ICES WGDEC REPORT 2014

ICES ADVISORY COMMITTEE

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Report of the ICES/NAFO Joint Working Group on Deep-water Ecology (WGDEC)

24–28 February 2014

Copenhagen, Denmark

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

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Executive summary

On 24th February 2014, the joint ICES/NAFO WGDEC, chaired by Neil Golding (UK) and attended by fifteen members met at the ICES Headquarters, Copenhagen 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. A significant number of new records were brought to the group this year totalling 7469, which now constitute 46% of records within the VME database. The new data were from a range of sources including fisheries surveys and seabed imagery surveys. For one area within the NEAFC Regulatory Area in the Southern Mid Atlantic Ridge, WGDEC made a recommendation for an extension to an area currently to be closed to bottom fisheries for the purposes of conservation of VMEs.

Within the NEAFC regulatory area the following areas were considered:

- **Josephine Seamount**: Additional historic VME indicator records were presented this year which supports the current ICES advice.
- **Southern Mid-Atlantic Ridge**: The group considered records of VME indicators on the Mid-Atlantic Ridge between the present NEAFC closure (Southern MAR) and the border with the Portuguese EEZ. A recommendation is made to extend the current NEAFC Southern MAR bottom fishing closure southwards.
- **Hatton Bank**: New information on longline bycatch of stony corals and gorgonians was available. No modification recommended to current closed area.
- **Rockall Bank**: New information from commercial fishery with observer, but no bycatch recorded.

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

- **East Rockall Bank**: Of particular interest to WGDEC was new information from a seabed imagery survey of the East Rockall slope, where *Lophelia pertusa* colonies were observed from one transect. No bottom fishing closure recommendations were made at this time.
- **Faroe-Shetland Channel**: New records of sponges (Geodia, *Axinellidae* and *Phakellia ventilabrum*) were presented from a seabed imagery in this area, indicative of the VME habitat Deep-sea sponge aggregations. No bottom fishing closure recommendations were made.
- **Bay of Biscay**: New records of VME indicators collected from 2009 to 2012 were considered by WGDEC. This submission accounted for over the half the new VME indicator records submitted this year. No bottom fishing closure recommendations were made.
- **Norway**: New records of VME indicators from seabed imagery surveys undertaken by the MAREANO project were submitted to WGDEC. No bottom fishing closure recommendations were made.
- **Faroe Islands**: New records of *Lophelia pertusa* from bottom trawling bycatch was made available; the weight was very low, and less than 1kg.

- **Greenland**: New records of sponges from *Geodia* genus were made available from bottom trawling bycatch; the weight was approximately 100kg, below the current threshold for sponges.

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

- **Flemish Cap and Grand Banks**: Records of VME indicator species caught as bycatch were reported to WGDEC. Weights were very low and no catches exceeded 1kg.

For the first time since 2006, WGDEC was able to analyse the spatial distribution of bottom fishing activity in the NEAFC Regulatory Area following submission of VMS-data from 2013 to ICES from NEAFC. After filtering for speed and bottom fishing gear types, WGDEC examined the general data distribution and also looked at some areas in greater detail, such as Hatton and Rockall Banks and the Mid-Atlantic Ridge.

WGDEC sought to develop a system that would formalise expert opinion and utilise as much relevant information from the ICES VME database. Historically, information on the presence of VME indicator species was plotted and expert opinion used to interpret the likelihood that the data indicate the presence of VMEs. A multi-criteria assessment (MCA) method was developed and trialled with information from within the current ICES VME database. The system currently developed goes some way to providing a simple means of assessing qualitatively different types of information on different types of VME indicator species. This weighting system will be further developed at WGDEC 2015.

WGDEC agreed an approach and format for collating records of multibeam bathymetric surveys with the NAFO and NEAFC RAs. There was an acknowledgement that there are many multibeam catalogues already in existence, so these should be utilised alongside any new records that are brought to WGDEC by its members.

WGDEC reviewed state-of-the-art of high resolution 'terrain-based models' for predicting VME distribution. It was noted that the emergence of large-scale multibeam derived high-resolution bathymetry surveys has provided practitioners with the means to greatly increase species distribution model resolution. Predictive modelling approaches to mapping offer one option in the application of the precautionary approach to identify areas where VMEs are known *or likely to occur.* As well as modelling presence or presence/absence, density/abundance based modelling approaches are also being developed, which will allow the identification of areas of high densities of VME indicator species and by inference VMEs. WGDEC concluded that peer reviewed predictive models of the distribution of VMEs or VME indicator species should be taken into consideration in management decisions regarding human use of the deep-sea ecosystem.

1 Opening of the meeting

WGDEC began discussions at 14:00 on February 24th 2014 at the ICES Headquarters in Copenhagen, Denmark. Deliberations primarily focused on what was being asked of the group by NEAFC, the EC and ICES. Following introductions, the opening discussion focused on assigning leads to each Terms of Reference, a review of the agenda for the week ahead and the identification of key issues for group discussion.

2 Adoption of the agenda

2013/2/ACOM28 **WGDEC terms of reference for the next meeting**

The ICES/NAFO Joint **Working Group on Deep-water Ecology** (WGDEC), Chaired by Neil Golding, UK, will meet on 24th–28th February 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; (NEAFC/EC request);

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.

WGDEC will report by 5 April for the attention of the Advisory Committee.

Supporting Information

Priority:	High as a Joint group with NAFO and is essential for feeding information to help answer external requests
Scientific justification and relation to action plan:	a) These maps are required to meet part of the European Commission MoU request to "provide any new information regarding the impact of fisheries on ..... sensitive habitats" and the NEAFC request " to continue 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." The location of newly discovered/mapped sensitive habitats is critical to these requests. It is essential that ICES/WG chair asks its Member Countries etc. to supply as much information that they may have on Hatton and Rockall fisheries distribution and "habitat catch" by one month in advance of the WGDEC meeting. Otherwise the answer to most of the sub-question will be "no data available to ICES" b) This is an important development of the VME database. Records within the VME database originate from a number of different sources; from specific targeted habitat mapping surveys with a high degree of spatial accuracy through to bycatch records from towed gear/longlining. Through developing a weighting system for these records, the information underpinning any new recommendations on closures, or modifications to existing closures, can be assessed and weighted based on reliability and significance. c) Following a request from NEAFC within the 2013 WGDEC ToR to map VME elements (e.g. geomorphological features), a catalogue of existing multibeam/swathe bathymetry data will be extremely valuable for the development of future WGDEC advice, with VME occurrences often associated with VME elements. d) High resolution 'terrain based models' are becoming more prevalent as a method of identifying potential VME occurrences in information being brought to the groups attention. The review will assess the provenance of data generated by these models, and how such data should be used by the group.
Resource requirements:	The usual helpful support from the Secretariat will be appreciated.
Participants:	The Group is normally attended by some 15–20 members and guests.
Secretariat facilities:	None.
Financial:	No financial implications.
Linkages to ACOM and its expert groups	ACOM is parent group. WGDEEP is related, but no explicit overlap in work this year.
Linkages to SCICOM and its expert groups	
Linkages to other organisations:	

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; (NEAFC/EC request)

3.1 Introduction

A significant amount of new data that indicate the presence of VMEs were submitted to ICES WGDEC in 2014 and these were incorporated into the ICES VME database; 7,469 records which constitutes a 46% proportion of all data within the 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 and Norway. Following discussion amongst the group, some minor revisions were agreed to the WGDEC VME database, and these are outlined in Annex 5 (Table 4 & 5). For the first time since 2006, data on fishing activity within the NEAFC RA for 2013 was provided by NEAFC for use by WGDEC; this is reported on at the end of this section.

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;

- Josephine Seamount
- Southern Mid-Atlantic Ridge
- Hatton Bank
- Rockall Bank

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

- East Rockall Bank
- Faroe-Shetland Channel
- Bay of Biscay
- Norway
- Faroe Islands
- Greenland

Areas considered within the NAFO RA include;

- Flemish Cap and Grand Banks

3.2 Areas within the NEAFC regulatory area

3.2.1 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 (VME Elements) that potentially support the species groups exemplified as VMEs (FAO guidelines, 2009).

Following a recommendation by WGDEC in 2013, ICES advised that a bottom fishing closure be placed around Josephine Seamount to protect these vulnerable habitats (i.e. VMEs) (ICES, 2013b).

