. and *Anthomastus* spp. occurred.

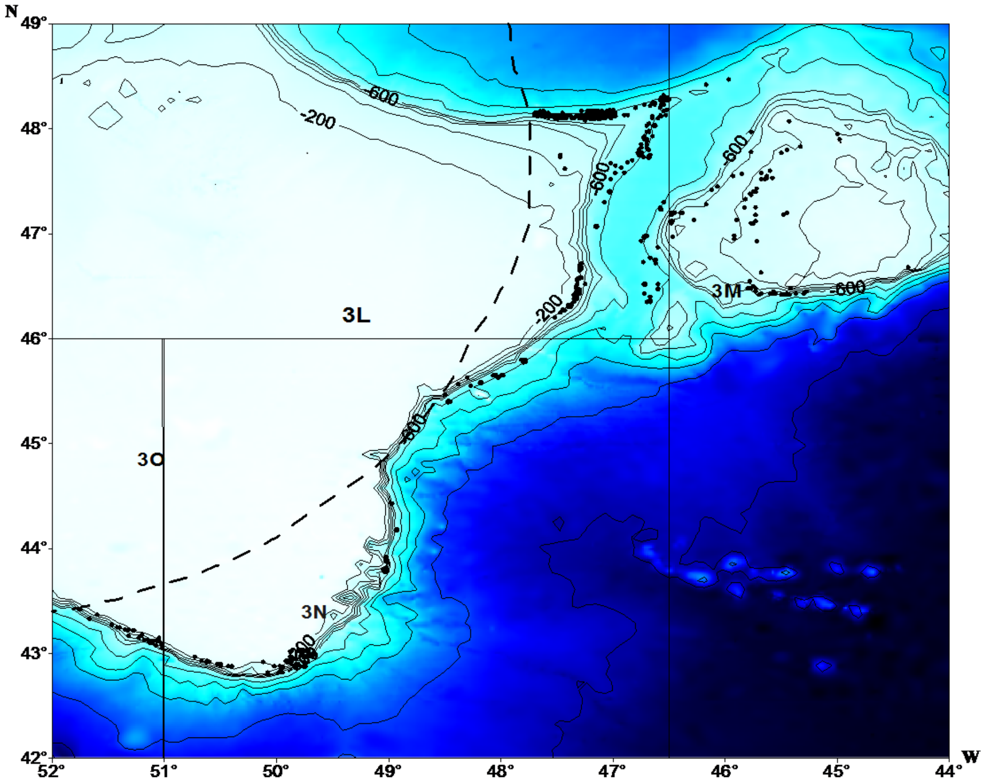


Figure 3.15. Positions of the Russian trawlers in the NAFO RA in 2012.

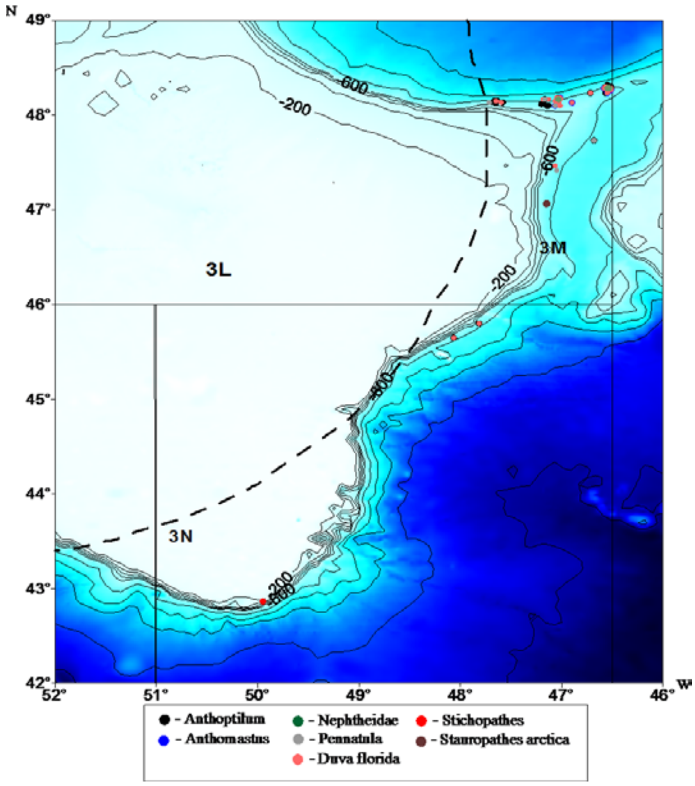


Figure 3.16. Records of cold-water coral catches recorded by observers onboard Russian trawlers.

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4 Evaluate whether buffer zones applied in the current bottom fishing closures are appropriate. Additionally, ICES is requested to include, specify and illustrate buffer zones in its future advice on closures in the NEAFC Regulatory Area as appropriate.

4.1 Introduction

ICES WGDEC considers a buffer zone to be a spatial margin of safety assurance around the VME feature that is to be protected. By safety is meant minimizing direct impacts by the unintentional passing of fishing gear into the closed area as well as indirect impacts such as the resuspension of sediments caused by trawling adjacent to the closure (Palanques *et al*., 2006; Puig *et al*., 2012).

The VME indicator database used by ICES to assess the likelihood of VME presence consists of mainly point records of species that indicate a VME is likely to be present. While recognizing this is the best available data, there are varying levels of spatial uncertainty associated with the records ranging from trawl bycatch (with low spatial accuracy) to dynamically positioned ROV observations (with high spatial accuracy). Thus the approach ICES takes in its advice for closing an area of VME to bottom fishing outlines the minimum boundary that encompasses the VME indicator records plus the maximum uncertainty associated with that record. For example, if a record of VME indicator derives from a trawl path of length 3 km, the boundary will be drawn 1.5 km either side of the midpoint of the trawl. It is important to note that this is not the buffer zone; the buffer zone is a further extension to this boundary. The spatial extension of the buffer zone may vary and is based on the following considerations.

a) the potential for fishing gear to unintentionally stray into the area where the VME is located;

b) the VME and the site-specific seabed topography and bathymetry;

c) the accuracy of the monitoring and enforcement method.

4.1.1 The potential for fishing gear to unintentionally stray into the area where the VME is located

This is mainly of function of the uncertainty of where the fishing vessel is relative to the following fishing gear. This will be a function of water depth and the trawl warp length deployed. In deep-water trawling, the typical warp length deployed decreases with water depth, from around 3:1 at 200 m to 2:1 at 500 m and more. Thus as a 'rule-of-thumb' buffer zones for closures in areas where the seabed is between 200–500 m should be three times the water depth. At depths beyond 500 m a buffer zone of twice the depth should be appropriate. In the case of highly variable depths across a site (from 200 to over 500 m depth difference) the buffer zone on the upper and lower extents may vary accordingly. When drawing the boundary for the closure, each VME indicator record is buffered and then a polygon is created that encompasses the buffer zones around all the pertinent VME indicator records. These criteria are in line with those adopted by the UK Joint Nature Conservation Committee in the consideration of buffer zones for Special Areas of Conservation (JNCC, 2012). Although defined primarily with bottom trawling in mind, such criteria for buffering a protected area is also considered a precautionary measure for vessels deploying bottom contacting static gear such as longlines or pots since the surface position at deployment may be different from the bottom contact position if there is a strong influence of currents, tides, etc.

4.1.2 The VME and the site-specific seabed topography and bathymetry

VMEs occur in a range of seabed types from steep sided canyons, seamounts and slopes of bedrock (e.g. coral gardens) to undulating course substratum (*Lophelia* reefs) to flat sedimentary plains (deep-sea sponge aggregations and seapens). For VMEs that occur on flat or undulating seabeds and for which there is a high risk that a vessel engaged in bottom fishing practices nearby may unintentionally stray the gear inside the protected area a buffer zone as outlined above (the rule-of-thumb) is absolutely essential.

On the other hand, VMEs on very steep slopes are to large extent protected from the direct impact of trawls because the trawl cannot be deployed on such grounds without severe damage and loss of gear. In such cases, where the risk of straying is mitigated by the fishermen's own incentive to avoid the steep slopes and cliff edges, a buffer zone may be reduced from the normal warp length/water depth rule of thumb. However because some fishing operations may deliberately target areas close to steep edges, in order to be assured that no significant risk is posed to the VME area a full assessment based on fine scale fishing activity (VMS data) in the area will need to be made. It must be clearly demonstrable that the fishing vessel's gear remains outside the protected area for which protection is required. In addition, evidence may be required that if trawling is to be permitted directly adjacent to a closure, there should be assurance that the activity will not cause a smothering effect on VMEs (Palanques *et al*., 2006; Puig *et al*., 2012) for example when adjacent to the upper edge of steep slopes or canyon walls. Consequently, a buffer zone may still be required on the shoal-side of a steep-sided closure if the adjacent sediment is soft and readily disturbed by trawl gear.

WGDEC does in some cases use the presence of geomorphological features or 'VME elements' such as the steep edges of seamounts to define boundaries for closures because of their tendency to be associated with VMEs. When this is the case and there is no direct evidence of VME indicators the boundary of closure is drawn to reflect the VME element and usually without a buffer zone.

4.1.3 The accuracy of the monitoring and enforcement method

Currently, most RFMOs and states receive VMS signals from their fishing vessels at two hourly intervals. At an average towing speed for bottom trawls of 3.5 knots, this suggests that the vessel can work up-to 3 nautical miles (n.m.) within a closed area and move out again without being detected by the compliance authority. Similarly the edges of a closed area can be crossed without the vessel being detected of any infringement. At present the buffer zone criteria applied by ICES WGDEC would require increasing the temporal resolution of VMS data to at least one hour to ensure the 'rule of thumb' adopted to generate buffer zones is appropriate.

4.2 Presentation of buffer zones in the work of ICES WGDEC

In the past ICES has drawn and presented closure boundaries as simple polygons that included a buffer zone. As of this year ICES WGDEC will present the minimum closure boundary with the buffer zone around the VME indicator records explicitly shown (see maps in ToR (a)).

4.3 Conclusion

ICES WGDEC is confident that the buffer zone criterion it uses to extend closures beyond the immediate estimated position of a VME indicator record is appropriate and therefore adequate for the protection of VMEs in that area. Under some circumstances, for example, where the boundaries of closures are drawn according to VME elements, i.e. geomorphological features, rather than actual VME indicator records, a buffer zone may or may not be required depending on the assessed risk that bottom contact fishing poses.

4.4 References

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5 Assess whether the list of VME indicator species is exhaustive and suggest possible addition to that list. The basis for the assessment should be the FAO Guidelines specifying taxa and habitats that may be relevant. ICES should focus on taxa (species or assemblages of species) that tend to form dense aggregations of assumed particular functional significance. NAFO Scientific Council has in 2012 conducted a similar assessment and revision and to the extent scientifically valid harmonization with NAFO lists would be beneficial. ICES is furthermore asked to map VME elements (i.e. geomorphological features) in the NEAFC RA. This would include seamounts and knolls at fishable depths (with summits shallower than 2000 m), canyons, and steep flanks. Also in this exercise, harmonization with NAFO SC evaluations would be beneficial. ICES is specifically requested to advice NEAFC on the occurrence of hydrothermal vents and measures applicable to protect hydrothermal vents and associated communities in the RA

5.1 Introduction

As this term of reference was very broad WGDEC divided it into the three following subsections:

1) Assess whether NAFO's list of VME indicator species is exhaustive, suggest possible addition to that list for NEAFC area and harmonize the species list for the two RAs.
2) Map VME elements (i.e. geomorphological features) at depths <2000 m in the NEAFC RA and harmonize with NAFO VME elements.
3) Map the location of hydrothermal vents and cold seeps within NEAFC area.

5.1.1 Assess whether NAFO's list of VME indicator species is exhaustive, suggest possible addition to that list for NEAFC area and harmonize the species list for the two RAs

A number of criteria can be used to determine which of the multitude of marine species should be considered to be indicators of vulnerable marine ecosystems. These criteria, as laid out by FAO, suggest that species indicative of VME's should be:

1) unique or rare;
2) functionally significant;
3) fragile;
4) have unusual life-history traits, such as being long-lived, slow growing, late maturing, recruit unpredictably;
5) contribute to the structural complexity of the ecosystem.

Most of the focus on VME indicator species has been on sponges and corals, the latter including both hard corals and gorgonian octocorals. WGDEC examined the concept of VME indicator species in 2009, in particular reviewing the major structure-forming habitats. Deep-sea sponge aggregations, coral reefs, coral gardens, and biogenic reefs have most commonly been considered to be those forming structural habitats. However, some additional habitat types were described including soft bottom gorgonian fields, Xenophyophora fields, Actiniaria (sea-anemone) fields and glass sponge fields.

In 2012 the NAFO Scientific Council proposed a list of taxa that could be used as indicators of VMEs in the NW Atlantic. This list was drawn up by considering each of the candidate VME indicator species in relation to the criteria outlined by the FAO guidelines. WGDEC considers that it is not necessary to list all the likely species that would be indicators of VMEs in the NEAFC area. Instead it is more pragmatic to consider the taxa by habitat type and/ or at the level of the taxonomic category of Family. Table 5.1 lists seven broad VME types for the NE Atlantic with those taxa that will most likely be found in those habitats. For comparison and harmonization the equivalent set of species from the NAFO list is also given. All the habitats listed are likely to contain significant aggregations of the representative taxa, and those taxa will most commonly meet the criteria of long-lived, functional significance or fragility.

Table 5.1. List of deep-water VMEs and their characteristic taxa. NAFO species have been aligned with the proposed VME type for NEAFC and their representative taxa. In some cases no species were listed by NAFO Scientific Council.