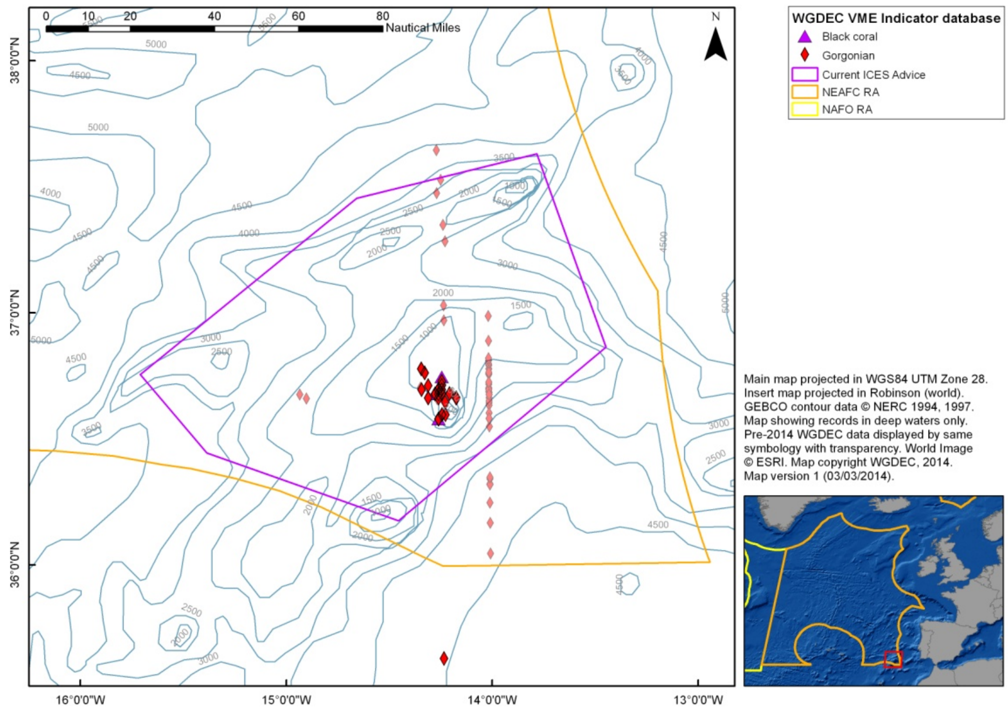

Figure 1. Map of Josephine Seamount showing the ICES advised closure to bottom fishing as a black line (June, 2013) and new 'historic' VME indicator records (bold) presented alongside existing data (transparent) for the Josephine Seamount area.

Additional VME indicator records were presented this year at WGDEC (Figure 1). These historic records from Josephine Seamount were from reports from the Prince Albert I of Monaco campaigns (Studer, 1901), Grasshoff (1972, 1977, 1985), Pasternak (1985). These records cover two species of black corals and eleven gorgonians from depths between 170 and 500 m. Most of these VME indictors are from between 200 and 300 m depth. The two gorgonians *Ellisella* (*Ctenocella*) *flagellum* and *Callogorgia verticillata* were dominant in terms of number of records. The geographic positioning should be considered as fairly coarse. These records support the ICES Advice (June, 2013) for a closure to bottom fishing being established.

WGDEC also had access to fishing activity data for 2013 from within the NEAFC Regulatory Area. This is discussed in Section 3.5.

3.2.2 Southern Mid-Atlantic Ridge (MAR)

The present bottom fishing closures on the Mid-Atlantic Ridge were established by NEAFC in 2009, following ICES evaluation. They were selected by NEAFC as three presumed representative ridge sections that, based on general information on bathymetry and depth distributions of VME indicators, were likely to contain VMEs.

Mapping of VME indicators on the Mid-Atlantic Ridge remains too limited to provide detailed advice on closure boundaries using current procedures adopted by WGDEC in areas with more observed VME indicator records. However in 2013, the Mid-Atlantic Ridge was recognized by WGDEC among features regarded as VME elements, hence the Group maintains the view that the reasoning underlying the establishment of the current bottom fishing closures on the Ridge remains appropriate.

This year, the group considered records of VME indicators on the Mid-Atlantic Ridge and noted occurrences of black corals, gorgonians, sea-pens and soft corals in the area between the present NEAFC closure (Southern MAR) and the border with the Portuguese EEZ (Figure 2). These are published observations from 2004 made by cameras on ROVs and bycatches in scientific bottom trawls (Mortensen *et al*., 2008). These records were available as the bottom fishing closures were introduced by NEAFC (2009) but not specifically used to configure the ridge segment selected as a closure at that time. The current procedure used by WGDEC to define closure proposals was not established at that time.

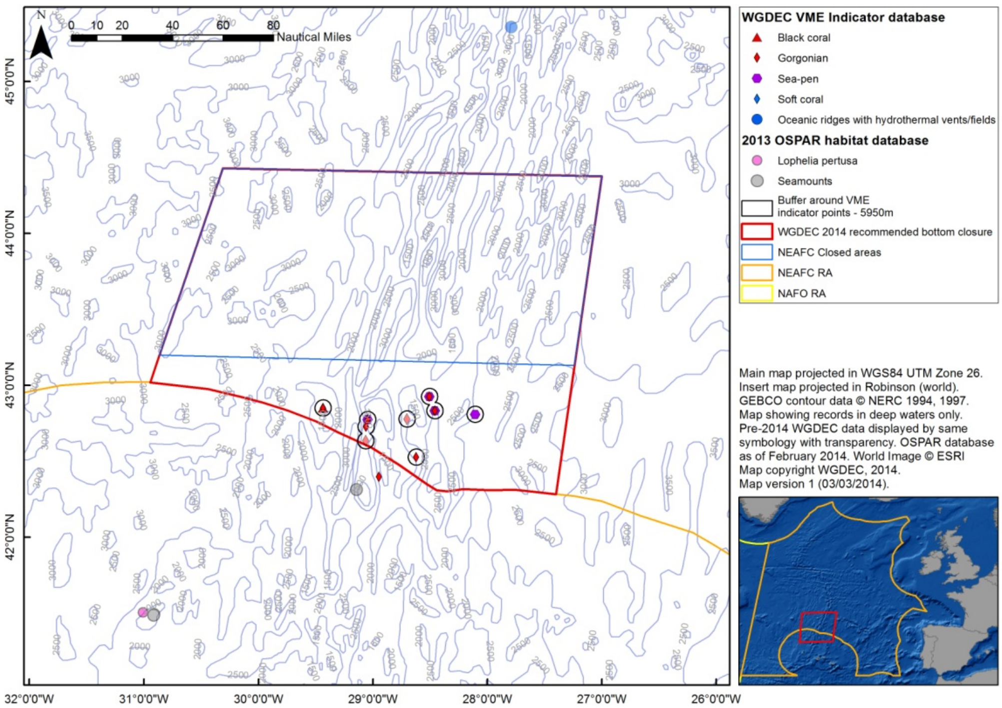

Figure 2. Map of Southern Mid-Atlantic Ridge showing the recommended bottom fishing closure extension in red, alongside the existing NEAFC closure in blue.

Even if there are no documented records within the current closure, it remains likely that distributions of the taxa observed to the south also extend into the closure and that WGDEC recommends that the current Southern MAR closure be maintained.

However, the records shown in Figure 2 document that aggregations of VME indicators occur beyond the present closure. To be consistent with current procedures, WGDEC therefore recommends an extension of the Southern MAR closure southwards to comprise the documented sites. Applying the established WGDEC procedure to delineate candidate bottom fishing closures (incl. the application of buffer zones), WGDEC recommends an extension of the Southern MAR closure to comprise the subarea of the MAR illustrated in Figure 2. Coordinates of the recommended closure modification are provided in Table 1.

Recommendation: to extend the current Southern MAR bottom fishing closure southwards as outlined in Figure 2 to include VME indicator records (Mortensen *et al.*, 2008).

Table 1. Coordinates of points for the recommended modification of the Southern Mid Atlantic Ridge bottom fishing closure.

POINT NUMBER	LATITUDE (N) (DMS)	LONGITUDE (W) (DMS)	LATITUDE (DECIMAL DEGREES)	LONGITUDE (DECIMAL DEGREES)
1	43° 3' 57.026"	31° 4' 19.428"	43.06584	-31.07206
2	44° 30' 0.000"	30° 30' 0.000"	44.50000	-30.50000
3	44° 30' 0.000"	27° 0' 0.000"	44.50000	-27.00000
4	42° 23' 57.514"	27° 24' 33.406"	42.39931	-27.40928
5	42° 24' 37.729"	27° 33' 56.230"	42.41048	-27.56562
6	42° 25' 39.397"	27° 46' 57.106"	42.42761	-27.78253
7	42° 25' 18.841"	27° 59' 16.870"	42.42190	-27.98802
8	42° 25' 39.397"	28° 14' 21.010"	42.42761	-28.23917
9	42° 24' 37.765"	28° 22' 34.174"	42.41049	-28.37616
10	42° 24' 58.321"	28° 28' 23.518"	42.41620	-28.47320
11	42° 27' 22.177"	28° 33' 42.010"	42.45616	-28.56167
12	42° 34' 54.337"	28° 49' 6.670"	42.58176	-28.81852
13	42° 41' 24.829"	29° 4' 10.774"	42.69023	-29.06966
14	42° 46' 53.653"	29° 21' 18.142"	42.78157	-29.35504
15	42° 51' 0.289"	29° 33' 37.834"	42.85008	-29.56051
16	42° 55' 6.925"	29° 49' 43.534"	42.91859	-29.82876
17	42° 57' 51.373"	30° 3' 4.822"	42.96427	-30.05134
18	42° 59' 36.205"	30° 13' 41.734"	42.99339	-30.22826
19	43° 2' 20.653"	30° 32' 52.258"	43.03907	-30.54785

3.2.3 Hatton Bank

Within the NEAFC regulatory area new data were available from observer records during Russian commercial long-lining just north of the current Hatton Bank closed area (Figure 3) in May 2013. There was bycatch of VME indicator species from between 58°05' N, 17°43' W and 58°05' N, 17°27' W at depths from 800–1300 m. The stony coral *Lophelia pertusa* (1.5 kg) and a gorgonian (*Keratoisis*) (1.0 kg) were caught (Vinnichenko, Kanishchev and Fomin 2014).

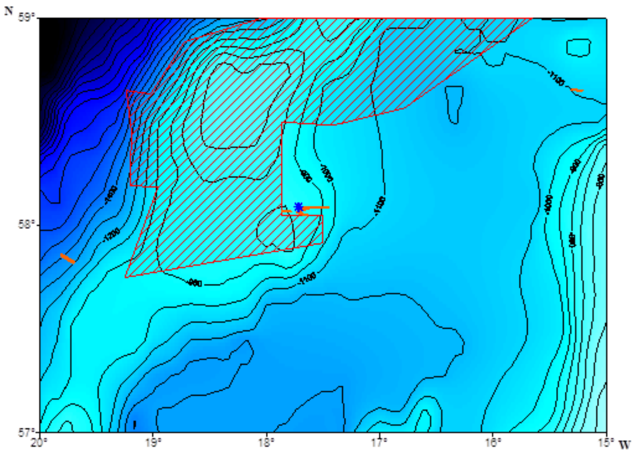

Figure 3. Longline sets (VMS data) of the Russian vessel with an observer aboard and occurrence of cold-water corals on the Hatton Bank in 2013 - tracks of longline sets, - corals, - closed areas.

3.2.4 Rockall Bank

There was a short-term (April 2013–May 2013) Russian bottom fishery with observer participation in international waters of the bank between 56°30'–57°15' N, 14°40'–15°30' W, at depths 250–650 m (Figure 4) using trawls and longlines. No observations of VME indicator species were recorded (Vinnichenko, Kanishchev and Fomin, 2014).

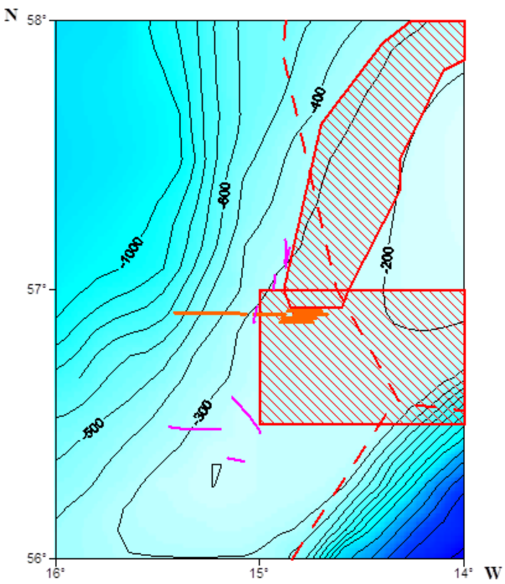

Figure 4. Tracks of hauls and longline sets (VMS data) of the Russian vessels with observers aboard on the Rockall Bank in 2013 - haul tracks, - longline set tracks, - boundary of 200-mile zone, - closed areas.

3.2.5 Other new records of VME indicators

Plymouth University's Marine Biology and Ecology Research Centre have reanalysed existing deep-water survey data spanning both NEAFC RA and the UK EEZ regions to identify occurrence of the stony coral *Solenosmilia variabilis*. The work has revealed the occurrence of the species on George Bligh Bank from the 2005 DTI cruise; on Anton Dohrn seamount from the 2009 JNCC-DTI survey; within the Hatton-Rockall Basin from stills captured on the 2011 JC060 NERC cruise; and on the Hebrides Terrace Seamount from 2012 footage from JC073 NERC cruise.

3.3 Areas within EEZs of states or unions

3.3.1 East 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 where bottom fisheries are regulated by NEAFC. An area in the NW of Rockall Bank has been closed to bottom fishing since 2007. ICES advised a boundary modification to this bottom fishing closure in 2012, and reiterated this advice in 2013 (ICES, June 2013).

A research cruise was undertaken in 2013 by Marine Scotland Science over Rockall Bank, Rosemary Bank Seamount and areas of the Hebridean continental slope. VME indicators were observed during towed video transects and from trawl survey bycatch. Of particular interest to the Group were towed video transects completed on the East Rockall slopes. In this area four towed video transects were completed at depths ranging from approximately 250 m down to 950 m (Figure 5). The shallowest transect revealed significant coverage of *Lophelia pertusa* colonies along the transect.

WGDEC do not recommend a new bottom fishing closure to encompass these records at this time. However, WGDEC does recommend that ICES advice from 2013 (ICES, June 2013) is maintained.

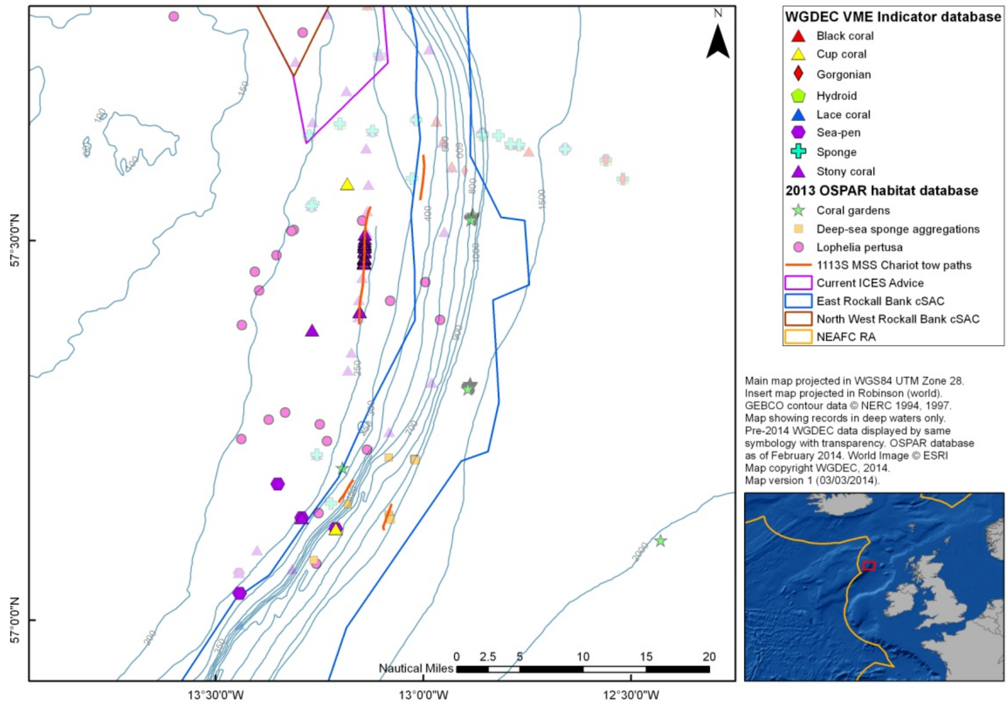

Figure 5. Map of the northeastern area of Rockall Bank showing video transects (red lines) and occurrence of *Lophelia pertusa* colonies along the shallowest transect in the centre of the map at approximately 250 m water depth.