PROPOSED NEAFC VME HABITAT TYPE	REPRESENTATIVE NEAFC TAXA	CORRESPONDING NAFO SPECIES
1. **Cold-water coral reef**		
A. *Lophelia pertusa* reef	*Lophelia pertusa*	*Lophelia pertusa**
B. *Solenosmilia variabilis* reef	*Solenosmilia variabilis*	*Solenosmilia variabilis**
2. **Coral garden**		
A. **Hard bottom coral garden**		
i. **Hard bottom gorgonian and black coral gardens**	ANTHOTHELIDAE	ANTHOTHELIDAE *Anthothela grandiflora* *
	CHRYSOGORGIIDAE	CHRYSOGORGIIDAE *Chrysogorgia* sp. *Metallogorgia melanotrichos* *Iridogorgia* sp.
	ISIDIDAE, KERATOISIDINAE	ISIDIDAE, KERATOISIDINAE *Acanella arbuscula* *Acanella eburnea* *Keratoisis ornata* * *Keratoisis* sp. * *Lepidisis* sp.
	PLEXAURIDAE	PLEXAURIDAE *Swiftia* sp. * *Paramuricea grandis* *Paramuricea placomus* * *Paramuricea* spp. *Placogorgia* sp. *Placogorgia terceira*
	ACANTHOGORGIIDAE	ACANTHOGORGIIDAE *Acanthogorgia armata* *
	CORALLIIDAE	CORALLIIDAE *Corallium bathyrubrum* *Corallium bayeri*
	PARAGORGIIDAE	PARAGORGIIDAE *Paragorgia arborea* * *Paragorgia johnsoni*
	PRIMNOIDAE	PRIMNOIDAE *Calyptrophora* sp. *Parastenella atlantica* *Primnoa resedaeformis* * *Thouarella grasshoffi* *Narella laxa*
ii. Colonial scleractinians on rocky outcrops	*Lophelia pertusa*	
iii. Non-reefal scleractinian aggregations	*Enallopsammia rostrata* *Lophelia pertusa* *Madrepora oculata*	*Enallopsammia rostrata* *Madrepora oculata* *
B. Soft bottom coral gardens		

Proposed NEAFC VME Habitat Type		Representative NEAFC Taxa	Corresponding NAFO Species
	i. Soft bottom gorgonian and black coral gardens	CHRYSOGORGIIDAE	CHRYSOGORGIIDAE *Radicipes gracilis* *
	ii. Cup-coral fields	CARYOPHYLLIIDAE FLABELLIDAE	----- -----
	iii. Cauliflower Coral Fields	NEPHTHEIDAE	-----
3. Deep-sea Sponge aggregations			
A.	Ostur sponge aggregations	GEODIIDAE	GEODIIDAE *Geodia barretti* * *Geodia macandrewii* * *Geodia phlegraei* *
		ANCORINIDAE	ANCORINIDAE *Stelletta normani* * *Stelletta* sp. *Stryphnus ponderosus**
		PACHASTRELLIDAE	PACHASTRELLIDAE *Thenea muricata* *
B.	Hard bottom sponge gardens	-----	ACARNIDAE *Iophon piceum* *
		AXINELLIDAE	AXINELLIDAE *Axinella* sp.* *Phakellia* sp. *
		-----	ESPERIOPSIDAE *Esperiopsis villosa* *
		MYCALIDAE	MYCALIDAE *Mycale (Mycale) lingua* *
		POLYMASTIIDAE	POLYMASTIDAE *Polymastia* spp. * *Weberella bursa* * *Weberella* sp.
		TETILLIDAE	TETILLIDAE *Craniella cranium* *
C.	Glass sponge communities	ROSSELLIDAE	ROSELLIDAE *Asconema foliatum* *
		PHERONEMATIDAE	-----

Proposed NEAFC VME Habitat Type	Representative NEAFC Taxa	Corresponding NAFO Species
4. Seapen fields	ANTHOPTILIDAE	ANTHOPTILIDAE *Anthoptilum grandiflorum*
	PENNATULIDAE	PENNATULIDAE *Pennatula aculeata* * *Pennatula grandis* *Pennatula sp.*
	FUNICULINIDAE	FUNICULINIDAE *Funiculina quadrangularis* *
	HALIPTERIDAE	HALIPTERIDAE *Halipteris* cf. *christii* * *Halipteris finmarchica* * *Halipteris* sp. *
	KOPHOBELEMNIDAE	KOPHOBELEMNIDAE *Kophobelemnon stelliferum* *
	PROTOPTILIDAE	PROTOPTILIDAE *Distichoptilum gracile* *Protoptilum* sp. *
	UMBELLULIDAE	UMBELLULIDAE *Umbellula lindahli*
	VIRGULARIIDAE	VIRGULARIIDAE *Virgularia* cf. *mirabilis**
5. Tube-dwelling anemone patches	CERIANTHIDAE	*Pachycerianthus borealis* *
6. Mud and sand emergent fauna	BOURGETCRINIDAE	BOURGETCRINIDAE *Conocrinus lofotensis*
	ANTEDONTIDAE	ANTEDONTIDAE *Trichometra cubensis*
	HYOCRINIDAE	HYOCRINIDAE *Gephyrocrinus grimaldii*
	XENOPHYOPHORA	-----
7. Bryzoan patches	-----	EUCRATEIDAE *Eucratea loricata*

*** species common in the NEAFC area.**

5.1.2 Comparison of VMEs between NAFO and NEAFC regulatory areas

It is important to appreciate that in the NEAFC area there are several biogeographic provinces, whereas the NAFO RA comprises of just one. WGDEC reviewed the biogeographic differences between the two RAs in 2011 and also in 2012 with respect to whether the NAFO field identification guides for corals and sponges could be applied to the NEAFC RA.

Table 5.1 shows that a large number of taxa and some species are common to the NE and NW Atlantic. For the most part, the Families in both areas are comparable. There were, however, some species and families not on the NAFO list. In the NAFO area these species and families presumably did not fulfil the FAO VME criteria. However, the NEAFC RA can be quite different and WGDEC is of the opinion in some localities the following may represent VMEs.

- Cup corals can be locally abundant in some sedimentary areas of the NE Atlantic. Cup corals are small and fragile, most likely long-lived and may class as VMEs if they occur in sufficient concentrations. They are often observed in association with other small dense patches of invertebrates (e.g. Brancato *et al.*, 2007). Aggregations of cup corals and dead coral skeletons may serve as habitat for juvenile stages of deep-sea fish (Costello *et al.*, 2005). However, at present there is insufficient data on the abundance and distribution of cup corals to confidently assign what constitutes a 'field' as opposed to a solitary occurrence.

- Coral gardens dominated by soft corals of the Family Nephtheidae are found in the northern part of the NE Atlantic. In the NEAFC area they can be found to depths greater than 1000 m. Again there is uncertainty about these species qualifying as VMEs, but until more information is available WGDEC takes a precautious stand and does not discount them as non-VME.
- Xenophyophores are large multinucleate single-celled creatures that agglutinate sand grains and other particles into structures that provide habitat for a large number of species including isopods, tanaids, ophiuroids, nematodes, harpacticoid copepods, polychaete worms, peracarid crustaceans, and peanut worms (sipunculans) (Levin and Thomas, 1988; Hughes and Gooday, 2004). Xenophyphores are mentioned as an example of a possible VME indicator group in the FAO guidelines (2009) due to their meeting multiple VME criteria. There is little doubt these organisms are extremely fragile and as a consequence specimens are unlikely to be evident in commercial or research trawl catches. On the other hand there is little known about their longevity, how fast they grow and thus whether they are comparable to VMEs such as deep-sea sponge aggregations.

In addition there were a few species on the NAFO list that are of less relevance to the NEAFC area. These include;

- A species of sea lily (crinoid) in the family Hyocrinidae. There is insufficient data at present to assess whether it is likely to occur in significant densities in NE Atlantic.
- Bryozoan patches of the family Eucrateidae (*Eucratea loricata)*. According to the World Register of Marine Species, this is a species of the NW and NE Atlantic, primarily in shelf waters, but also can be found at bathyal depths. It can be found in dense beds such as on part of the Grand Banks, but at depths less than 100 m (Murillo *et al.*, 2011). WGDEC could not find any evidence that this species, nor dense bryozoan beds of any kind, occurring within the NEAFC Regulatory Area, since most of the latter is in deep water.

In summary, the list of species proposed by NAFO can be harmonized into a more general list of VME types for the NEAFC RA. There are a few discrepancies that arise either because there is no geographic overlap or there is some uncertainty as to whether the species class as a VME indicators, e.g. cup corals, soft-corals and Xenophyphores. Further research is needed to determine if these species and groups in the NEAFC RA do actually constitute VME as defined in the FAO guidelines.

5.2 Map VME elements (i.e. geomorphological features) at depths <2000 m in the NEAFC RA and harmonize with NAFO VME elements

5.2.1 Introduction

NAFO recognizes a range of physiographic settings, essentially the physical habitat and landscape features, where VME species have a high likelihood of occurring (NAFO SCS Doc. 12/19, 2012; page 39). The link between particular structures in the environment and particular "species groups" and VMEs can aid in identifying places for attention by management (e.g. Heifetz *et al*., 2005; Vetter *et al*., 2010).

WGDEC applied NAFO's VME element classification framework to features in the NEAFC RA. Table 5.2 lists the VME elements (and the NAFO equivalent) identified by WGDEC that have a high likelihood of supporting VMEs. Maps are provided that illustrate the distribution of VME elements that can be identified with available data. In some cases there is evidence of VME indicator species associated with these elements, but for other areas this cannot be verified at the current time. Development of a VME element classification system at this stage provides a framework to develop greater tactical capabilities related to VME management.

Table 5.2. List of VME indicator elements known to occur in the NAFO and NEAFC Regulatory Areas with a naming convention to facilitate identification and descriptions of VMEs to foster conservation objectives. Table modified from NAFO SCS Doc 12/19, 2012.

Physical VME Indicator Elements				
ICES/NEAFC Nomenclature	Examples from NEAFC RA	Explanation	NAFO Nomenclature	Examples from NAFO RA
Isolated Seamounts	Six groupings in Figure 5.2	Non-MAR seamounts.	Seamounts	Fogo Seamounts (Division 3O, 4Vs) Newfoundland Seamounts (Division 3MN) Corner Rise Seamounts (Division 6GH) New England Seamounts (Division 6EF)
Steep-slopes and peaks on mid-ocean ridges	Mid Atlantic Ridge (Figure 5.1)	Steep ridges and peaks support coral gardens and other VME species in high density	NA	
Knolls	Hatton Bank Fangorn Bank	A class of VME element normally only evident where multibeam surveys have been carried out.	Knolls	Orphan Knoll (Division 3K) Beothuk Knoll (Division 3 LMN) Southeast Shoal Tail of the Grand Bank Spawning grounds (Division 3N)
Canyon-like features	Loury Canyon, margin of Edora's Bank	A steep sided 'catchment' feature not necessarily associated with a shelf, island or bank margin.	Canyons	Shelf-indenting canyon; Tail of the Grand Bank (Division 3N) Canyons with head >400 m depth; South of Flemish Cap and Tail of the Grand Bank (Division 3MN) Canyons with heads >200 m depth; Tail of the Grand Bank (Division 3O)
Steep flanks >6.4º	SE Rockall	from NAFO SCR Doc 11/73	Steep flanks >6.4º	South and Southeast of Flemish Cap. (Division 3 LM)

Each of these elements is described below with particular attention to how these can function as keystone structures and reference locations within the NEAFC RA where applicable.

5.2.2 The Mid-Atlantic Ridge as one contiguous VME element

The Mid-Atlantic Ridge (MAR) is the largest single area of lower bathyal habitat (800–3500 m) in the North Atlantic amounting to 45.7% of the area (Priede *et al.*, 2012). The entire ridge between Iceland and the Azores may be characterized as a major geomorphological feature with many steep and seamount-like structures. WGDEC therefore considers it to be one contiguous VME element. The MAR has a complex topography comprising of the axial valley and flanks with hills and valleys of various depths and configurations. In addition, some major fracture zones occur where the ridge axis is broken and by deep east–west steep-walled canyon-like troughs. The major double fracture is the Charlie-Gibbs Fracture zone at about 52°N. The topography of large sections of the MAR has been mapped by multibeam acoustics, and all available bathymetry data were compiled in a report to the Census of Marine Life MAR-ECO project in 2002. An overview map is shown in Figure 5.1.

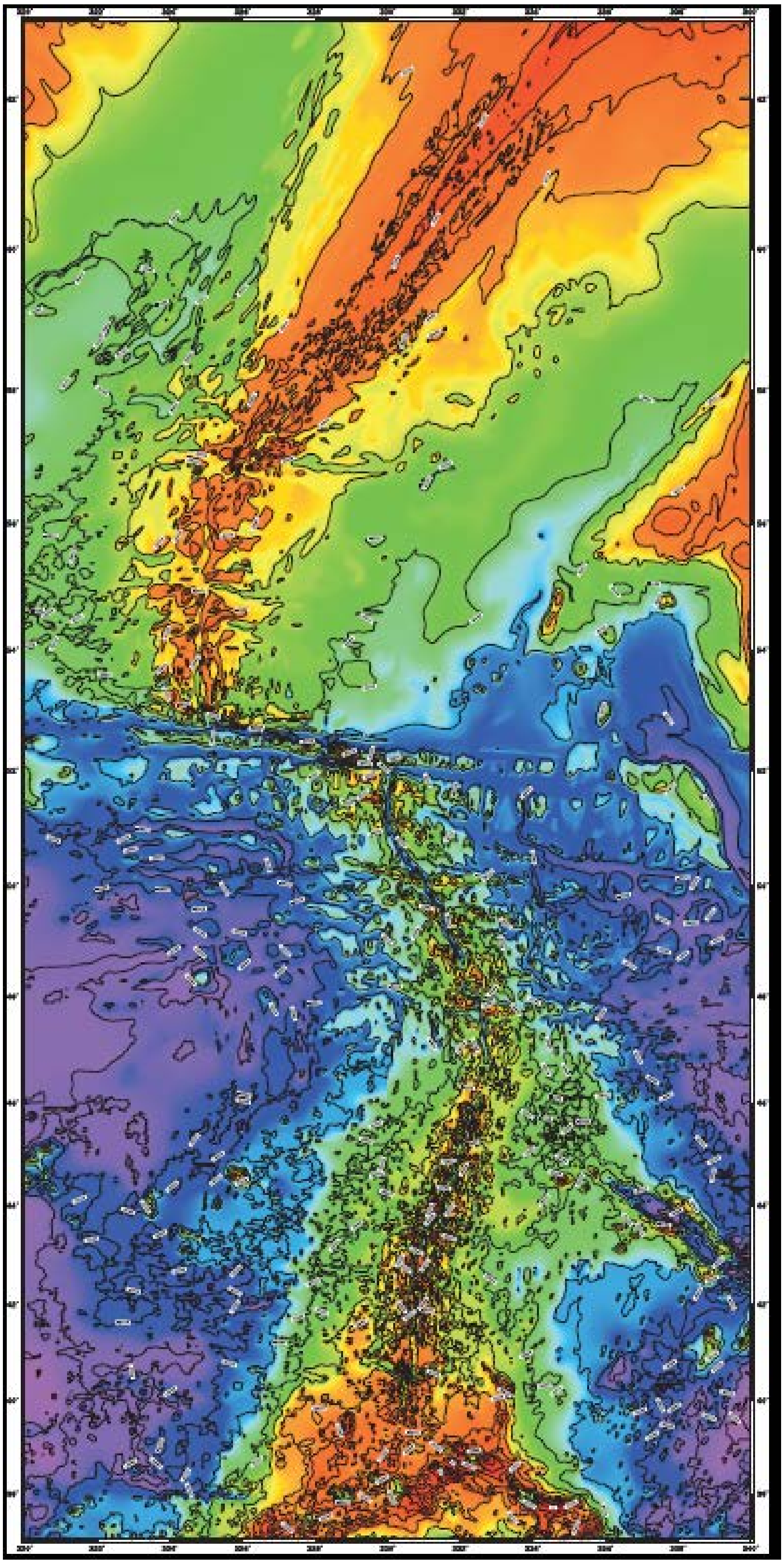

Figure 5.1. The extent of the Mid-Atlantic Ridge from the Azores in the south to Iceland in the north showing how it is an unbroken chain of pinnacles, knolls, seamounts, ridges and troughs that together make up one contiguous VME element.

The MAR north of the Charlie-Gibbs Fracture is known as the Reykjanes Ridge, and northwards this ridge becomes shallower and the topography less complex. Some structures have been named as seamounts, e.g. the Hecate Seamount in the Charlie-Gibbs Fracture, and the Faraday Seamounts further to the southwest. It should be emphasized, however, that the MAR is different from isolated seamounts in the open ocean, and should rather be considered the equivalent of a terrestrial mountain range with a double chain of more or less prominent peaks and steep-sloped ridges, some of which are shallower than 2000 m and may be inhabited by species and communities recognized as VMEs. Unlike isolated seamounts, closely spaced seamounts and mid-ocean ridges can produce rectilinear flows that influence patterns in the distribution, abundance and connectivity of organisms, including VME species.

The MAR is a slow-spreading ridge, and calculations based on observations in the recent ECOMAR and MAR-ECO project have confirmed that as much as 95% of the surface area of the MAR is covered by sediments, mainly biogenic sediment. Rocky areas and steep cliff faces are prominent and frequent, but not extensive in terms of surface area (Priede *et al*., 2013). Seven swathe-bathymetry transects covering a total of 10 093 km^2 across the MAR revealed that the flanks of the MAR are dominated by flat terraces separated by steep slopes, often with cliffs, parallel with, and facing the ridge axis (Figure 5.2). On the gentle slopes, sediment cover was interrupted by occasional rocky outcrops but on the steep slopes there were cliffs with bare rock on the vertical faces but often a talus with very unstable soft sediment slope at the base of the cliff.