3.3.2 Faroe-Shetland Channel

There are several historic records of deep-sea sponge aggregations on the margin of the Faroe-Shetland Channel running SW–NE. A dedicated survey lead by the JNCC aboard the FRV Scotia in October and November 2012 to the Wyville Thomson Ridge Site of Community Importance (WTR SCI) and the Faroe Shetland Sponge Belt possible Nature Conservation Marine Protected Area (FSS pMPA) was carried out to increase the evidence base for these areas. 29 towed video transects were completed in the WTR SCI amounting to 17.6 km surveyed. 32 towed video transects were completed along the 500 m contour of the Faroe Shetland Channel, amounting to 31.4 km surveyed (Figure 6). Photographic imagery was collected to identify the habitats and biological communities present within the survey areas. Cup corals, gorgonians, hydroids, soft corals, sponges and stony corals were all observed on WTR. In particular, further records of *Lophelia pertusa*, *Madrepora oculata* and axinellid sponges were observed. The latter are considered to be indicators of hard-bottom sponge gardens.

Sponges were the dominant VME indicator along the Faroe Shetland Channel, which were the objective of the video transects. Moving northeast among the survey stations revealed an increasing abundance of deep-sea sponges (Geodia, *Axinellidae* and *Phakellia ventilabrum*) indicative of the VME habitat Deep-sea sponge aggregations; potentially the subtypes Ostur sponge aggregations and Hard-bottom sponge gardens.

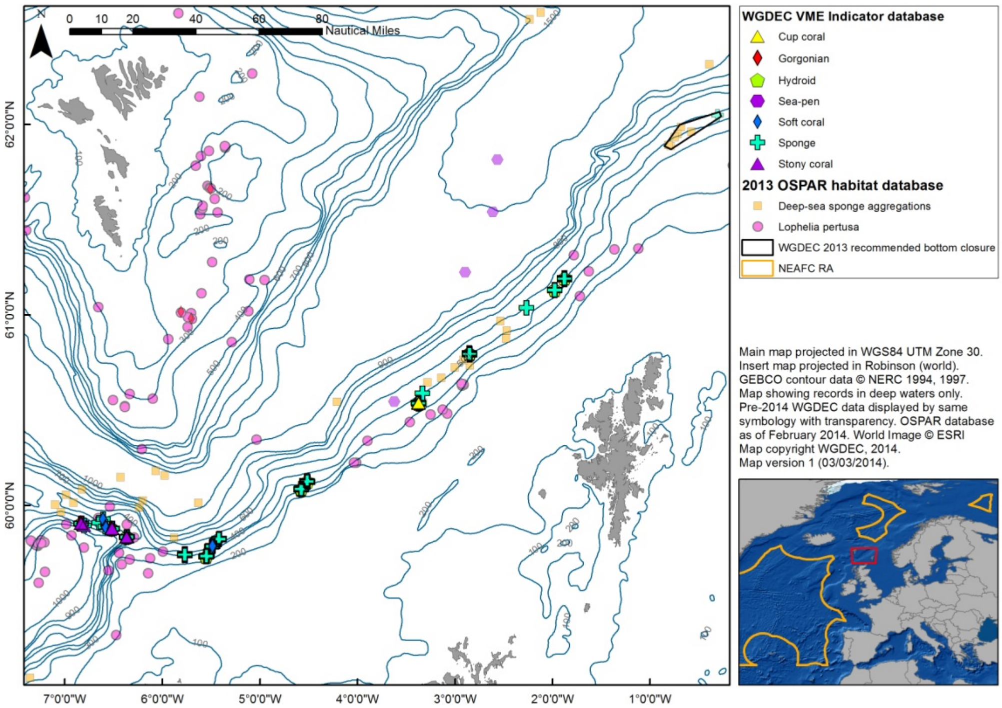

Figure 6. Map of the Wyville Thomson Ridge and Faroe Shetland Channel showing new VME indicator records from a JNCC survey in 2012.

3.3.3 Bay of Biscay

Within the framework of the EU-funded project CoralFISH and to comply with the Marine Strategy Framework Directive, Ifremer has undertaken an exploration of the deep-sea canyons of the Bay of Biscay with a focus on cold-water coral habitats.

The dataset submitted (Figure 7) provides the occurrences of cold-water coral habitats and deep-sea sponge communities in 19 canyons of the Bay of Biscay. Data were gathered along photo or video transects during six cruises between 2009 and 2012. Video transects were conducted with the ROV Victor6000 during the BobEco cruise while photo transects were conducted with the towed camera SCAMPI (BobGeo 1 and 2; Evhoe 2010, 2011, 2012). A total linear distance of 296 km has been covered by these video/still transects.

Along each transect, images were taken with a period of 30 to 60 seconds, either from the towed camera or frame grabs of the ROV videos. Images were quality-controlled for altitude and image quality (focus, visibility) before analysis. For each image complying with the quality control, the habitat was defined according to the CoralFISH classification of cold-water coral habitats. In addition VME indicator species were identified down to the lowest possible taxonomic resolution.

In the present dataset, CoralFISH habitats and species were assigned to the WGDEC list of VME indicators. The occurrences of VME indicator species represent a total of 4291 records.

VME indicator species occur in all canyons of the Bay of Biscay explored so far although the distribution of scleractinian cold-water coral habitats is skewed towards the northern half of the Bay. The exploration of the canyons was guided by historical data, dating back to the 19th to mid-20th centuries. In many cases, historical records of *Lophelia pertusa* reefs turned out to be coral rubble. In the present dataset, live and dead coral reefs as well as coral rubble were merged into the Stony coral group. It should be noted that in the Bay of Biscay *Lophelia pertusa* co-occurs with *Madrepora oculata*. Coral reefs are built by both species, which are, in many cases difficult to distinguish from images.

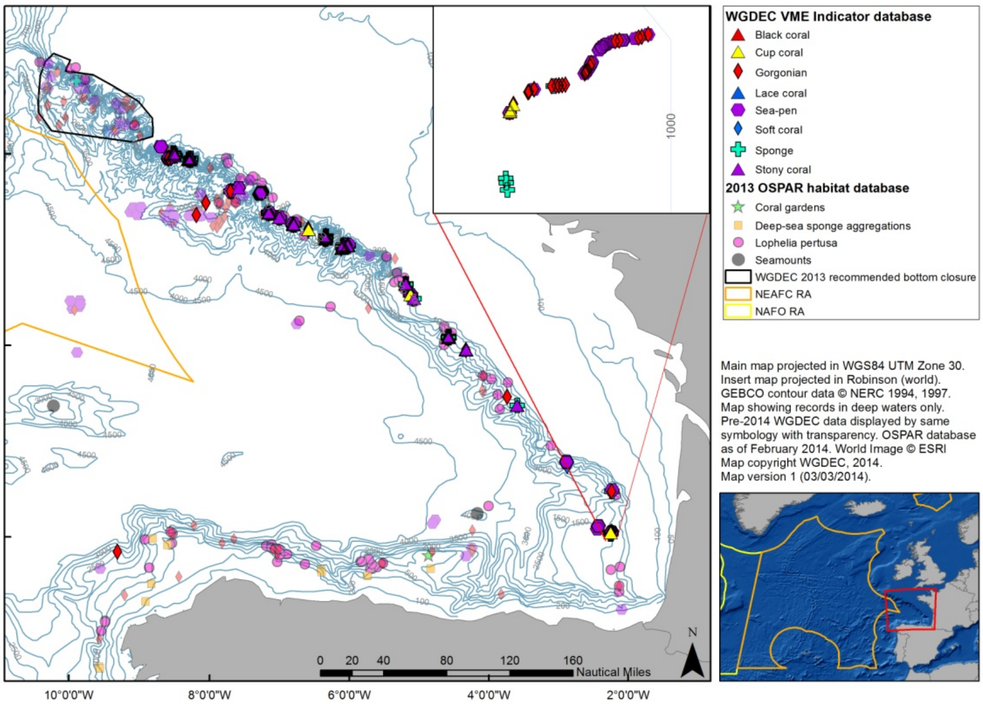

Figure 7. Map of the Bay of Biscay illustrating new VME indicator records from Ifremer in the context of existing information for the region.

3.3.4 Norwegian waters

The MAREANO project has mapped depth and topography, sediment composition, biodiversity, habitats and biotopes as well as pollution in the seabed in Norwegian coastal and offshore areas. Since 2006, 1290 locations have been visited across a survey area of 130 000 km^2. Each location is represented by a 70 m long video transect. At a quarter of the locations the seabed is additionally sampled with different gears to document species not possible to identify on video, and to estimate biomass and production.

The video recording provides results from observations made during the recording in the field and from detailed analyses later in the laboratory. With respect to VMEs and VME indicators, MAREANO has here provided point observations of VME indicators observed in the field (Figure 8). These field records represent the points of first observation of species within 230 m sections along the video transects.

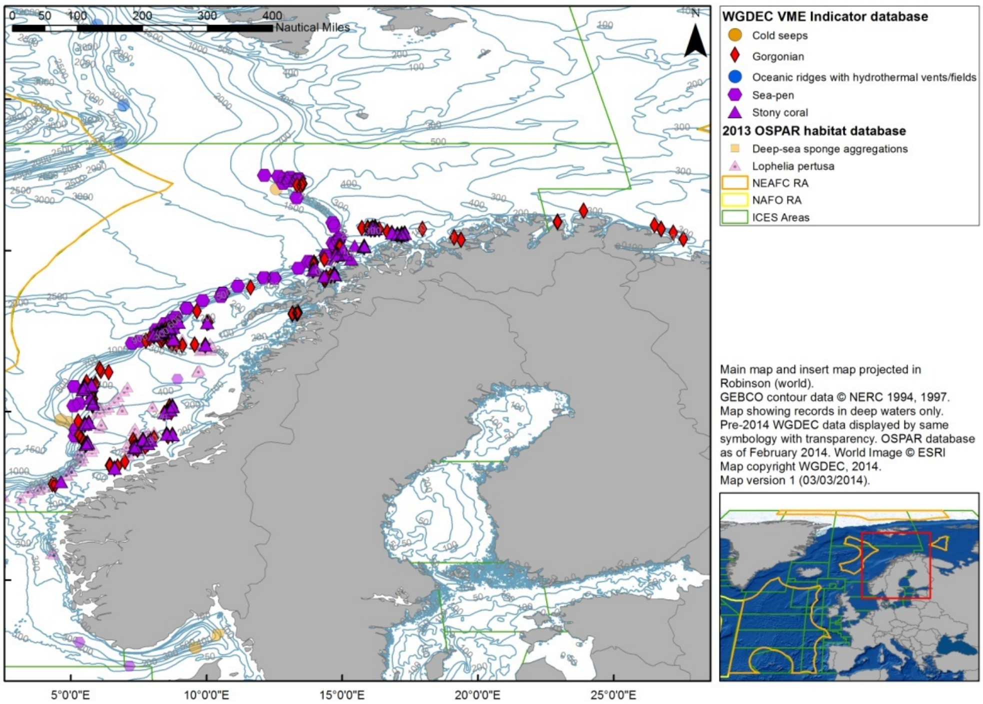

Figure 8. Map of the Norwegian waters illustrating the data submitted to WGDEC from the MAREANO project.

3.3.5 Faroe Islands

Within the Faroese EEZ a single observation of *Lophelia pertusa* was made from onboard a Russian bottom trawler fishing in April–May 2013 on the slopes of the Louzy and Bill Baileys Banks (Figure 9). When hauling between 60°57' N, 11°05' W and 60°56' N, 10°42' W, at 590–630 m water depth, a catch of *Lophelia pertusa* weighting less than 1 kg was recorded. The other catches did not contain any VME indicator species. (Vinnichenko, Kanishchev and Fomin, 2014).

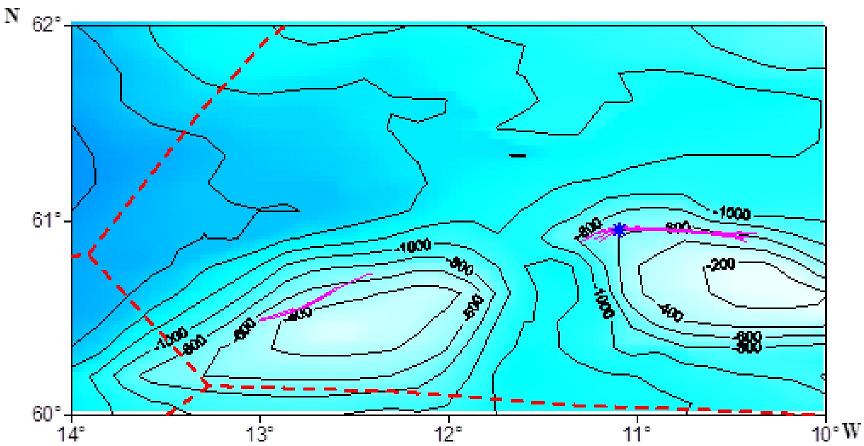

Figure 9. Haul tracks (VMS data) of the Russian vessel with an observer aboard and occurrence of cold-water corals in the Faroese Fishing Zone in 2013 —- haul tracks, ✱ - corals, ( ) - boundary of 200-mile zone.

3.3.6 Greenland

The group received information on the Russian halibut fishery with observer participation in Divisions 1C/D (63°40'–64°30' N, 54°57'–57°58' W), at the 800–1300 m depths (Figure 10) in July–October 2013. When trawling between 64°22' N, 54°57' W and 64°28' N, 55°14' W at 831–900 m depth, one catch contained approximately 100 kg of sponges from *Geodia* genus (Vinnichenko, Kanishchev and Fomin, 2014). VME species indicators were not found in the other catches taken there, as well as in Division 1A between 69°15'–70°05' N, 58°54'–60°59' W, at 700–1300 m depths (Figure 11).

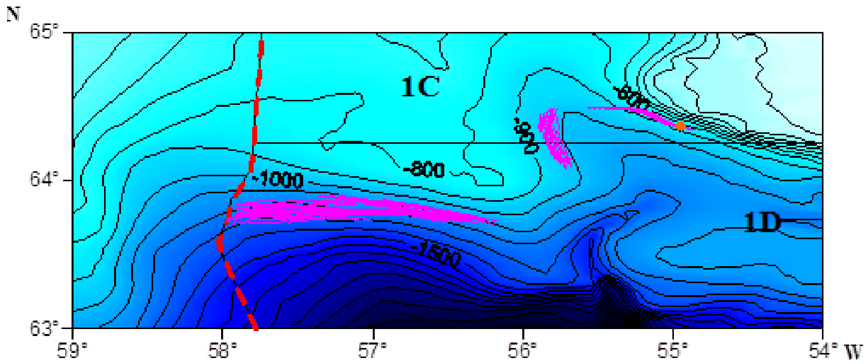

Figure 10. Haul tracks (VMS data) of the Russian vessel with an observer aboard and occurrence of sponges in Divisions 1CD of the West Greenland in 2013 —— - haul tracks, ● - sponges, ( ) - boundary of 200-mile zone.

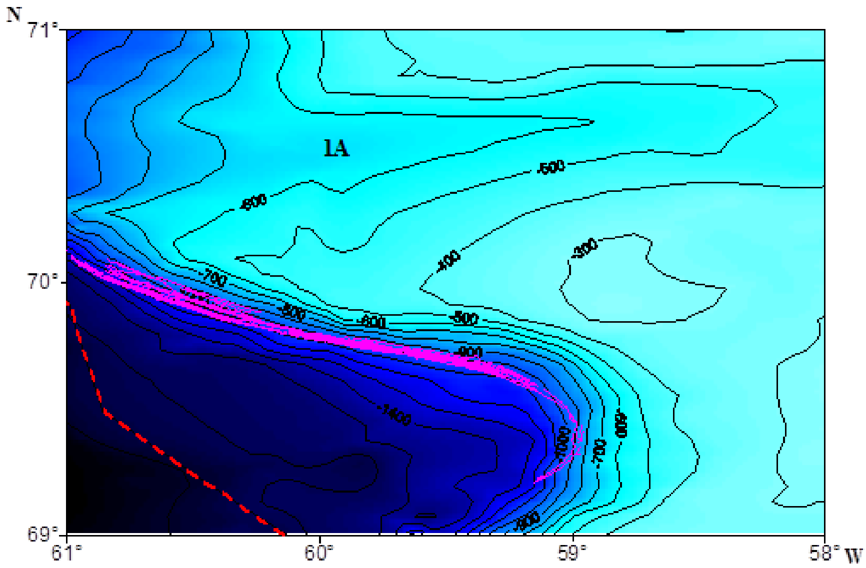

Figure 11. Haul tracks (VMS data) of the Russian vessel with an observer aboard in Division 1A of the West Greenland in 2013 —— - haul tracks, ( ) - boundary of 200-mile zone.

In August–September 2013, bottom trawling was conducted by a Russian trawler with observer onboard in an area bounded by 62°08'–63°29' N, 37°28'–40°46' W, within the depth range of 950–1200 m (Figure 12). No VME indicators species were recorded (Vinnichenko, Kanishchev and Fomin, 2014).