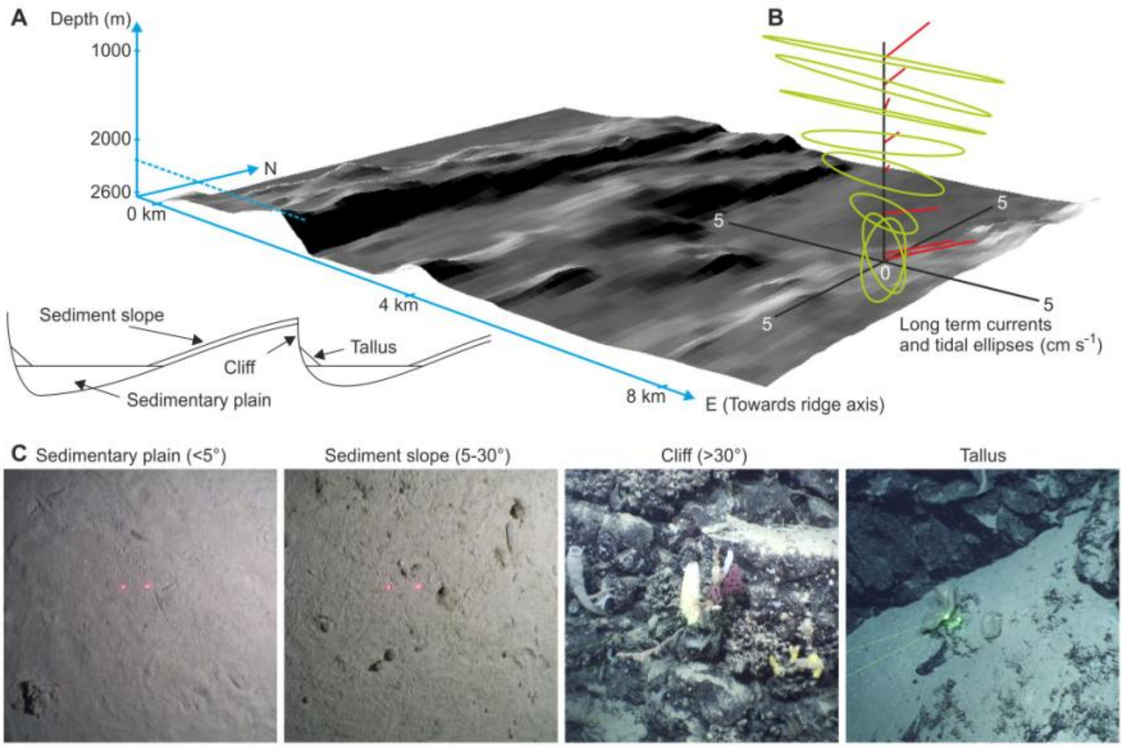

Figure 5.2. Characteristics of the topography and bottom substrata of the Mid-Atlantic Ridge. Upper figure is an output from multibeam swathe bathymetry of a section across the ridge. From Priede *et al*. (2013).

WGDEC considers the MAR to be a very significant VME element of the NEAFC RA which undoubtedly has many peaks and steep-slopes with associated VMEs at depths shallower than 2000 m, but mapping individual features ('VME elements') has not been attempted. It is likely that most features shallower than 2000 m on the MAR are potential VME elements. WGDEC recommends that the MAR be considered a single element in the current classification. Mapping activities for particular sections of the MAR may be useful in future depending upon proposed fisheries activities.

5.2.3 VME elements in the Rockall-Hatton area

The Rockall-Hatton area is also a vast topographically complex area that has numerous VME elements within it, e.g. seamounts, banks, steep flanks and knolls many of which are at depths <2000 m. Several of these have been previously identified as sites of VMEs, e.g. the upper section of Hatton Bank, Edora's Bank and several areas in the NW and SW of Rockall Bank. For these areas closures to bottom fisheries have been imposed by NEAFC. However there are additional areas that WGDEC has identified as containing VME elements. These are illustrated in Figure 5. 3 and described below;

- South Rockall Escarpment and Lorian Bank. This is an area of steep flank rising from 2000 m to the top of Lorian Bank (technically a knoll) at a depth of 800 m. No data on VME indicators are available for the area.
- Fangorn Bank. This is a knoll of very high rugosity rising from 2000 m to around 1500 m. There is a single longline bycatch record of black coral from this area.
- Edora's Bank western approach. There are two seamounts in this area known as the Eridor Seamounts both with summits above 2000 m. There is also a steep flanked ridge running toward Edora's Bank that is above 2000 m. There is also a third seamount in the area known as Rohan Seamount that lies due south of Edora's Bank, but the summit at or just below 2000 m. No data on VME indicators are available for the area.
- The South Hatton Knoll. This is a geological feature considered to be a VME element. It has already been considered by WGDEC in ToR (a) and recommended for closure to bottom fisheries. There are VME indicator records from area (Figure 3.6).
- The southwest corner of Lousy Bank. This small area is the lower slope of a seamount. No VME indicators are recorded from this part of the seamount, although the upper part of the seamount has many records of *Lophelia pertusa*.

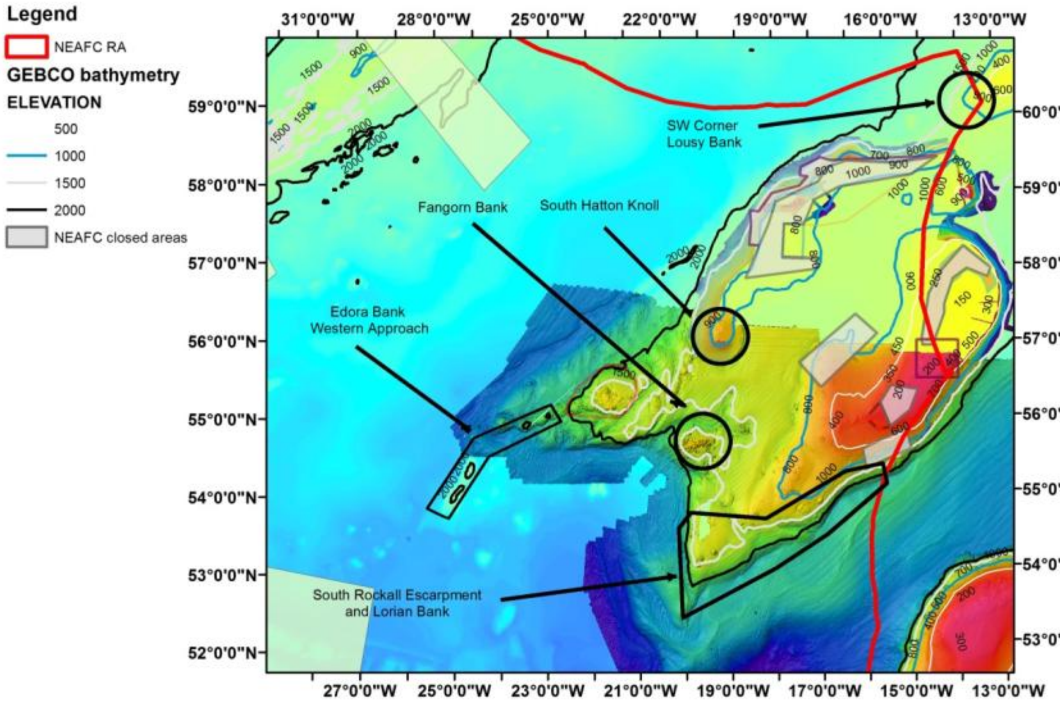

Figure 5.3. The Rockall-Hatton area showing areas (black circles and polygons) containing geomorphological features that can be considered VME elements at depths less than 2000 m (black contour) that are currently open to bottom to fisheries closures. Also shown are areas currently closed by NEAFC to bottom fishing. Background multibeam bathymetry courtesy of Irish Geological Survey, Instituto Español de Oceanografía (IEO) (Spain), DTI (UK) with depth contours based on Gebco.

5.2.4 Isolated seamounts

Seamounts by definition rise 1000 m or more from the surrounding seabed. They occur on mid-ocean ridges, in arcs and chains and as isolated features. WGDEC considers isolated seamounts apart from those on the Mid-Atlantic Ridge (covered in Section 5.1.3). Isolated seamounts are extinct volcanoes that originally formed as the spreading seabed crossed a mantle hot spot. These steep walled features are unique with regard to their effects on water flow, producing topographically induced upwellings, with significantly accelerated flows along the upper slopes and peaks. Such flows maintain large areas of exposed basalt that are dominated by suspension feeding communities (e.g. coral and sponge) and support higher trophic level predators that feed on advected prey. Interactions of upwelling flows with flow regimes over seamount summits can produce circular flows around and over the peaks that can entrain upwelled nutrient rich water, enhancing local production, and entraining larvae that can facilitate local recruitment.

Guyots are flat topped seamounts with diameters of 10 km or more. The tops of these types of seamounts are often covered with thick sediments (primarily material of oceanic origin). Those within fishable range can be targeted by traditional fishing gear. However, based on experience on the western North Atlantic seamounts, there are areas of exposed basalt that contain coral and sponge communities (Figure 5.4) and fish or large expanses of seabed with xenophyophores. The resolution of existing regional scale bathymetric data does not allow a comprehensive analysis of this class of VME element. There is only one confirmed guyot with a summit at or less than 2000 m present in the NEAFC area. It is unnamed and lies west of the Maxwell fracture zone on the MAR at approximately 48°N and 38°W. Although a particular subtype of seamount, management strategies for guyots should be considered apart from steep peaked seamounts as fishing strategies and gear related impacts will be quite different.

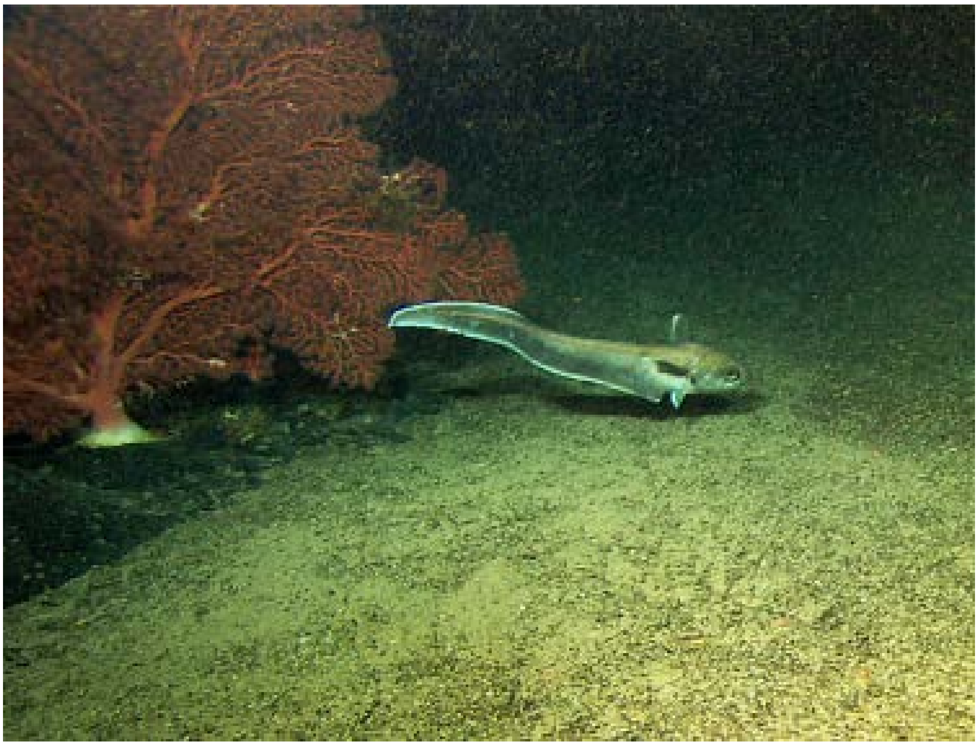

Figure 5.4. An example of coral adjacent to and embedded in sedimentary environments on flat topped seamounts (Guyots) in the North Atlantic. The image shows exposed basalt bedrock with a *Paragorgia* sp. colony and a roundnose grenadier *Coryphaenoides rupestris* (Manning Seamount, depth ca. 1330 m). (Images from Auster *et al.*, 2011).

Isolated seamounts are widely distributed throughout the NEAFC RA (Figure 5.5; data from Morato *et al.*, in press). An analysis of regional scale bathymetric data allowed identification of six clusters of isolated seamounts. These seamounts have been aggregated into six groups (Figure 5.5, Table 5.3). The west-central and east-central clusters have the largest number of seamounts. Summit depths are likely to be in the range where fishing is possible but difficult.

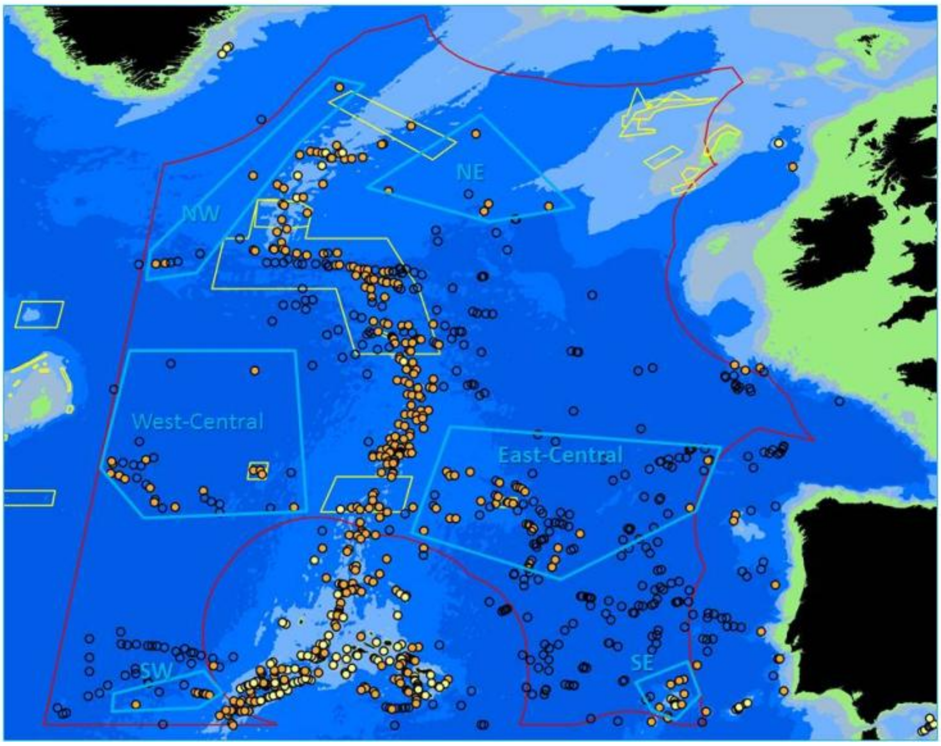

Figure 5.5. The six clusters of isolated seamounts identified within the NEAFC RA. Those with summits <2000 m indicated in orange.

Table 5.3. Seamounts with predicted summit depths less than 2000 m from the NEAFC area grouped according to Figure 5.5. Data from Morato *et al*. In press.

SW NEAFC Seamount Group				
Latitude (decimal)	Longitude (decimal)	Summit depth (m)	Height (m)	Basal_area (km²)
36.4246	-33.8668	434	2036	934
36.0525	-33.7383	802	1355	981
36.4796	-33.8358	936	1507	1111
35.989	-33.6681	968	1111	1099
36.4723	-33.7754	985	1483	867
36.3057	-34.3175	1011	1263	1119
36.4544	-33.4795	1098	1281	783
36.4507	-33.378	1106	1253	841
36.4875	-34.0619	1131	921	449
36.328	-33.9304	1229	1342	488
36.9826	-34.8651	1717	984	1145
36.6708	-38.0743	1774	1637	1088
37.0739	-35.5123	1869	1110	914
37.0222	-35.1158	1958	1063	792
37.0316	-35.1771	1968	1095	878
37.0182	-35.0318	1972	970	560
37.0541	-35.3837	1986	1022	688

West Central NEAFC Seamounts				
Latitude	Longitude	Summit depth	Height	Basal area
43.4153	-32.2388	895	2601	841
43.4194	-37.6799	943	2926	1147
43.59	-38.672	1058	3194	1413
44.7278	-34.3646	1240	2228	1263
44.7219	-34.0554	1379	1716	877
44.4216	-40.2322	1491	2736	1584
44.5803	-33.9406	1607	1612	999
44.9656	-40.9232	1729	2187	1504
44.0997	-38.9873	1798	2321	1161
45.1114	-39.4312	1855	2077	1328
43.994	-36.5227	1861	2084	1074
44.5156	-40.4651	1885	2157	1504
44.5443	-40.5186	1904	2108	1408
45.0443	-40.9905	1940	1912	1600
44.6221	-40.9294	1951	2216	1252
NW NEAFC Seamount Group				
Latitude	Longitude	Summit depth	Height	Basal area
52.4838	-41.0124	1558	1980	1130
56.0755	-37.3454	1754	961	784
52.5106	-40.5756	1823	1714	1372
59.9183	-34.1654	1962	976	698
NE NEAFC seamount group				
Latitude	Longitude	Summit depth	Height	Basal area
54.9042	-25.285	1533	1478	1137
54.5966	-25.4485	1645	1081	1264
57.8537	-26.5802	1681	1108	883
54.8042	-22.2819	1724	1623	1036
55.42	-30.3948	1842	1127	969
East Central NEAFC Seamount group				
Latitude	Longitude	Summit depth	Height	Basal area
43.5762	-22.4496	958	1952	1568
43.574	-22.3927	961	2033	1568
43.5941	-22.4984	993	1971	1600
44.5381	-25.2685	1098	1780	1600
43.4113	-26.7975	1124	1942	652
43.0192	-24.7639	1226	2214	716
44.1213	-22.1207	1231	2169	936
44.6749	-24.3592	1234	1742	1274
43.0233	-25.0386	1297	2072	979
43.3909	-14.1022	1316	3715	988
41.3219	-20.1974	1407	1947	1291
41.3236	-20.173	1407	1993	1303

43.971	-21.7314	1529	1832	1408
43.5406	-22.2267	1588	1620	1472
45.0787	-13.4134	1682	2506	1382
43.7909	-22.9436	1714	1562	1317
44.6842	-25.4386	1747	1150	1207
44.0691	-21.8688	1750	1462	1363
44.1033	-21.9925	1798	1330	965
41.4425	-21.2099	1801	1713	1297
42.4846	-19.0334	1801	2425	1520
43.6296	-23.7155	1823	1256	1335
42.5894	-26.1673	1859	1479	1029
41.9835	-19.9793	1872	2052	1327
44.5478	-25.0516	1888	941	779
43.5319	-23.0083	1915	1052	724
42.8153	-21.5212	1981	1371	1365
44.2914	-22.9451	1983	1747	1206
43.3793	-25.7231	1985	1048	997
41.5813	-20.0606	1997	1535	1309
42.6668	-21.1705	1999	1532	1360
SE NEAFC Seamount Group				
Latitude	Longitude	Summit depth	Height	Basal area
36.7903	-14.3063	120	1714	1328
36.6345	-14.2357	153	2251	1270
36.8565	-14.4412	162	1593	1600
36.7007	-14.2756	188	1915	1552
36.669	-14.2468	192	2081	1221
37.0303	-13.8794	846	1830	1520
36.2319	-14.5563	925	2287	1199
36.304	-14.5609	1000	2026	1268
36.6783	-13.9654	1197	2192	538
36.5771	-14.9466	1213	1263	1424
37.5095	-13.9323	1335	2393	1269
37.3402	-14.5041	1356	1567	1477
37.4694	-14.137	1456	1721	1107

5.2.5 Knolls

Knolls are topographic features of that rise less than 1000 m from the surrounding seabed. Such features are not necessarily volcanic in origin and can be formed by processes related to seabed spreading. These topographic highs may produce accelerated flows as for seamounts such that the upper slopes and peaks are non-depositional environments supporting similar suspension feeding communities. The resolution of standard regional scale bathymetric data does not allow a comprehensive analysis of this class of VME element. However, where there is multibeam data examples of such 'knoll' features in the Rockall Hatton area have been identified

(Figure 5.3). Future requests for information from NEAFC for specific regions in the RA can facilitate such analyses and potentially future research.

5.2.6 Canyon-like features

Submarine canyons are landscape features that form catchments and have steep bathymetric gradients. Compared to adjacent slope environments they are areas of high habitat heterogeneity and have enhanced diversity of benthic organisms. Complex flow regimes and transport of materials within catchments contribute to this diversity. Like other steep-sided habitats, suspension feeding organisms dominate hard substratum. Harris and Whiteway (2011) investigated the occurrence of submarine canyon systems along continental shelves and slopes based on the ETOPO1 dataset. Most canyons are found along the European continental margins and there appear to be very few in the NEAFC RA that are not part of the Mid-Atlantic Ridge. One such canyon-like feature is the Loury Canyon (from De Leo *et al*., 2010) that forms the northern border of Edora's Bank. This canyon lies partially in a closure already established for the Edora's Bank area. More detailed multibeam bathymetry will be needed to identify the relevant geo-morphological VME elements with typical canyon characteristics.

5.2.7 Steep flanks and slopes

Edges of features and steep slopes are physiographic elements that potentially support VME species such as corals and sponges based on geologic and oceanographic processes similar to previously described elements (e.g. accelerated flows, non-depositional environments, advected food resources). Using bathymetric data, NAFO has classified areas of 6.4° or greater slopes as VME elements in contrast to adjacent areas of lower slope (Murillo *et al*., 2011). However existing regional scale bathymetric data are not resolved to a fine enough scale to make a comprehensive analysis of this class of VME element. Where there is multibeam bathymetry for example on the SE Corner of Rockall bank, a steep edge is readily identifiable (Figure 5.3).

5.3 Map the location of vents and seeps sites in the NEAFC RA

There are only five known or inferred vent sites and no as yet confirmed cold seeps within the NEAFC RA (Figure 5.6). The vents sites, other than the one possible site on the Reykjanes Ridge, are otherwise below 2000 m depth so are not likely to be impacted by fishing activities. As mentioned in Section 3.2.3 there is evidence of an active cold seep in the Rockall-Hatton Basin. Further details on vent sites within the Northeast Atlantic are given in Section 7.

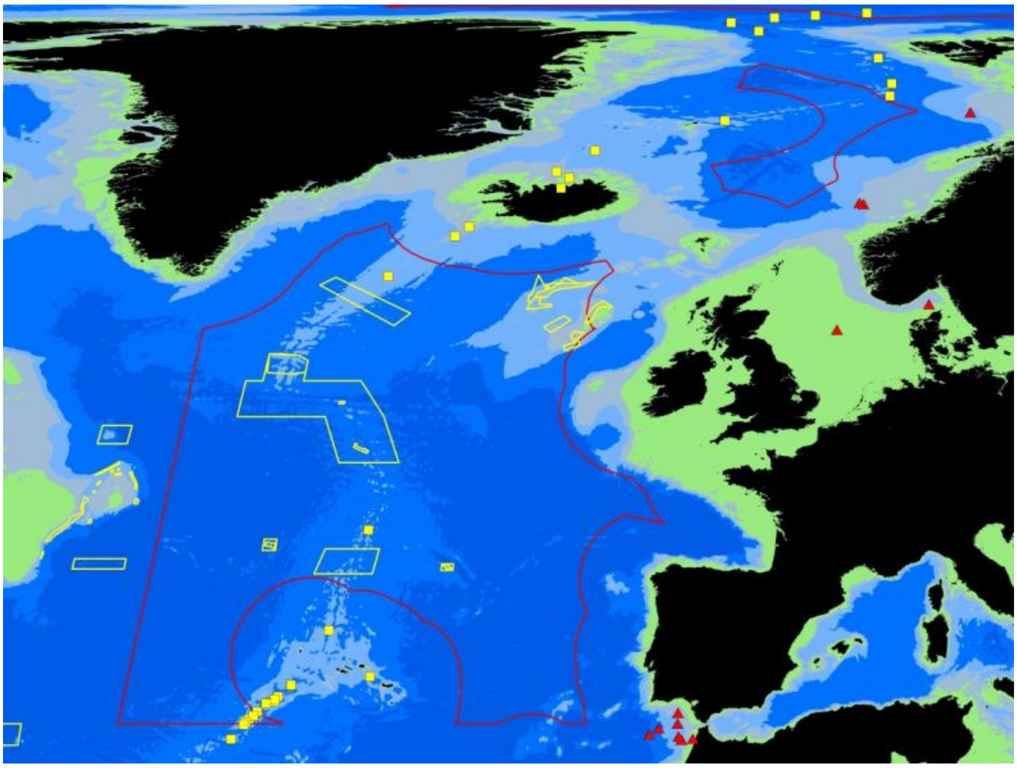

Figure 5.6. Confirmed or inferred hydrothermal vents (yellow squares) and cold seeps (red triangles) in the North Atlantic. NEAFC RA area shown as red boundary.

5.4 Concluding remarks

WGDEC identified three areas where VME elements are concentrated in the NEAFC area and where currently unprotected could be at risk from significant adverse impact by bottom fisheries. These include;

- The Mid-Atlantic Ridge (MAR);
- Certain areas on the Rockall-Hatton Plateau area;
- Six clusters of isolated seamounts on either side of the MAR.

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6 The appropriateness of applying the threshold levels for VME indicator species for longline fishing as adopted in the SEAFO, and CCAMLR, in the NEAFC RA.

6.1 Introduction

Although longlines are generally accepted to be less damaging to VMEs than bottom trawls, they can nevertheless have significant cumulative adverse impacts (Durán Muñoz *et al*., 2011; Sampaio *et al*., 2012). This is because longlines are often deployed in areas that are particularly likely to contain VMEs, e.g. seamounts, knolls and steep sided slopes. Moreover, video surveys carried out in CCAMLR region, show that the area of seabed affected by demersal longlines (when the gear is being hauled up) can be comparable with that of demersal trawls and interaction with benthic organisms is can be high (Welsford and Kilpatrick, 2008).

SEAFO and CCAMLR have introduced similar measures to protect VMEs from significant adverse impacts of longline fisheries. In CCAMLR the relevant regulation is CCAMLR Conservation Measure 22-07 entitled 'Interim measure for bottom fishing activities subject to Conservation Measure 22-06 encountering potential vulnerable marine ecosystems in the Convention Area' (CCAMLR, 2010). The equivalent measure in SEAFO is 'Conservation measure 22/11 on Bottom Fishing Activities in the SEAFO Convention Area' (SEAFO, 2011).

Currently NEAFC operates a simple VME encounter measure for all fishing gear types including longlines that states that if over 30 kg of live corals or 400 kg of live sponges is taken as bycatch per set a VME is considered to have been encountered and must be reported. The CCAMLR and SEAFO regulations are considerably more complicated than this, but potentially offer greater protection for VMEs. WGDEC has therefore reviewed the regulations and considered if they would be appropriate for NEAFC to adopt. In addition WGDEC consulted with experts on longline fishing and technology external to the group.

6.2 Considerations for NEAFC

It was concluded that the VME encounter definitions and threshold levels adopted for longline fisheries by SEAFO and CCAMLR would be appropriate to longline fisheries in the NEAFC RA. The system for quantifying VME indicator encounters as a certain number of 'VME indicator units' recovered from a defined segment of a longline set is more appropriate than the current practice in NEAFC where encounters are defined as a fixed quantity per longline set. In particular WGDEC notes that the CCAMLR and SEAFO regulations have the requirement to issue 'alerts' when vessels send notifications of accumulated subthreshold bycatch of VME indicators. This does not cause interruption of the fishery, but creates an incentive to move to areas with less likelihood of encountering VME indicators. WGDEC consider this to be a very proactive measure for protecting VMEs that would be of benefit the conservation objectives of NEAFC.

If adopted, the CCAMLR and SEAFO measures require vessels to mark segments of each longline set and quantify, log and report bycatches of VME indicator species by individual segments. If catches above thresholds are recovered, then detailed reporting is required. Collectively these requirements are rather demanding. The system may function satisfactorily in the CCAMLR RA where the longlining is conducted by industrialized large vessels with 100% on-board scientific observer coverage. Observers assist the vessels in meeting the quantification of VME indicators and reporting duties. In NEAFC, however, observers are only required in 'new fishing areas', not in 'existing fishing areas'. Without greater observer coverage for the NEAFC area the feasibility of the implementing the regulations is therefore a concern as is the likelihood of underreporting.

It is important to appreciate that the longline fisheries in the NEAFC RA vary considerably according to target species, characteristics of the fishing areas and traditions. Longline fisheries in the NEAFC RA range from technically advanced and highly mechanized fisheries on large vessels to small-scale traditional artisanal fisheries. Consequently NEAFC may need to consider differentiating the measures by fishery or vessel category focusing on the larger, more industrialized component of this fishery.

6.3 Specific measures that would comprise an equivalent longline regulation in the NEAFC RA

Definitions

1) 'VME indicator unit' means either one litre of those VME indicator organisms that can be placed in a 10-litre container, or one kilogramme of those VME indicator organisms that do not fit into a 10-litre container. VME indicator taxa are those referred to in the NEAFC bottom fishing regulations.

2) 'Line segment' means a 1000-hook section of line or a 1200 m section of line, whichever is the shorter.

3) 'Risk Area' means an area where ten or more VME indicator units are recovered within a single line segment. A Risk Area has a radius of 1 n mile from the midpoint of the line segment from which the VME indicator units are recovered.

Vessel requirements

1) CPs shall require their vessels to clearly mark fishing lines into line segments and collect segment-specific data on the number of VME indicator units.

2) If ten or more VME indicator units are recovered in one line segment, CPs shall require their vessels to complete hauling any lines intersecting with the Risk Area without delay and not to set any further lines intersecting with the Risk Area. The vessel shall immediately communicate to the Secretariat and to its Flag State the location of the midpoint of the line segment from which those VME indicator units were recovered along with the number of VME indicator units recovered.

3) If five or more VME indicator units are recovered within one line segment, CPs shall require their vessels, to immediately communicate to the Secretariat and to their Flag State the location of the midpoint of the line segment from which those VME indicator units were recovered along with the number of VME indicator units recovered.

Management action

1) On receipt of a notification under paragraph 2 above, the Secretariat shall:

1.1) record the location of the Risk Area;

1.2) within one working day of receipt, notify all fishing vessels in the relevant fishery and their Flag States that the Risk Area is closed; and that all vessels shall immediately cease setting any further lines intersecting with the Risk Area.

2) On receipt of five notifications under paragraph 3 within a 10′x10′ rectangle, the Secretariat shall, within one working day of receiving the fifth notification, send an Alert Notice to all fishing vessels in the relevant fishery and their Flag States of the coordinates of the fine-scale rectangle, indicating that VMEs may occur within that area. Vessels may continue to fish in the area.

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7 Incorporate data on known hydrothermal vents and seeps in the ICES area into the ICES WGDEC VME database and maps and review the associated fauna and potential threats from anthropogenic pressures

7.1 Introduction

Seeps, vents, and other reduced ecosystems contain a variety of organisms with unique functions related to chemoautotrophy, respiration, detoxification, mineral precipitation and dissolution, attachment, and sensing (chemotaxis). Among the most remarkable observations regarding different size groups and taxa, from bacteria to fish, are the high heterogeneities from small to large scales. (Vanreusel *et al*., 2009). Chemosynthetic habitats are isolated and highly fractured ecosystems in which the organisms require distinct environmental features and cues to maintain their populations (temperature, presence of sulphide and CH4, hard ground, particle flux). (Vanreusel *et al*., 2009). Data on the presence of hydrothermal vents and seeps from a range of validated sources were compiled and integrated in the ICES VME database.