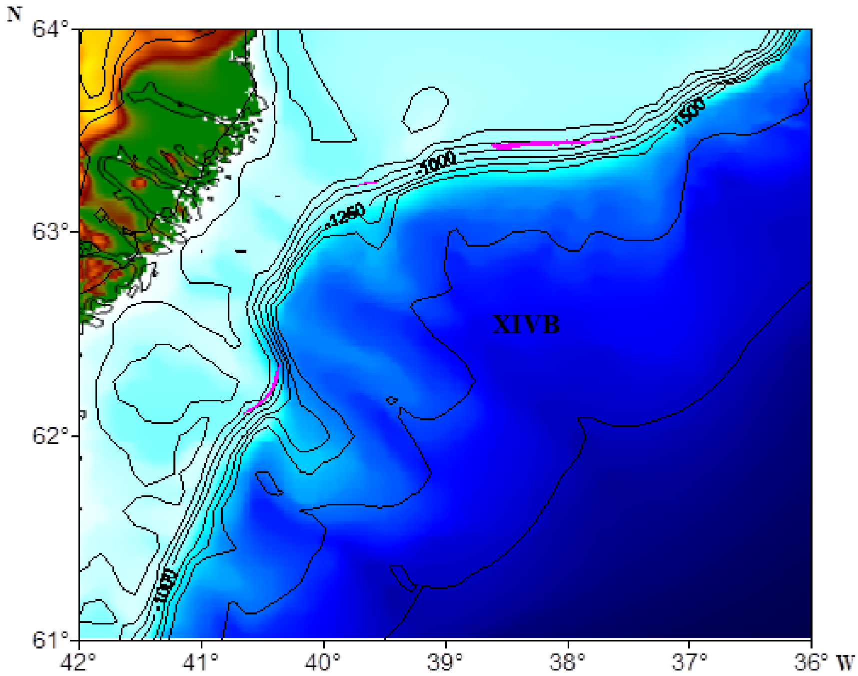

Figure 12. Haul tracks (VMS data) of the Russian vessel with an observer aboard in the East Greenland in 2013 —— - haul tracks.

3.4 Areas within NAFO regulatory area

Russian bycatch data from commercial trawling in the Flemish cap area was submitted to the Group this year (Figure 13). Data on VME indicator species were collected by Russian observers during four surveys of fishing vessels (Vinnichenko, Kanishchev and Fomin, 2014). The observations were conducted on the Flemish Cap, Flemish Pass and the Grand Banks (Subareas 3LMNO) in January–November 2013.

Bottom trawlings were conducted in an area bounded by 42°50'–48°52' N and 44°10'–51°41' W in the depth range 170–1145 m (Figure 13). Small numbers of cold-water corals were recorded all over the studied area except for the southwestern slope of the Grand Banks, where they were not observed. In the catches eleven species from three orders, *Alcyonacea, Antipatharia* and *Pennatulacea,* were found, among them *Anthoptilum* spp., *Duva florida, Nephtheidae* spp., *Pennatula aculeata* and *Pennatula borealis* prevailed. In addition, few numbers of *Anthomastus* spp., *Gersemia* spp., *Halipteris* spp., *Radicipes gracilis*, *Stauropathes arctica* and *Pennatula phosphorea* have been observed. In some parts of the Flemish Cap, within the 230–400 m depth range, sponges were captured beside corals (Figure 13). In the catches 16 species were found among which *Phakellia* spp. and *Lophon piceum,* as well as *Polymastia* spp. and *Homaxinella* spp. predominated. The capture of VME indicators did not exceed 1 kg per haul at all locations (Vinnichenko, Kanishchev and Fomin, 2014).

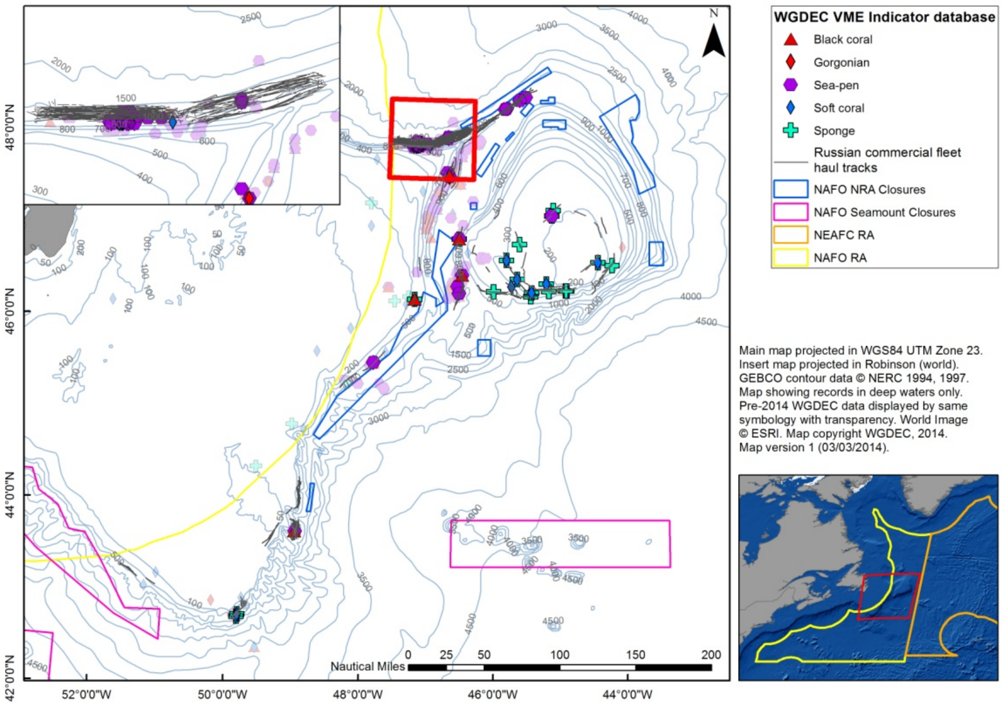

Figure 13. Map of the Flemish cap area showing VME indicator data observed from Russian commercial trawls in 2013.

3.5 VMS data submission from NEAFC for 2013

3.5.1 Background

In a first attempt to analyse the spatial distribution of bottom fishing activity in the NEAFC Regulatory Area, WGDEC utilized VMS-data from 2013 received by ICES from NEAFC. The dataset comprised raw data, i.e. all records received from all fishing vessels that operated in the Regulatory Area (RA) in 2013, hence filtering was necessary to achieve relevant data for vessel categories conducting fisheries with bottom-touching fishing gear. The following gear codes were selected for bottom trawling (Beam Trawl (TBB), Bottom Otter Trawl (OTB), Bottom Pair Trawl (PTB) and Multi-rig Otter Trawl (OTT)) and longlining (Long Line Static; LLS). To exclude records transmitted during steaming between fishing areas, speed filters were applied, accepting only records indicating speeds between 1 and 4 knots for trawlers and less than 5 knots for longliners. Records from areas with bottom depth exceeding 2000 m, i.e. the current maximum depth of bottom fishing, were also excluded. The vast majority of records were from trawlers of various categories, and it was a concern that filtering by gear using trawl gear codes given in the dataset did not seem to provide a fully reliable dataset. This may reflect that some miscoding has occurred, and the Group would propose that co-operative efforts between ICES and NEAFC is established to develop filtering techniques to achieve an improved dataset representing bottom fisheries only.

As expected, fishing activity is very unevenly distributed. WGDEC considered certain subareas of particular concern, i.e. subareas where bottom fishing closures have been established or proposed to protect VMEs. Layers showing closures (including the 'Haddock box') and the 'existing fishing areas' were added to maps of the VMS records. The overall Northeast Atlantic map for bottom trawling (Figure 14) and static longlining (Figure 15) and the detailed maps shown further below comprise all data that according to the gear codes represent bottom trawling.

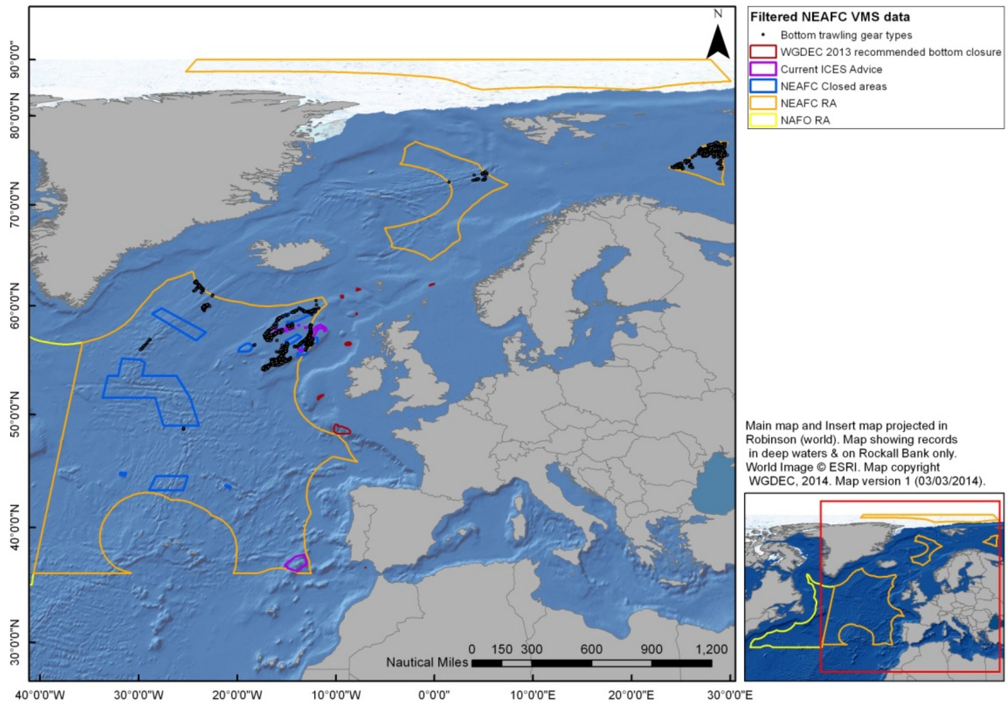

Figure 14. Map showing 2013 NEAFC VMS data for bottom-trawling gear types across the NEAFC area (note that records deeper than 2000 m have been excluded).