7.2 Hydrothermal vents

Hydrothermal vents occur on mid-oceanic ridges, back-arc basins, volcanic arcs and active seamounts. These environments are highly dynamic, heterogeneous and ultimately ephemeral. Vent organisms can experience variations in the temperature and chemistry of their environment on the time-scale of seconds as a result of turbulent mixing of hydrothermal fluids and ambient seawater, typically overlaid on longer-period tidal variations (Johnson *et al*., 1988; Scheirer *et al*., 2006). On a fast spreading ridge like the East Pacific Rise (EPR) the lifetime of a hydrothermal vent field might be 12 years, while on a slow spreading ridge (the case of the oceanic ridges in the NEAFC area) the lifetime is expected to be much longer. The hydrothermal vents in the North Atlantic lie along the Mid-Atlantic Ridge (MAR). While some have been visually surveyed and studied, several remain unconfirmed and are inferred based of chemical plume detection in the overlying water column. The actual number of hydrothermal vents and locations remains unknown.

7.2.1 Hydrothermal vents in the southern MAR

Until 2005, all known vent fields in the NEAFC area were located south of the Azores. In this area four hydrothermal vent fields were discovered along a gradient of increasing water depth: Menez Gwen (37°51′N, 840–865 m), Lucky Strike (37°17′N, 1620–1730 m), Mount Saldanha (36°33′N, 2300 m) and Rainbow (36°13′N, 2260–2350 m). At Lucky Strike and Menez Gwen communities are dominated by the vent mussel (*Bathymodiolus azoricus*) with high percentage cover, and at the Rainbow vent field the communities are dominated by swarms of the shrimp *Rimicaris exoculata*. The Mount Saldanha vent, discovered in 1998, showed unusual geological and biological settings, which most striking feature is the absence of benthic vent macrofauna in the active site (Desbruyères *et al.*, 2000). In August 2006 a vent field was discovered on the southern flank of the Lucky Strike volcano which has been named Ewan.

In 2011 a new hydrothermal vent field was discovered, Moytirra vent field at 45ºN. Overall, the faunal assemblage at the Moytirra vent field shows some high-level taxonomic similarities to assemblages at other known Mid-Atlantic Ridge vent fields, but also some differences in assemblage structure. ROV dives at the Moytirra vent (Wheeler *et al*., 2011) identified three distinct morphotypes of alvinocaridid shrimp, which were observed on vent chimneys and on the valley wall above the vent edifices. Other crustaceans identified included haustorid amphipods, and brachyuran crabs that are present on vent chimneys, the adjacent rift valley wall, and sulphide rubble at the base of vent edifices. Chordates observed at the vent field include zoarcid, macrourid, and ophidiid fish. Specimens of scale worms terebellomorph, and spionid polychaetes, and peltospirid limpets, skeneid, and turrid gastropods were also collected. Compared with fast spreading ridges hydrothermal vents, the NEAFC ones have not change since they were discovered. There are micro-variations in terms of percentage (Cuvelier *et al.*, 2011) which contrasts with the dynamics established for many east Pacific hydrothermal vent communities. The frequencies of tectonic and volcanic events that can disrupt the pathways for vent fluids are lower on the slow-spreading Mid-Atlantic Ridge, resulting in greater temporal stability in the location and activity of vent sites (Copley *et al*., 2007). This way, major changes in population size or habitat extent are not expected, unless a major geological phenomenon happens or vent fluid activity changes.

7.2.2 Hydrothermal vents in the northern MAR

In 2005, two vent fields were discovered around 71°N latitude on a part of the Arctic Ridge system called the Mohns Ridge at 500–700 m depth (Schander *et al*., 2009). The first field is located right in the middle of the Mohns Ridge fault zone. It contains several tens of chimneys that vent fluids with temperatures as high as 250°C. Amphipods, anemones and bacterial mats dominated the organisms associated to the vents. A type of hydroid was also observed both on the vent structures as well as on the surrounding areas. A second extensive vent field was located on top of a volcanic ridge about 5 km south of the first field. It was roughly 100–200 m in size and much denser than the first field. The chimneys were so dense in some areas that it was difficult to get the ROV into the field.

In 2008, vents were found along the northerly Arctic portion of Mid-Atlantic Ridge at 73°N (Schander *et al*., 2010), about 300 km from the nearest land, Bear Island. The first black smoker found is associated to a chimney that is around 11 m in height. The field has been named Loki's Castle because the many hundreds of turrets and small chimneys of the field appear like a fantasy castle. Preliminary observations suggest that the ecosystem around these northerly vents is diverse and appears to be different from the vent communities observed elsewhere. The hydrothermal field is located on top of a linear deep-sea volcano, one of the many thousand that are found along the Mid-Atlantic Ridge. The water emerging from the smokers measured over 300°C. There is a hydrothermal vent field inferred by plume detection that lies south of Iceland and is shallower than 2000 meters (Figure 5.6).

7.2.3 Gaps in knowledge

Due to the difficulties and costs of exploring and studying hydrothermal vents at the Mid-Atlantic Ridge, there are gaps in knowledge that the scientific community are trying to fill including biomass studies, trends in biomass changes, relation of percentage cover, population size, habitat extent with physiological stages and life cycle of the species. A permanent observatory has been initiated at the Lucky Strike vent site in the framework of the EU. Project Esonet (Colaço *et al*., 2010). Integrated monitoring of environmental and biological settings of the vents began in 2010. Studies on the dispersal of the key species, biogeography phenomena, and variability at different time-scales are lacking.

7.3 Cold seeps

Cold seeps are characterized by the patchy occurrence of sulphide and/or methane-dependent biota, including microbial mats and symbiont-bearing invertebrates (Bivalvia, Polychaeta) that can form small clusters or spread over large fields in high densities. This high spatial variability at scales of tens to hundreds of meters has been attributed to the magnitude of fluid flow and the correlated chemical depth profiles (Henry *et al*., 1992; Barry *et al*., 1997; Olu *et al*., 1997; Sahling *et al*., 2002; Levin *et al*., 2003; de Beer *et al*., 2006). In the Northeast Atlantic, cold seeps were discovered along the Nordic margin and in the Gulf of Cadiz. Every seep in the region along the European margin is different in terms of community composition and biodiversity. (VanReusel *et al*., 2009).

7.3.1 Nordic margin

Along the Nordic margin, the highly active Håkon Mosby mud volcano (72°N) at 1280 m water depth on the Barents Sea slope south of Svalbard, was the target of several multidisciplinary cruises. The Storegga slide at 64°N and associated Nyegga pockmarks were also visited. Håkon Mosby mud volcano was first observed in 1989 during a sidescan sonar survey (Vogt *et al*., 1997). The concentric structure of the mud volcano can be divided into several subhabitats characterized by different biogeochemical sediment conditions (de Beer *et al*., 2006; Niemann *et al*., 2006b). The Storegga area is known for its giant Holocene slide, one of the largest ever mapped on continental margins (Paull *et al*., 2008). On the northeastern flank of the Storegga slide, complex pockmarks are located in the so-called Nyegga area at 740 m water depth. These pockmarks are circular and feature up to 190 m-long ridges of carbonate rock (Hovland *et al*., 2005).

At the Håkon Mosby mud volcano, the symbiont-bearing megafauna are dominated by siboglinids (tubeworms) that lack both mouth and gut and live in symbiosis with sulphur-oxidizing bacteria stored inside their bodies (Lösekann *et al*., 2008). Wide areas in the periphery of this mud volcano are covered with the curled brownish tubes of the species *Sclerolinum contortum*, buried up to 70 cm deep in soft sediment. In some areas, clusters of the straight black tubes of *Oligobrachia haakonmosbiensis webbi* (Smirnov, 2000) stand erect about 5 cm above the seabed. Both species are also found further south on pockmarks at the Storegga slide and at Nyegga, where they surround every dark spot of methane seepage (Decker *et al*., 2012). Many small symbiont bearing bivalves belonging to the family Thyasiridae have been sampled on these sites, especially in siboglinid fields at the Håkon Mosby mud volcano, whereas numerous larger Vesicomyidae shells have also been observed at the Storegga and Nyegga pockmarks (Decker and Olu, 2012).

At Nyegga, 1 m-high pillow structures covered with a carpet of siboglinids are known as “submarine pingoes;” they are described by Hovland and Svensen (2006) as local hydrate (ice) accumulations. In all the explored areas, *Sclerolinum* seem to dominate, whereas *Oligobrachia* has a discrete, highly patchy distribution (Decket *et al*., 2012). Filamentous bacteria often cover their tubes and the spaces between tubes provide shelter to a highly diversified macrofauna, particularly between the twisted creeping tubes of *Sclerolinum*. *Sclerolinum* can therefore be compared to other habitat-providing species such as deep-water corals, as it harbours a great epifaunal biodiversity on the otherwise barren soft sediments of the Norwegian deep margin.

Among nonsymbiotic megafaunal species, the fish of the Zoarcidae family, *Lycodes squamiventer* is the most abundant at the Håkon Mosby mud volcano (Gebruk *et al*., 2003) Image analysis from the Vicking cruise (2006) confirmed previous observations of Gebruk *et al*. (2003) on the distribution of this zoarcid fish: they show the highest abundances in the most active area of the volcano, and are particularly associated with microbial mats (Decker and Olu, 2012). Zoarcidae is the typical fish family encountered at hydrothermal vents and cold seeps, with some endemic species likely having adapted to the toxic environment. On the Storegga slide and in Nyegga pockmarks, nonsymbiotic megafauna are much more abundant and diverse, probably for two reasons. The very large ophiurid *Gorgonocephalus* sp., reaching up to 0.5 m diameter, is the most striking species of this background megafauna, but abundant comatules, crinoids, and pedonculate sponges were also observed.

7.3.2 Gulf of Cadiz, Spain

The Gulf of Cádiz is located between Iberia and Africa on the Atlantic side, between 9°W and 6°45'W, and 34°N and 37°15'N. It is considered a hot spot of biodiversity (Cunha *et al*., 2012). The hydrography of the study area is complex, with the influence of Mediterranean outflow water on the shallower eastern mud volcanoes, and evidence of input of high-nutrient Antarctic Intermediate Water in the deeper western regions (Van Aken, 2000). The area has a complex tectonic history and is now dominated by thick sedimentary deposits. Since their initial discovery in the area in 1999 (Kenyon *et al*., 2000), a large number of mud volcanoes have been identified, located in four main fields and exhibiting different but generally very localized hydrocarbon seepage (Niemann *et al*., 2006b; Figure 1B). The presence of carbonate chimneys indicates past activity. At most of them, the majority of the methane is consumed within the sediments, and does not reach the hydrosphere. In contrast to the Håkon Mosby mud volcano, where permanently high fluxes of reduced compounds are readily indicated by the presence of large aggregations of siboglinids and bacterial mats. The mud volcanoes in the Gulf of Cádiz do not show evidence of dense aggregations of living chemosynthetic megafauna.

An initial ROV transect at 1100 m depth on the Darwin mud volcano during a sampling campaign with RRS *James Cook* in 2007 revealed a mass of mytilids identified as *Bathymodiolus mauritanicus* on the top of this mud volcano. However, most of this accumulation comprised empty shells. Other megafauna, not directly chemosynthesis-dependent, consisted of stylasterine corals attached to the carbonate cap, scavenging crabs, and corals. Aside from the dead mytilid fields, the chemosynthetic species of the Gulf of Cádiz live mostly buried inside the sediments, a distribution that is probably related to the shallow (<30 cm) depth of the sulphide/methane gradient. The most common species include siboglinid polychaetes (*Siboglinum* spp.) and solemyid bivalves (*Acharax* sp., *Petrasma* sp.), but also other frenulate (*Polybrachia*, *Spirobrachia*, *Bobmarleya*, *Lamellisabella*) and bivalve taxa (*Lucinoma*, *Thyasira*, *Bathymodiolus*, Vesicomyidae) (Génio *et al*., 2008; Hilário and Cunha, 2008; Rodrigues *et al*., 2008). Several nonchemosynthetic species were also observed associated with different mud volcanoes at various water depths. In contrast to the shallower mud volcanoes, the Carlos Ribeiro mud volcano at 2200 m water depth has a more diverse nonchemosynthetic-dependent megafauna. The mud volcano center consists of series of concentric ridges that support very few megafauna except siboglinid tubeworms and a mobile echinothurid sea urchin found close to the “eye” of the volcano. Most of the more extensive megafauna comprise suspension-feeding cnidarians situated at the periphery of the mud volcano, including poriferans the seapen *Umbellula*, and dense gorgonian bushes. Further from the mud volcano the enigmatic athecate hydroid *Monocaulus* was observed. At some time in the past, mud overflowed the volcano's crest and slid down its southeast side, where huge numbers of deposit-feeding holothurians were observed.

7.3.3 Other areas

A recent survey on the west side of Rockall bank revealed fauna typical of cold seep ecosystems (Section 3.2.3; Oliver and Drewery, in prep).

7.4 Identified threats

In 2010, an International workshop sponsored by the International Seabed Authority (ISA) was held to formulate general guidelines for the conservation of vent and seep ecosystems at regional and global scales, and establish a research agenda that aimed at improving existing plans for the spatial management of vent and seep ecosystems. At this workshop, human activities associated with non-ecological services of vents and seeps were identified, as also the different levels of impact on vent and seep ecosystems. A number of anthropogenic pressures arising from indirect commercial activities, such as shipping, cable laying and waste disposal, may impact upon seeps and vents. An expert judgment approach (Teck *et al*., 2010) gathered the opinions of scientists to estimate the levels of impact of activities on the structure and function in chemosynthetic ecosystems below 250 m (VanDover *et al*., 2011). Taking into account the overall intensity of direct impacts, the persistence of impacts, and the likelihood of an activity, the most severe threats to natural ecosystem structure and function at vents and seeps are currently the extractive industries (minerals at vents, oil, gas and methane hydrates at seeps) and the impacts of bottom-trawl fisheries at seeps.

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8 Explore the use of survey data from the ICES VME database to address bycatch thresholds in different regions, e.g. NAFO and NEAFC RAs

8.1 Introduction

VMEs tend to be patchily distributed as a consequence of heterogeneity in physical conditions, seabed substratum and biological productivity. As such if one were to randomly sample the seabed most of samples will record no or very few or small amounts of VMEs and a few samples will record very many or large amounts. In other words, a threshold amount is sampled at some point that indicates that a patch of VME has been encountered. Much effort has been put into trying to determine what are appropriate thresholds for various types of VME indicator species that would indicate that a commercial fishing vessel has encountered an actual VME.

8.2 Survey bycatch rates of VME indicator taxa in the NAFO regulatory area

The NAFO encounter provisions for 2013 were adopted at the 34th Annual Meeting in September 2012. Article 22 paragraph 3 outlines reads as follows:

> "For both existing bottom fishing areas and unfished bottom areas, an encounter with primary VME indicator species is defined as a catch per set (e.g. trawl tow, longline set, or gillnet set) of more than **7 kg of seapens, 60 kg of other live coral and 300 kg of sponges**. These thresholds are set on a provisional basis and may be adjusted as experience is gained in the application of this measure."

The thresholds for seapens and sponges were determined based on analyses of research vessel trawl catch and consideration of catchability through comparison of trawl catch and *in situ* biomass and significant adverse impacts (Kenchington *et al*., 2011). The encounter value for other live corals (gorgonian corals in this context) was previously established through assessment of the cumulative research trawl catch for the Flemish Cap and Grand Bank areas.

Threshold values of VMEs can be determined based on patterns in the cumulative catch curves such that a point of maximum curvature or rapid change toward the asymptote may be indicative of a naturally occurring or ecologically relevant reference point (Kenchington *et al*., 2009). Threshold values can also be based on particular quantiles, however, while there is some biological basis for using quantile thresholds in some species, choosing a point to define when catches go from relatively small to large is often subjective.