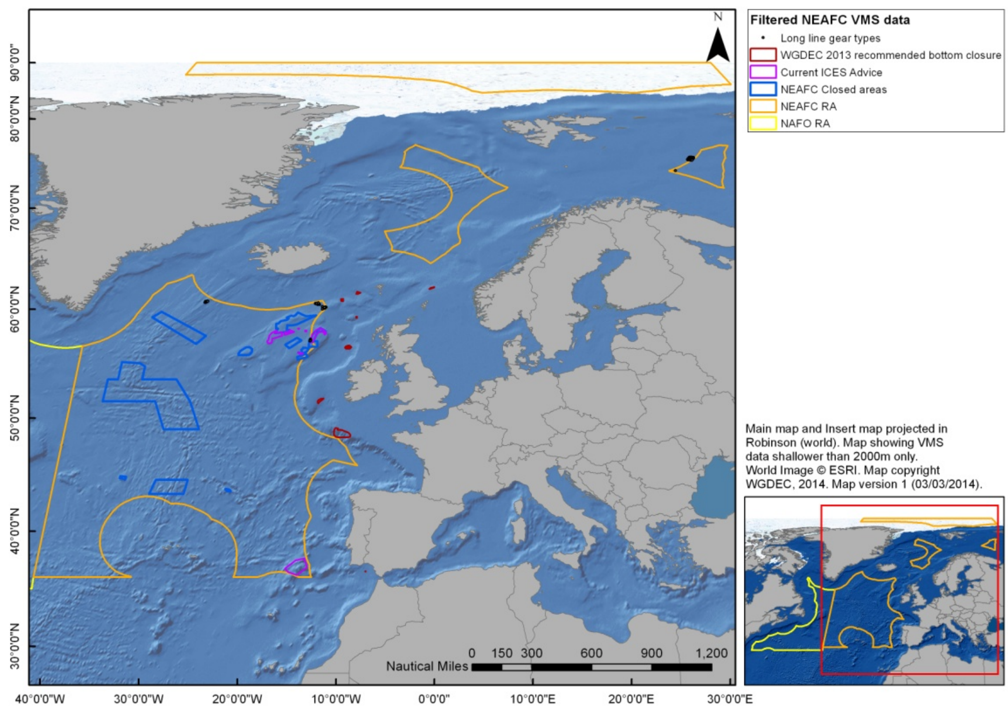

Figure 15. Map showing 2013 NEAFC VMS data for static longline gear types across the NEAFC area.

3.5.2 Hatton and Rockall Banks

The NEAFC VMS data in Figure 16 show fishing activity around the features that are closed, and also within the subareas on SW Hatton advised by ICES in June, 2013 (ICES, 2013b) as an extended bottom fishing closure.

Most of the activity appears to be restricted to ‘existing fishing areas’, yet in some areas there also appears to be fishing between such areas.

There also appears to be bottom trawling in the ‘Haddock box’.

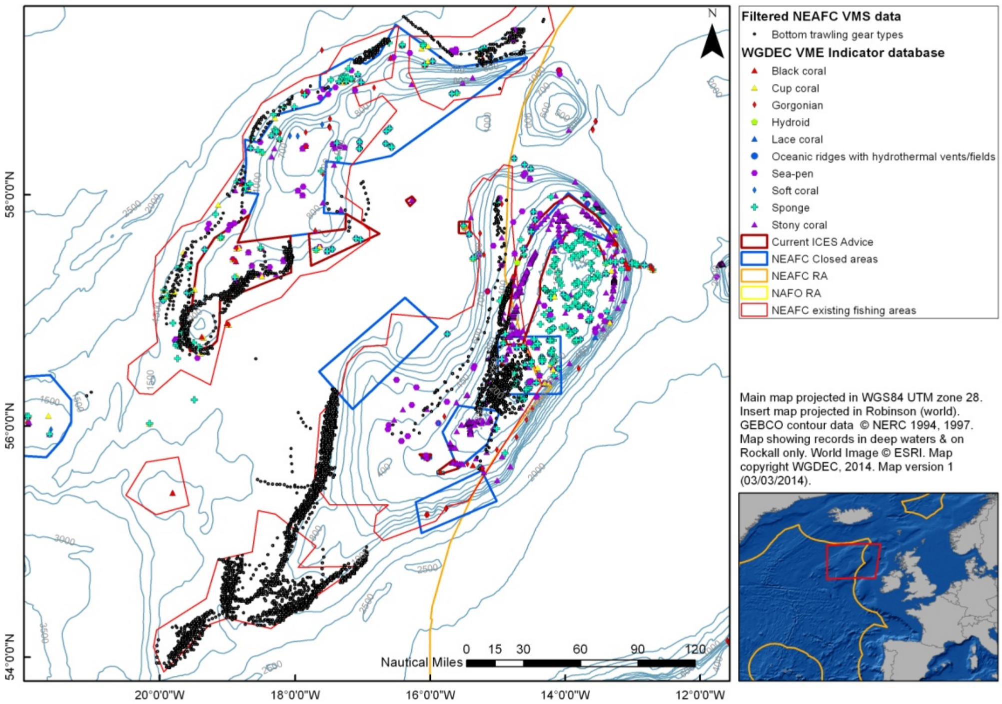

Figure 16. More detailed map showing 2013 NEAFC VMS data (filtered for bottom-trawl gears and excluding points deeper than 2000 m) across Hatton and Rockall Bank. Existing NEAFC fishing areas are highlighted in orange.

3.5.3 Mid-Atlantic Ridge (Reykjanes Ridge)

The data (Figure 17) suggests that rather extensive bottom trawling occurs in two areas on the Reykjanes Ridge. The Group could not determine if these records are valid bottom fishing records, but were concerned that they might represent miscoded records of midwater trawling for redfish and roundnose grenadier. ICES is certainly aware of the redfish fisheries with midwater trawls on the western flank of the Reykjanes Ridge, and also the recent development of a midwater trawl fishery for roundnose grenadier in the Reykjanes Ridge to the southeast of Iceland (ICES, 2013a)

All this activity is recorded in ‘new fishing areas’. The Mid-Atlantic Ridge is regarded by ICES as having VME elements; hence extensive bottom fishing in the area may cause significant adverse impacts on likely VMEs.