When first considering this issue, NAFO (2008) opted to use the upper percentile of 97.5 as a standard for seapen catch distributions due to the statistical relevance of this measure which marked the upper limit of the 95% confidence intervals around the mean. However, the ecological relevance of this threshold, in regards to conservation of VME indicator populations or functional roles remains unknown. For some taxa there may be good reasons to choose lower thresholds. For example, a precautionary approach may be indicated if catch efficiency is unknown, or may be low or highly variable over a range of size. Fragility of individuals or colonies should also be considered as breakage and disintegration will greatly affect catch retention. Most importantly, research trawl distances are often much shorter than commercial trawls.

NAFO did not use the values derived from such analyses of research trawl bycatch directly, nor did it scale up the values to match mean commercial differences. NAFO recognized that the aggregated distribution of these taxa, over scales that were generally much smaller than the average commercial trawl of 13.8 km in the area, would over inflate any value derived through scaling up from the research vessel (RV) catches collected in 1 km trawls. Instead they used the RV catch thresholds derived from the cumulative distribution to map the location of these large catches. They then used geospatial statistics to estimate the equivalent commercial catch threshold by superimposing actual (VMS data) and modelled (based on average tow length and random placement and orientation) commercial trawls over the biomass layer (e.g. Cogswell *et al.*, 2011). Many of these points were considered, to the extent possible, in subsequent work on this issue by NAFO (Kenchington *et al.*, 2011). Direct use of the values established from the RV catches will provide a conservative starting point for assessment of encounter thresholds in the NEAFC area.

8.3 Survey bycatch rates of VME indicator taxa in the NEAFC regulatory area

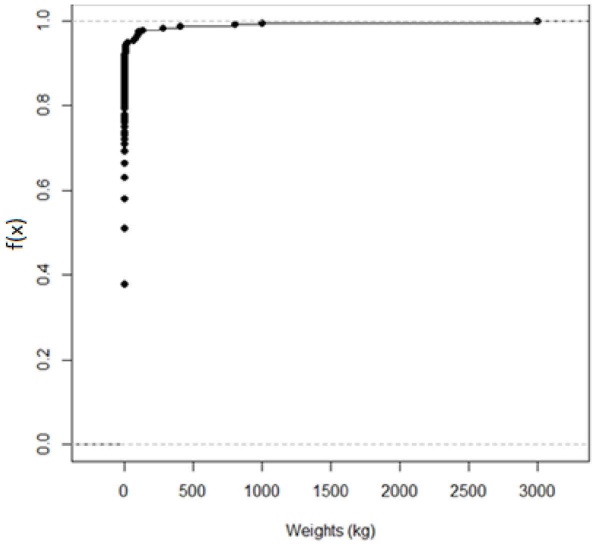
Current quantitative bycatch thresholds for VMEs in the NEAFC regulatory area are 30 kg of live coral and 400 kg of sponges. The NEAFC bottom fisheries regulation expresses that these thresholds are set on a provisional basis and may be adjusted as experience is gained in the application of this measure.

Similar analyses of research survey data to those described above from NAFO were attempted this year by WGDEC. The preliminary results were informative with regards to distribution and density patterns of VMEs, but without information on catch retention and without cross-validation with visual survey data (as done by NAFO), the analysis could not provide a satisfactory scientific basis for evaluating the current threshold levels adopted for bottom fisheries in the NEAFC RA. The results are however very useful to WGDEC when evaluating data on VME records in the ICES VME database and for delineating areas where VMEs are likely to occur and which should be considered closed to bottom fishing. They also make interesting comparison to the analyses undertaken by NAFO.

Cumulative catch curves were constructed for sponges, sea-pens and *Lophelia pertusa*, using a subset of survey trawl bycatch data from the ICES VME database comprised of data from Marine Scotland trawl surveys in the Rockall area. This survey has a standard trawl gear type (a fine-mesh bottom trawl) and tow duration of between 30–60 minutes covering a distance of approximately between 3–6 km respectively. This survey samples a limited subarea of the NEAFC RA, and only the parts of that subarea classified by NEAFC as 'existing' fishing areas. The survey does not sample inside the 'Bottom fishing closures' which are presumed to contain a higher abundance of VME indicator species/VMEs. The patterns revealed are not likely to be representative for the entire NEAFC RA, but nevertheless cover one of the more important areas. As expected the bycatch distribution plots for each VME indicator show a highly skewed distribution with a small number of large bycatches indicating that there are a few dense patches and many larger areas where the VME indicator species are present at low densities.

8.3.1 Sponges

Cumulative catch distributions of sponges from survey bycatch data show two distinct changes in curvature which may be indicative of ecologically relevant reference points (Figure 8.1). This pattern is also illustrated by the thresholds between quantiles (Figure 8.1.); from the 85% quantile at 0.66 kg to the 90 % quantile at 1.70 kg and to the 95% quantile at 25.10 kg. Inspection of the plot reveals there are three sections of curve that describe changes in the distribution from individual sponges to small aggregations and then to bigger aggregations; the probability of an encounter with the larger patch is very low, less than 5% of trawls encountered more than 25 kg.

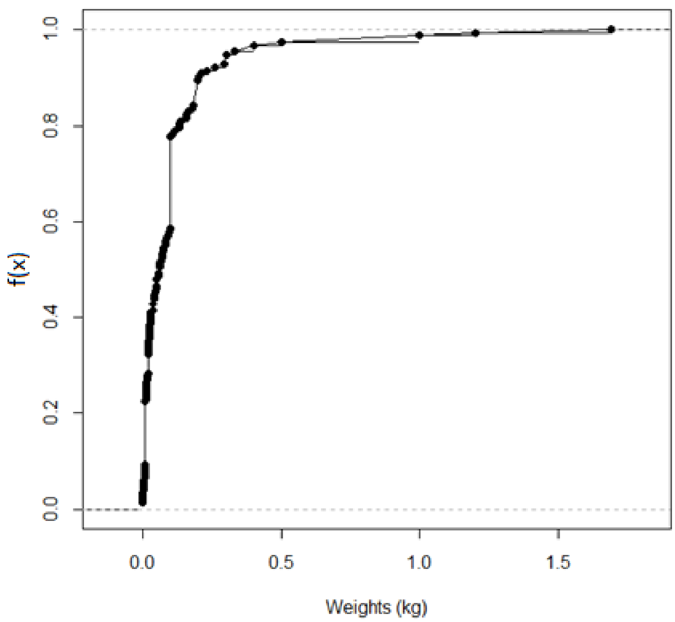


Quantile	Weight (kg)
25% quartile	0.00
50% median	0.01
75% quartile	0.10
80%	0.24
85%	0.66
90%	1.70
95%	25.10
100%	3000

Figure 8.1. Cumulative distribution of sponge catch (kg) from survey trawl bycatch data (n=166). Catch weight are presented as quantiles.

8.3.2 Seapens

For seapens the bycatch patterns in the cumulative catch curve show a change of curvature and the catch weight quantiles show a natural break between the 90% quantile at a weight of 0.203 kg and the 95% quantile at a weight of 0.313 kg (Figure 8.2.).

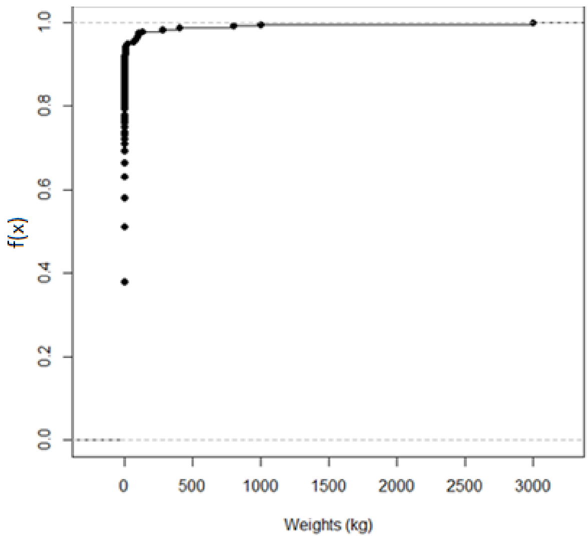


Quantile	Weight (kg)
25% quartile	0.014
50% median	0.060
75% quartile	0.100
80%	0.132
85%	0.200
90%	0.203
95%	0.313
100%	1.690

Figure 8.2. Cumulative distribution of seapen catch (kg) from survey trawl bycatch data (n=152). Catch weights are presented as quantiles.

8.3.3 *Lophelia pertusa* (cold-water coral)

Interpretation of the cumulative catch curve constructed for *Lophelia* is more difficult as catch efficiency of this fragile organism is considered to be low due to its tendency to break and shatter upon impact and pass through the net (Parker *et al.*, 2009). From the cumulative catch curve constructed for *Lophelia* it was not possible to select a threshold that would indicate a significant concentration. Therefore, any catch of *Lophelia* (live or dead) in research surveys may be regarded as an indicator of a near-by aggregation of this species, i.e. a VME. The level of bycatch that is biologically significant is unknown and in such cases a precautionary approach is to take the 50% quantile (median) as a bycatch weight threshold. For the cumulative catch curve presented here the 50% quantile has a catch weight of 0.230 kg (Figure 8.3.); a figure so small that it essentially equates to any bycatch of *Lophelia* being cause for concern. As mentioned previously it is almost impossible to scale this value to what would be a plausible bycatch threshold for commercial trawlers.



Quantile	Weight (kg)
25% quartile	0.00
50% median	0.01
75% quartile	0.10
80%	0.24
85%	0.66
90%	1.70
95%	25.10
100%	3000

Figure 8.3. Cumulative distribution of *Lophelia* catch (kg) from survey trawl bycatch data (n=90). Catch weight are presented as quantiles.

8.4 General discussion

Bottom trawls are designed to catch fish and are poor sampling tools for most sessile benthic organisms and in general the catchability of VME indicator species is unknown (Auster *et al.*, 2011). Additionally, the sampling efficiency is likely to be species-specific and for some species the trawl may only retain a very small proportion of the VME species that was actually impacted (Parker *et al.*, 2009).

An issue when determining appropriate bycatch threshold weights are the uncertainties in the natural distribution and abundance of VME species (Auster *et al.*, 2011; WGDEC, 2012) and the functional role such species play across a gradient of patch sizes. The sole use of biomass values can be misleading without some idea of the numbers of colonies that make up the biomass value for the bycatch data. Many smaller individuals could compose a significantly large patch but a few large colonies may just indicate a few isolated, albeit large, individuals.

There is a pressing need to calibrate survey bycatch data with bycatch rates from commercial trawling. Move-on rules require a threshold based on commercial bycatch rates. Commercial trawls typically tow for over two hours compared to half hour tows for survey trawl sampling. Moreover, these data from survey trawling have been collected based on a random sampling survey design protocol which does not specifically target any one place within the area being surveyed (unlike commercial trawling where areas of high fish density are targeted). This difference in "sampling strategies" implies that the sampling probability will be different affecting our method for analysing the data. This limitation in the data should be kept in mind when inferring measures to be used for commercial bycatch thresholds.

Data which can be used to analyse spatial variation in local density and patch size across habitats are required to better inform appropriate bycatch thresholds. Visual survey methods may be more appropriate than trawl survey data for the characterization of VME habitats. For example towed camera platforms, remotely operated vehicles (ROVs) and submersibles can be used to assess distribution patterns of these habitats. Methods are currently in development to use visual data collected by a towed camera system to quantify seabed observations of VME species such as *Lophelia pertusa* and sponges. The towed camera system allows for areas up to 125 000 m^2 to be surveyed, a substantial area that is more comparable to that surveyed by demersal trawl sampling. Image analysis techniques have been developed and can be used to quantify the area occupied by the coral. From the towed camera transects in the Rockall area which have been analysed to date, *Lophelia* is shown to be distributed sparsely and patchily throughout the closed areas. It does not exist as large reef complexes such as in Norwegian waters, but rather in small patches and clusters where suitable substratum exists. Once data from visual surveys can quantify the spatial distribution and densities of VMEs it may be possible to assess what bycatch from survey and commercial trawl gear actually represents.

8.5 References

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Parker, S., Penney, A. and Clark, M. 2009. Detection criteria for managing trawl impacts on vulnerable marine ecosystems in high seas fisheries of the South Pacific Ocean. *Marine Ecology Progress Series* **397**, 309–317.

9 Review and, if necessary, update the ecosystem section of the area overviews in the WGDEEP report in advance of WGDEEP so that WGDEEP can take greater account of ecosystem aspect

9.1 Introduction

The aim of the 'Ecosystem Considerations' sections provided in the WGDEEP reports is presumably to provide regional overviews relevant to WGDEEP's tasks and the fish stocks it assesses. WGDEC reviewed the relevant section in the WGDEEP 2012 report. WGDEC did not have the time or all the necessary expertise available to update the sections. Instead WGDEC offers a means of restructuring and focusing the content of the sections to make them more relevant and the information more readily accessible. WGDEC noted that on occasion the overviews included information on shelf ecosystems. Unless there is an explicit link between the shelf ecosystems and the deep-water ecosystems, WGDEC suggest that the focus be on solely deep-water ecosystems, the production system sustaining those communities, and the physico-chemical conditions they experience. Of particular interest are the deep-water communities associated with;

- the continental shelf break (>200 m) and the continental slope (to depths of 2000 m);
- the Mid-Atlantic Ridge;
- knolls, seamounts, steep slopes and canyons;
- deep oceanic island slopes, e.g. Iceland;
- deep fjords, e.g. Norway.

It would be appropriate for the overview to highlight those taxa and assemblages that are likely to be especially vulnerable to bottom fishing operations according to the criteria laid down by FAO (2009). Many of the above issues do not require full accounts or reviews, but reference to key literature would be necessary and sufficient. In the 2012 report of WGDEEP, a general comment can be made that the 'ecosystem consideration' sections span from the very thorough to the very brief. Consequently, there is a lack of consistency in content between areas and it is difficult to readily find particular information, e.g. benthic assemblages for each area.

9.2 Recommendation

WGDEC suggest that all sections be reviewed, restructured and updated with the aim of achieving greater consistency in terms of content and style. This would also allow for easier updating as new information becomes available. In particular it would be useful if each area were split into several subsections each with a paragraph or more of text. Those subsections could be;

1) Topography, bathymetry and seabed types;
2) Oceanographic conditions and variability;
3) Plankton and micronekton assemblages;
4) Demersal and mesopelagic fish assemblages;
5) Spawning sites or key feeding areas of fish species;
6) Benthic species assemblage structure and occurrence of VMEs;
7) Biogeographic pattern and linkages to other ecoregions;

8) Wider ecological processes including foodwebs, bentho-pelagic coupling and energy transfer.

9.3 Specific comments for each region

WGDEC has also some specific comments on each of the sections for each area that may help WGDEEP restructure and improve this section of their report.

Iceland and Greenland seas

This section is very extensive and comprehensive but could be made more concise and relevant if it focused exclusively on deep-water ecosystems.

Barents Sea and Norwegian Sea

The focus very strongly biased towards oceanography and benthos. More information is required on deep-water fish communities and how they are distributed in relation to hydrography. A short section of deep-water foodwebs should be summarized and added. There is no information on fjord systems which are characteristic for this area.

Faroes

The focus is also very strongly biased towards oceanography and benthos. Information on deep-water fish communities, how they are distributed in relation to hydrography, and deep-water foodwebs should be summarized and added.

Celtic Seas

This is a very extensive section and the contents are appropriate. There has been quite a bit of work in this region recently and updating would be useful, especially references to recent literature. There are some general statements that are not really related to the Celtic Seas and the section on potential effects of exploitation is not really appropriate here.

North Sea and Skagerrak

This section is extensive and the content largely appropriate. Some more emphasis on foodwebs would be beneficial. The section on potential effects of exploitation is not really appropriate here.

South European Shelf

This is a very short section and needs expanding and updating in line with the recommendations above.

Oceanic Northeast Atlantic

The contents of the section are largely appropriate, but updating and referencing is required. A lot of information is available from recent studies on the MAR and on seamounts in and around the Azores. Again, the potential effects of exploitation do not belong here.

Annex 1: List of participants

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Annex 2: WGDEC terms of reference for the next meeting

The ICES/NAFO Joint **Working Group on Deep-water Ecology** (WGDEC), Chaired by XXXX, XX, will meet in March 2014 at ICES Headquarters in Copenhagen, Denmark:

a) Provide all available new information on distribution of VMEs in the North Atlantic and update maps with a view to advising on any boundary modifications of existing closures to bottom fisheries;

b) Develop a system of weighting the reliability and significance of VME indicator records so that advice on closures can be more clearly presented and interpreted;

c) Catalogue sources of multibeam/swathe bathymetry data for deep-water areas throughout the North Atlantic so that such data can be more readily accessed and used by WGDEC in its advice;

d) Review the state-of-the-art of high resolution 'terrain-based models' for predicting VME distribution and developments in understanding the functional significance of VMEs, notably as providers of essential habitat for fish.

Annex 3: Recommendations

Recommendation	Adressed to
WGDEC recommends that the ICES Data Centre continue to assist in developing an online GIS functionality of the ICES VME database.	ICES Data Centre
WGDEC recommends that recent (post 2009) VMS data are provided to ICES in advance of the 2014 WGDEC meeting. NEAFC areas of interest include fisheries in the Rockall-Hatton area, all seamounts with summits < 2000 m and the Mid-Atlantic Ridge. EU EEZ areas of interest include the continental slope including the Bay of Biscay and all seamounts/banks. All form of identification of vessel, nationality and any information on catch should be removed from the data., WGDEC will however need the data to be resolved at the finest possible temporal and spatial scale (not aggregated) and provided with information on fishing gear type, e.g. bottom trawl.	NEAFC and EC

Annex 4: Technical Minutes from the Vulnerable Marine Ecosystems Review Group (RGVME)

- RGVME
- 14–16 May 2013 at ICES, Copenhagen, Denmark
- Participants: Leonie Dransfeld, Ireland (Chair), Murray Roberts, UK and Ole Tendal, Denmark (Reviewers), Francis Neat, UK (Chair of WG) and Claus Hagebro (ICES Secretariat)
- Working Group: WGDEC

The Review Group reviewed the following special requests for advice from NEAFC:

a) Provide all available new information on distribution of VMEs in the North Atlantic and update maps with a view to advising on any boundary modifications of existing closures to bottom fisheries (NEAFC request).

b) Evaluate whether buffer zones applied in the current bottom fishing closures are appropriate. Additionally, ICES is requested to include, specify and illustrate buffer zones in its future advice on closures in the Regulatory Area as appropriate (NEAFC request).

c) Assess whether the list of VME indicator species is exhaustive and suggest possible addition to that list. The basis for the assessment should be the FAO Guidelines specifying taxa and habitats that may be relevant. ICES should focus on taxa (species or assemblages of species) that tend to form dense aggregations of assumed particular functional significance. NAFO SC has in 2012 conducted a similar assessment and revision and to the extent scientifically valid harmonization with NAFO lists would be beneficial. ICES is furthermore asked to map VME elements (i.e. geomorphological features) in the NEAFC RA. This would include seamounts and knolls at fishable depths (with summits shallower than 2000 m), canyons, and steep flanks. Also in this exercise, harmonization with NAFO SC evaluations would be beneficial. ICES is specifically requested to advice NEAFC on the occurrence of hydrothermal vents and measures applicable to protect hydrothermal vents and associated communities in the RA (NEAFC request).

d) Advice on the appropriateness of applying the threshold levels for VME indicator species for longline fishing as adopted in the SEAFO, and CCMLAR, in the NEAFC RA (NEAFC request).

Written for ADGVME

General Comments

- The outcome is an interesting and inspiring report.
- This report does a very competent job of addressing each of the terms of reference. It is in the most part very well written with a good level of background information setting the wider scientific context to each topic.
- Latitude and longitudes on the map figures are often too small to be legible. These should be adjusted to match the suitable size used in Figure 5.3.
- There should be consistency in the maps; i.e. same colour coding and symbols across maps. Also a consistency on how to present the maps would be

good; some maps only have the new data in it like Figure 3.1 and some maps have all supporting data that are used as a basis of advice, like in Figure 3.2.

- Evidence of VME occurrence is not given in a quantitative or relative way that allows making comparisons with previous closures and/or recommendations. New findings are expressed as "substantial", "extensive", "aggregations" but there are no overarching criteria, at what scale or quantity the indicator species should occur to warrant a closure. In some cases, the thresholds of the move on rule are referred to, but this is not done in all cases.
- Although request 1 asks to supply all *new* information, it would be useful to present it in the context of information/data that are already available and have been used for closures (or previous advice for closures). This has been done in some cases; e.g. 3.2.4 is a good example where cumulative quantitative data are presented based on the VME database.

Provide all available new information on distribution of VMEs in the North Atlantic and update maps with a view to advising on any boundary modifications of existing closures to bottom fisheries

Northwest Rockall Bank

WGDEC response: The extension of the closure to bottom fishing proposed by WGDEC in 2012 is recommended.

Basis: In a part of the proposed closure to bottom fishing recommended by WGDEC in 2012 (to the northeast) that is currently open to bottom fishing, a video transect revealed new observations of *Lophelia pertusa* reefs reaffirming that the extension is required. Diagram shows the new proposed boundaries, table gives the coordinates.

RGVME comment

WGDEC has proposed revised boundaries for the NW closure for the last few years. Every year, new evidence comes to light, which further supports the previous proposals. The RG supports the recommendations. To help the reader, it would be useful to include the previous evidence that lead to the recommendations of revised boundaries. WGDEC 2012 provided semi-quantitative evaluation of coral presence (in the form of *Lophelia* summed presence). It would be helpful to compare the new evidence of *Lophelia* (in terms of scale/intensity) in the newly proposed area with that inside the existing closure.

The diagram and its legend need further clarifications: the grey lines are presumably the newly proposed boundaries; these need to be added to the legend and clarified in the figure caption. Because the figure is zoomed in, it is not clear what the black line represents.

Southwest Rockall Bank

WGDEC response: SW Rockall closure boundaries to be revised.

Basis: Extend the boundary of the closure in the western corner to incorporate the new video records (and the 2012 bycatch record). The boundary is drawn around the positions of the records according to the estimated uncertainty of the data (500 m) and includes a buffer zone of three times the water depth.

RGVME comment

The recommendations are supported; furthermore it was good to highlight the absence of corals in the northern area without an immediate recommendation of reopening this section. There is some inconsistency in how the buffer zone is expressed. In the first paragraph of page 8, the buffer zone is two times the depth, in the following paragraph it is twice the wire depth between the vessel and the camera and in the recommendations on page 9 it is three times the water depths.

Hatton–Rockall Basin

WGDEC response: A closure to bottom fishing around the sponge aggregation is proposed that corresponds to twice the water depth.

Basis: In the middle of the Hatton-Rockall basin new data were presented from a research survey on the presence of an aggregation of deep-sea sponges (*Pheronema carpenteri* and *Hyalonema* stalked sponges) at approximately 1150 m water depth. The sponges were observed from ROV and drop-frame camera video and image footage.

RGVME comment

On page 11 there is a reference to Figure 3, which figure is this supposed to refer to?

On page 12 the work of Ross and Howell (2012) is referred to as a potential source of future information on VME distribution. WGDEC notes this, but do not use the predictions from this work as the resolution remains too coarse. See specific comments below for other potential issues with this work.

Does Figure 3.4 indicate that the new data support existing sponge data in the area based on the VME database? A sentence could be added to put the new finding into context of previous data. Longitudes need to be enlarged and latitudes added.

Hatton Bank

WGDEC response: Two areas, one to the southeast and one to the southwest of Hatton Bank to be closed to bottom fishing.

Basis: Presence of carbonate mounds which classify as VME elements (area to southwest of Hatton Bank); presence of large bycatch of sponges in the east (area to southeast of Hatton Bank); presence of small bycatch of gorgonians in the area (area to southwest of Hatton Bank); a 'knoll' area to the southwest of Hatton Bank visible from the bathymetric data from the National Irish Seabed survey multibeam dataset. This feature has the topographical relief associated with the presence of VMEs and there are records of gorgonians from the summit at depths <1000 m; two areas of outcropped rock (VME elements) on the western slope, visible on the Spanish multibeam data, which are also likely to be sites with VMEs; evidence of fishing (trawling) activity in the sedimentary areas (Hatton Drift) of the western slope.

RGVME comment

General: This section is very well written and puts new findings into context of existing data. It describes the criteria used to delineate the boundaries and describes data in a quantitative way and compares them to threshold limits. Figure 3.5 is a very clear representation of the data and can be used as a template of presenting spatial VME information for WGDEC in general. It visualizes existing data with cumulative quantities based on database records, but also shows the locations that had no VME indicator species in the bycatch.

On page 14 there is discussion of carbonate mounds from Hatton Bank. The first published evidence of coral carbonate mounds from Hatton Bank was published in 2008 (Cold-water coral reef frameworks, megafaunal communities and evidence of coral carbonate mounds on the Hatton Bank, Northeast Atlantic. Facies 54: 297–316).

Josephine Seamount

WGDEC response: a bottom fishing closure is established for the Josephine Seamount corresponding to the Josephine Seamount High Seas MPA established by OSPAR (OSPAR Decision 2010/5).

Basis: OSPAR Decision 2010/5 established a high seas MPA on the Josephine Seamount; there are concentrations of gorgonians (VME indicator species) on and around Josephine Seamount.

The summits and flanks of seamounts are listed amongst examples of geomorphological features that potentially support the species groups exemplified as VMEs according to FAO guidelines.

RGVME comment

A sentence should be added to describe on what basis the Josephine Seamount was designated as an OSPAR High Seas MPA and how the boundary for the MPA was delineated. The figure only shows presence/absence of corals, rather than cumulative quantities, and it is not clear why some records of gorgonias, i.e. in the southeast are not used for VME identification.

Hebrides Terrace Seamount

WGDEC response: A closure to bottom fishing is proposed that encompasses the steep flanks of the seamount with a buffer around the records of VMEs corresponding to twice the water depth.

Basis: Based on ROV transects, on the steep flanks between the depths of 1200 m and 1700 m, a large number of VME indicator species were recorded at high densities indicating VMEs.

RGVME comment

Section 3.3.1 on the Hebrides Terrace Seamount uses data gathered at sea during RRS *James Cook* 073 'Changing Oceans Expedition' for which I was principal scientist (Murray Roberts). The ICES report draws its information from Cross *et al*. (2013), a currently unfinalized report prepared for the UK Joint Nature Conservation Committee (JNCC). There are fundamental errors of taxonomy in the Cross *et al*. report and I think it should not be relied upon in detail. These are explained below. The summary in the ICES report is largely valid since it does not go into details on the nature of VME indicator species identified on the flanks of the Hebrides Terrace Seamount. However, the VME indicator categories in Figure 3.8 should be checked. I have informed the Chief Scientist of JNCC's parent body (the Department for Environment, Food and Rural Affairs) of these issues so that the JNCC report, and others affected by the same issue, can be corrected before they are finalized.

The Cross *et al*. report makes significant errors in the identification of deep-sea fauna from the Hebrides Terrace Seamount. Specifically, the hard coral *Solenosmilia variabilis* was misidentified as *Lophelia pertusa*. Both species are capable of constructing biologically rich but vulnerable biogenic Annex I reef habitats. The errors made in this and previous JNCC contracts not only impact upon studies and reports relevant to the Hebrides Terrace Seamount, but also those relating to corals on Anton Dohrn Seamount (see list of affected publications below). These errors are being perpetuated through the wider EU MPA process and relevant to the outcome of many stakeholder decisions based on deep-sea biotope classifications, predictive mapping, levels of connectivity between marine protected areas, species diversity, change in biological communities, and measurements of how unique these ecosystems are to the wider Atlantic marine seascape.

It was immediately clear to scientists on board the 'Changing Oceans Expedition JC073' in June 2012 cruise that the colonial scleractinian corals seen on video feeds from the Hebrides Terrace Seamount appeared different from *Lophelia*. Subsequent quantitative spatial analysis of the surveys conducted at Heriot-Watt University verified that all colonial scleractinian corals from the image data were in fact *Solenosmilia*, and no *Lophelia* was ever observed. We confirmed our identifications of *Solenosmilia* by sharing three digital images from the ROV images with the world authority in scleractinian taxonomy, Dr Stephen Cairns at the Smithsonian Institution (Washington DC, USA), who concurs with our visual identification. Sadly ROV technical problems prevented us sampling these corals at sea to further confirm the identification from skeletal features.

It is important to note that *Lophelia* and *Solenosmilia* inhabit chemically different environments, supporting our identifications of *Solenosmilia* on the Hebrides Terrace Seamount between approximately 1200–1700 m water depth. This is borne out in recent habitat suitability analyses (Davies and Guinotte, 2011). The 1200–1700 m depth zone corresponds to a much stronger influence of Labrador Seawater, more enriched in oxygen, less saline, with lower temperature and much less saturated in aragonite (McGrath *et al*., 2012), all of which closely correspond to the environmental setting of *Solenosmilia* and not *Lophelia*. Our wider JC073 carbonate chemistry and other hydrographic data bear this interpretation out (see Roberts *et al*., 2013; JC073 Cruise Report).

We followed this up with subsequent review of images in cruise reports to Anton Dohrn (Stewart *et al*., 2009; Long *et al*., 2010) and earlier ICES WGDEC reports. From these, it seems that *Lophelia* does occur on Anton Dohrn at shallower depths <1000 m. But after reviewing this limited collection of images, we are highly suspect of any record of *Lophelia* on Anton Dohrn deeper than about 1200 m, as these look identical with our images of *Solenosmilia* on the Hebrides Terrace. They also harbour identical associated biological communities of bamboo corals, blue encrusting sponges, large gorgonian octocorals and brisingids.

Listing in reverse chronological order of additional reports and studies known to us impacted by image analysis errors in taxonomy of *Lophelia* vs. *Solenosmilia*

Bullimore *et al*. 2013. Coral-characterized benthic assemblages of the deep Northeast Atlantic: defining "coral gardens" to support future habitat mapping efforts. ICES doi: 10.1093/icesjms/fss195.

Cross *et al*. 2013. Analysis of seabed imagery from the Hebrides Terrace Seamount. JNCC Report.

Ross and Howell. 2012. Use of predictive habitat modelling to assess the distribution and extent of the current protection of 'listed' deep-sea habitats. Diversity and Distributions doi: 10.1111/ddi.12010.

JNCC. 2012. SAC Selection Assessment Document. Offshore Special Area of Conservation. Version 5.

Howell *et al*. 2011. Using predictive modelling to map the distribution of selected habitats listed as MPA search features in Scottish waters. Report to JNCC.

ICES. 2011. Report of the ICES/NAFO Joint Working Group on Deep-water Ecology (WGDEC). 28 February–4 March, Copenhagen, Denmark. ICES CM 2011/ACOM:27. 105 pp.

ICES. 2012. Report of the ICES/NAFO Joint Working Group on Deep-water Ecology (WGDEC). 26–30 March 2012, Copenhagen, Denmark. ICES CM 2012/ACOM:29. 120 pp.

ICES. 2013. Report of the ICES/NAFO Joint Working Group on Deep-water Ecology (WGDEC). 11–15 March 2013, Floedevigen, Norway. ICES CM 2013/ACOM:28. 95 pp.

Long et al. 2010. JNCC Offshore Natura Survey of Anton Dohrn and East Rockall Bank Areas of Search. JNCC Report No. 437.

Stewart *et al*. 2009. JNCC Offshore Natura Survey. Anton Dohrn Seamount and East Rockall Bank Areas of Search. 2009/03 Cruise Report. Report Number CR/09/113.

Porcupine Sea Bight

WGDEC response: As this was once and still may be an area of dense sponge aggregations within fishing depths, a bottom fishing closure is recommended.

Basis: New 'historic' records of deep-sea sponge aggregations (*Pheronema carpenteri*) were made available to WGDEC. These were collected during scientific trawl surveys reported from the Porcupine Sea Bight at depths between approximately 1000 and 1500 m (Rice *et al*., 1990).

RGVME comment: There are little details given on the occurrence and concentrations of sponges in the historic records that lead to the recommendation of the closure. In addition, WGDEC has not mentioned or is not aware that there is already a SAC in the area which bans all bottom impacting activities. The basis of advice for the existing SAC includes historic records of mounds and corals from research surveys in 1997, 1998, 2001 and the coral database by Andre Freiwald (Figure 1 in this document). The advice for further protection in the area should be put into context with existing closures and previous evidence of VMEs. In addition, fisheries VMS information, where available, should be taken into consideration.

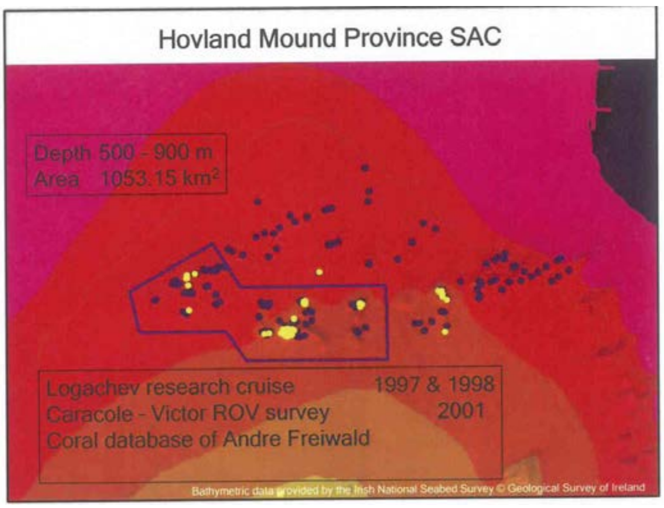

Figure 1. Location of mounds (blue dots) and coral (yellow dots), within and outside the site boundary at Hovland Mound (ICES 2007 citing Kelly, 2007).

Reference

ICES. 2007. Report of the *Ad hoc* Group for Western Irish Natura Sites (AGWINS), 21 June 2007, Dublin, Ireland. ICES CM 2007/ACE:06. 26 pp.

Rosemary Bank Seamount

WGDEC response: A closure to bottom fishing is proposed based on the trawl path plus a buffer of 2600 m (twice the water depth).

Basis: There are small bycatch records of corals and sponges from the upper seamount. In 2012 a trawl sample was obtained from the lower muddy slope at a depth of around 1300 m. A large bycatch of Geodia sponges was taken (>1 tonne).

RGVME comment

See below combined comment on Rosemary Bank, Faroe-Shetland Channel, Tampen area, Faroese waters.

Faroe-Shetland and Tampen area

WGDEC response: A closure to bottom fishing is recommended around the recent record and nearby historical records.

RGVME comment

RGVME comment see below combined comment on Rosemary Bank, Faroe-Shetland Channel, Tampen area, Faroese waters.

Faroese waters

WGDEC response: Two closures to bottom fisheries (Figure 3.12) are recommended around the areas where VME indicator species were encountered with a buffer zone of twice the water depth.

RGVME comment on Rosemary Bank, Faroe-Shetland Channel, Tampen area, Faroese waters

The RG does not have further details to add or alter. RG believes time has come for a next step, aiming for the general area at a more detailed description of the aggregations of sponges with respect not only to location and amount but also to taxonomic pattern of dominating species. We were able to distinguish between different 'types' of sponge aggregations both in the Faroes, in Iceland and on parts of the Norwegian continental slope; something like that could probably be made for the whole area of the report.

For the future, it should be the aim to carry out more detailed mapping at Rosemary Bank. What is given here as well as in other areas, are small bits of information to indicate the possible presence of extensive fields of sponges in a band, say between 600 and 1200 m depth.

For the Faroes, it may be discussed where to place VMEs, although the two suggested areas on the banks are fine for the time being. Also, areas on the western side of the Faroese plateau might be considered because of the local presence of large quantities of both sponges, *Lophelia* and octocorals, but would probably be in conflict with commercial fishery. *Lophelia* and sponge grounds were found in many places all over the Faroese area, octocorals more commonly on the sides of Faroese plateau. There is some mapping and regulation organized by the local authorities. Lousy Bank is not well known, and we should look more into it in future reports, if information can be provided/compiled.

Whittard Canyon (Irish Margin)

WGDEC response: WGDEC recommends that a closure to bottom fishing be put in place to protect the VMEs in this area. The closure boundary is drawn to encompass not only the VME records (with buffer zones of twice the depth), but also to protect particular geomorphological elements such as the steep sides of the canyon that are equally likely to harbour VMEs.

Basis: In 2012, WGDEC reported data on VMEs for the upper Whittard Canyon. New data, provided by the Marine Institute Ireland and National Oceanographic Centre Southampton,

- suggest the presence of VMEs in the head of the Whittard Canyon and the presence of dead coral rubble fields;
- indicate the presence of significant amounts of VMEs in different branches of the Whittard Canyon with substantial *Lophelia* reefs observed and over 30 coral types identified in reefs, coral garden environments and mixed soft sediment–hard bottom areas; high coral diversity observed inside and away from the reefs, coral communities occurrence observed in great densities with maximum density observed of over 800 coral colonies in a 100 m transect. VME indicator species observed belonged to Schizopathidae, Carophyliidae, Gorgonacea, Alcyoniidae, Paragorgiidae, Chrysogorgiidae, Isididae, Stylasteridae, Primnoidae and Pennatulacea.
- When delineating the boundary of the recommended closure, WGDEC highlights the importance of buffer zones due to the potential impact of trawling in areas adjacent to steep flanks or slopes and canyon walls and the resulting gravity flows and resuspended sediments.

RGVME comment

WGDEC recommends the closure of a large area in the Whittard Canyon for bottom fishing due to records of several VME indicator species. The figure shows the presence of VME indicators species but gives no indication of scale, extent or concentration. Some VMEs are drawn with a buffer zone, some are not. The area encompasses large areas that do not contain VME species, while other records such as the *Lophelia* records in the north are outside the recommended boundary. It is not clear from the figure, if the areas with no VME indicator species have been sampled with no records found, or if they have not been sampled. The format of Figure 3.4 would be much clearer in showing presence, quantity and absence of VME indicator species. Fishing with bottom impacting gear is occurring in the area mainly for hake, monk fish and megrim (Anon, 2009; MI unpublished data). The RG suggests that a more careful delineation of recommended boundaries is carried out using all available information including presence-absence and location and intensity of fishing activity. The recommendation of closing smaller sections within the area should also be considered.

Reference

Anon. 2009. Atlas of the Commercial Fisheries around Ireland, Marine Institute, December 2009.

Bay of Biscay

WGDEC response: WGDEC repeats its advice from 2011 to protect an area situated in the central part of the Bay of Biscay (cf. Figure 28 in ICES WGDEC Report of 2011). WGDEC also highlights that rugged topography and high habitat heterogeneity (like that observed at the Whittard Canyon) is typical for the entire Irish Margin/Bay of Biscay south of the Goban Spur, and makes the determination of appropriate closure zones difficult without more detailed and concise information on the distribution of VMEs in canyons along the whole margin. The development of terrain-based models could provide predictive information on the presence of VMEs in these less-accessible areas for which new data are obtained only sporadically.

The information gathered so far on the distribution of VMEs in the many canyon systems of the Irish Margin and the Bay of Biscay shows that many VMEs are present and that these are likely to be present in most areas along the geomorphologically complex Bay of Biscay.

RGVME comment

A map of the presence/absence of VME indicator species in the Bay of Biscay would be useful.

Gulf of Cadiz

WGDEC response: A closure to bottom fishing is proposed to protect cold-seep ecosystems.

Basis: Several records of coldseep ecosystems and mud-volcanoes were obtained this year from the Gulf of Cadiz.

RGVME comment

WGDEC mentions that several records of coldseeps and mud-volcanoes are obtained. Are all of these records contained in the one recommended closure?

References: WGVME comments

On page 31 the reference to Roberts *et al*. (2013) was published earlier this year. Citation can be updated to: Roberts J. M. and shipboard party (2013) Changing Oceans Expedition 2012. RRS James Cook 073 Cruise Report. Heriot-Watt University. 224 pp.

On page 34 the reference to Puig *et al*. (2012) can be updated. Nature 489: 286–289.

Evaluate whether buffer zones applied in the current bottom fishing closures are appropriate

WGDEC Response: The buffer zone criterion, which is used to extend closures beyond the immediate estimated position of a VME indicator record, is appropriate and therefore adequate for the protection of VMEs in that area. Under some circumstances, for example, where the boundaries of closures are drawn according to VME elements, i.e. geomorphological features, rather than actual VME indicator records, a buffer zone may or may not be required depending on the assessed risk that bottom contact fishing poses.

Basis: The spatial extension of the buffer zone may vary and is based on the following considerations:

a) the potential for fishing gear to unintentionally stray into the area where the VME is located;

b) the VME and the site-specific seabed topography and bathymetry;

c) accuracy of the monitoring and enforcement method.

In relation to a) a 'rule-of-thumb' buffer zones for closures in areas where the seabed is between 200–500 m should be three times the water depth. At depths beyond 500 m a buffer zone of twice the depth should be appropriate. In the case of highly variable depths across a site (from 200 to over 500 m depth difference) the buffer zone on the upper and lower extents may vary accordingly. In relation to b) for VMEs that occur on flat or undulating seabeds and for which there is a high risk that a vessel engaged in bottom fishing practices nearby may unintentionally stray the gear inside the protected area a buffer zone as outlined above (the rule-of-thumb) is absolutely essential. In cases, where the risk of straying is mitigated by the fishermen's own incentive to avoid the steep slopes and cliff edges, a buffer zone may be reduced from the normal warp length/water depth rule of thumb. Buffer zones may still be required on the shoal-side of a steep-sided closure if the adjacent sediment is soft and readily disturbed by trawl gear. WGDEC does in some cases use the presence of geomorphological features or 'VME elements' such as the steep edges of seamounts to define boundaries for closures because of their tendency to be associated with VMEs. When this is the case and there is no direct evidence of VME indicators the boundary of closure is drawn to reflect the VME element and usually without a buffer zone. In relation to c) at present the buffer zone criteria applied by ICES WGDEC would require increasing the temporal resolution of VMS data (currently at two hour interval) to at least one hour to ensure the 'rule of thumb' adopted to generate buffer zones is appropriate.

RGVME comment

The section is well structured and covers several aspects of uncertainty which require the application of a buffer zone, including the uncertainty associated with the location of the vessel in relation to the VME and uncertainty associated with monitoring. With regards to Section 4.1.1 it is important to consider vessel speed, gear type, flotation and bathymetry and propose the most conservative estimate for the rule of thumb in relation to warp to depth ratio[2].

With regards to 4.1.3 it is stated that the proposed buffer zones would require a one hour interval for VMS reporting. It would be very useful to give an indication, how much the buffer zones would need to be extended for the current two hour VMS reporting requirement.

[2] We have added this comment as it seems that there are different rule of thumbs among different deep-water surveys- while there is a similar ratio reported by one of the reviewers (3:1 down to 200–300 m, and 2:1 further down to 1000–1200 m), another reviewer reported a ratio of 2: 1 from 1500 m onwards.

Assess whether NAFO'S list of VME indicator species is exhaustive, suggest possible addition to that list for NEAFC area and harmonize the species list for the two RAs

WGDEC Recommendation: Taxa should be considered by habitat type and/ or at the level of the taxonomic category of family rather than listing all the likely species that would be indicators of VMEs in the NEAFC area.

Table which lists seven broad VME types for the NE Atlantic with those taxa that will most likely be found in those habitats is provided in the WGDEC 2013 report.

There are some differences between NAFO and NEAFC. In NEAFC the following may represent VMEs: Cup corals; Coral gardens dominated by soft corals of the Family Nephtheidae; habitat forming structures based on Xenophyophores. In the NAFO area there are species that are less relevant than in NEAFC: A species of sea lily (crinoid) in the family Hyocrinidae; Bryozoan patches of the family Eucrateidae (*Eucratea loricata*).

Basis: WGDEC considers that it is not necessary to list all the likely species that would be indicators of VMEs in the NEAFC area.

- All the habitats listed in the table are likely to contain significant aggregations of the representative taxa, and those taxa will most commonly meet the criteria of long-lived, functional significance or fragility.
- In the NEAFC RA, there are several biogeographic provinces, whereas the NAFO RA comprises of just one. For the most part, the families in both areas are comparable; however, some species and families are not on the NAFO list.

RGVME comment

The overall approach taken can be fully supported. Here are some specific comments:

In Table 5.1 the colonial scleractinian *Solenosmilia variabilis* could have been included in the list of 'coral garden' VMEs under 'ii Colonial scleractinians on rocky outcrops'. However, I appreciate that this information was not available in the JNCC's draft report from Cross *et al*., 2013, see below.

On page 40, second bullet point there is a sentence that reads 'Again there is uncertainty about these species qualifying as VMEs, but until more information is available WGDEC takes a precautious stand and does not discount them as non-VME.' I lost count of the number of double negatives and suggest this is rephrased for clarity, especially for those for whom English is a second language. I think the final part of the sentence could read '… but until more information is available WGDEC takes a precautionary position and considers them as a potential VME.'

On page 53, note there needs to be a line-break between the section heading and the first paragraph.

RGVME comments on the species list

Under VME habitat types is listed:

I Hard-bottom gorgonian and black coral gardens'. No black corals (Antipatharia) are mentioned, but the table could be extended after Primoidae with: Schizopathidae, and the species *Stauropathes arctica*.

III Non-reefal Scleractinian aggregates: I recommend *Lophelia* being taken out.

Lophelia can be found sometimes as smaller 'lumps' but generally should be considered reef- or bankforming. Madrepora is found as smaller aggregations.

Soft-bottom coral gardens

Ii Cup-coral fields: Under Flabellidae can be added the species *Flabellum alabastrum*.

Iii Cauliflower coral fields. I recommend *Gersemia rubiformis* to be added (under family Neptheidae).

6. Mud and sand emergent fauna

Under Xenophyophora can be added Syringamminidae with the species *Syringammina fragillissima*.

Evaluate the appropriateness of applying the threshold levels for VME indicator species for longline fishing as adopted in the SEAFO, and CCAMLR, in the NEAFC RA

WGDEC Response: VME encounter definitions and threshold levels adopted for longline fisheries by SEAFO and CCAMLR are considered appropriate to longline fisheries in the NEAFC RA.

Specific measures that would comprise an equivalent longline regulation in the NEAFC RA are described in WGDEC 2013 report in detail, including definitions for VME indicator units, line segments and risk areas; vessel requirements and management actions.

Implementation would require more extensive observer coverage (beyond current requirements of new fisheries) and NEAFC may need to consider differentiating the measures by fishery or vessel category focusing on the larger, more industrialized component of this fishery.

Basis:

- Longlines can have significant cumulative adverse impacts.
- SEAFO and CCAMLR conservation measures potentially offer greater protection for VME's, by having to quantify VME indicator encounters as a certain number of 'VME indicator units' recovered from a defined segment of a longline set.
- Regulation requires issuing alerts when vessels send notifications of accumulated subthreshold bycatch of VME indicators, which creates an incentive to move to areas with less likelihood of encountering VME indicators and is therefore considered to be very proactive measure for protecting VMEs.

RGVME comment

This section is very well written and the recommendations are well founded and supported. The section goes beyond the request of advice for the application of SEAFO and CCAMLR threshold levels and reviews the actual measures that are applied in these two regulatory areas to protect against the adverse effects of longlining to VMEs. It further adapts the measures to the NEAFC RA and highlights potential problems such as limited observer coverage and the diversity of longline fisheries in the NEAFC RA.