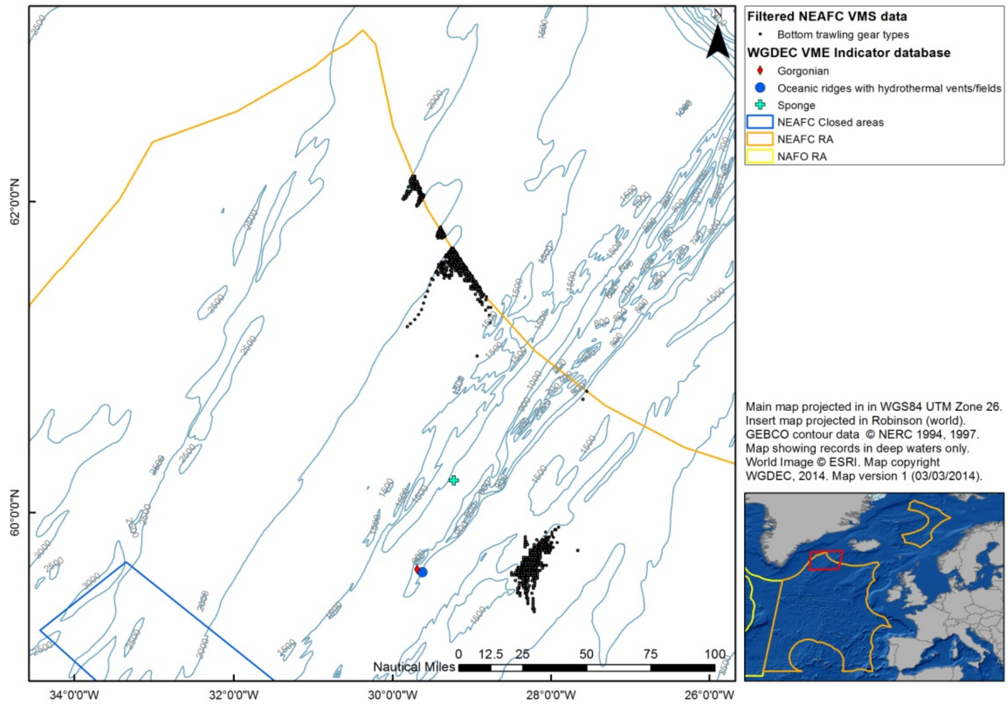

Figure 17. More detailed map showing 2013 NEAFC VMS data (filtered for bottom-trawl gears and excluding points deeper than 2000 m) across the northern section of the Mid-Atlantic Ridge.

3.5.4 Josephine Seamount

The shallower subarea of the Josephine Seamount is currently a NEAFC 'existing fishing area', i.e. open to bottom fishing. In 2013 ICES advised that the entire seamount and adjacent areas be closed to bottom fishing (ICES, 2013b). The basis of this advice was documented records of VME indicators, primarily gorgonian corals.

The VMS data from 2013 showed no records of bottom fishing activity within the proposed closure area on Josephine Seamount.

3.6 References

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4 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

4.1 Introduction

In the past ICES has presented much of its advice on vulnerable marine ecosystems (VMEs) in the format of maps. Information on the presence of VME indicator species is plotted and expert opinion is used to interpret the likelihood that the data indicate the presence of VMEs. If necessary, advice on spatial protection measures such as areas closed to bottom fishing is presented. A range of ancillary information such as estimates of the amount of VME, the type of survey method and whether the specimen was alive or dead are considered in this process. This expert opinion is usually summarized in the text of the report to justify the reasoning behind the interpretation of the data; however, it is not always obvious how it specifically relates to the data and hence can appear to be inconsistent. ICES WGDEC therefore sought to develop a system that would formalize expert opinion and utilize as much relevant information as possible from the ICES VME database. The aim was to produce an index that could be used to evaluate the likelihood of how representative a data point is of the presence of a VME.

Multi-criteria assessment (MCA) is a method of aggregating data on different criteria or attributes that contain information relevant to the decision and weighting these to provide a single metric that consolidates all this information. Although most widely used in economic decision-making, MCA can be readily applied to other decision-making problems and was considered in its simplest form as a useful tool to address this term of reference. The essential feature of MCA is the development of a matrix in which the performance of the data is weighted against each criterion (e.g. the survey method) and from which an aggregate value is derived. MCA has the following advantages over informal judgement;

- it is open and explicit and the scores and weights used provide an audit trail;
- the choice of criteria are open to analysis and to change if they are felt to be inappropriate;
- scores and weights can be cross-referenced to other sources of information and amended if necessary; and
- it can improve understanding and communication within the decision-making body and between that body and the wider community, for example, the client for which advice is being provided.

4.2 Application of Multi-criteria assessment (MCA) to the ICES VME data

The ICES VME database is currently comprised of approximately 8000 records of VME indicator species. Some records are *bona fide* VMEs such as recent ROV video footage of the large *Lophelia* reefs off Norway. For others there are varying levels of uncertainty, for example, scientific trawl survey bycatch records are associated with lower confidence and non-validated information from commercial fishing operations lower still. MCA seeks to establish which criteria are informative with respect to confidence, rank these main criteria and then assign a score to that criteria based upon the information available. The assignment of weights and scores is somewhat arbitrary. An important feature is that weights applied to criteria must sum to 100 and the scores assigned to each of the subcriteria (e.g. survey method) cannot exceed the weight applied to the main criteria.

In the case of the VME indicators four main criteria were agreed by WGDEC and ranked as follows;

1) Survey Method
2) Volume of Material
3) Date of observation
4) Whether the specimen was dead or alive

The survey method was considered to be the highest ranked in terms of assessing confidence in the data and assigned a weight of 40. Within the criterion 'Survey Method', six categories were ranked in terms of importance;

1) Visual survey – any form of video (ROV, towed camera, drop-frame, AUV, etc.). Spatial precision is usually very good and normally scientifically validated. This category receives the maximum weighting, i.e. 40.
2) Benthic sampler – any type of specifically targeted benthic sampling, e.g. grab, boxcorer. Spatial precision is usually good and samples are normally scientifically validated. This category receives the next highest weighting, i.e. 30.
3) Acoustic – for example, data from multibeam echosounders or sidescan sonar. Spatial precision is generally good. However, the method is only reliable at detecting certain VMEs, e.g. Lophelia reefs, at vertical distances of less than 500 m. The method is very reliable to detect bathymetrical features related with VMEs (FAO, 2009), such as pinnacles, outcrops, mounds, etc., as well as sedimentary areas where certain VMEs (e.g. reefs) are unlikely to occur. This category receives the next highest weighting, i.e. 20.
4) Bycatch from fishing gear from either scientific surveys or commercial vessels (nets or longlines) that have been validated by either scientists or trained observers. There are several sources of uncertainty with all bycatch data such as catch retention and spatial accuracy. The spatial accuracy in scientific surveys is a minor problem due the monitoring and short duration of the scientific hauls. The main source of uncertainly is the catchability of VMEs indicator species. With data derived from bycatch from fishing gear of commercial vessels (nets or longlines) there is greater uncertainty that arises from the spatial inaccuracy associated with long duration of fishing hauls. This category receives a relatively low weighting, i.e. 10.
5) Bycatch from commercial vessels that has not been validated by trained observers. This category receives a lower weighting, i.e. 5.
6) Unknown – there is no information on survey methods. This category receives the lowest weighting, i.e. 3.

The volume of material was considered the next highest ranked criterion and was assigned a weight of 30. Within this criterion three categories were weighted in terms of importance;

1) If the weight of bycatch was greater than the current threshold for cold-water stony corals (30 kg) or sponges (200 kg) a weighting of 30 was applied. For seapens, gorgonians and black corals for which no agreed threshold values have been derived, 1 kg of bycatch was considered sufficient for a maximum weighting to be applied.
2) If the weight of bycatch was less than these threshold values or if no information was available on the volume of material (e.g. visual surveys) a weighting of 10 was applied.

The date of observation was ranked next and was assigned a weight of 15. Within this criterion two categories were weighted;

1) If the record was recorded less than ten years ago it received a weight of 15.
2) If it recorded more than ten years ago or the observation date was unknown it received a weight of 5.

The final criterion and that of lowest ranking was whether the VME indicator record was dead or alive. This was given a weighting of 10.

1) If there was information that the species was alive, it was weighted as 10.
2) If the species was dead or was unknown then it was weighted as 5.

Following consultation within WGDEC a matrix was constructed (Table 2). To illustrate how the weighting system works consider the four hypothetical examples (1 to 4) in Table 2. Sample 1 is a recent visual observation from ROV of a *Lophelia* reef. It scores highly in all criteria except the volume of material because this cannot be estimated directly and is treated as unknown. It is given an overall value of 75. Sample 2 is recent and 'above threshold' (>30 kg) bycatch of *Lophelia* from a scientific trawl survey. While it scores low on survey method, it scores high on all other criteria giving an overall value of 70. Sample 3 is an old coral bycatch record that was below threshold from a scientific observer aboard a commercial fishing vessel. Its scores an intermediate value of 40. Sample 4 is an old coral bycatch record derived from a commercial fishing vessel without independent scientific validation. It scores lower than all the rest.

Table 2. Example of a multi-criteria assessment (MCA) matrix. Acoustic criteria to detect VMEs features were not used.

Relevant criteria	Rank	Group Weight	within group weight	Sample 1	Sample 2	Sample 3	Sample 4
Survey Method	**1**	**40**	**(max = 40)**	Score 1	Score 2	Score 3	Score 4
Visual	1		40	40			
Benthic	2		30				
Acoustic	3		20				
By-catch - research validated	4		10		10	10	
By-catch - fishermen	5		5				5
unknown	6		3				
Volume of material	**2**	**35**	**(max = 35)**				
> VME threshold	1		35		35		
< VME threshold or unknown	2		10	10		10	10
Date of observation	**3**	**15**	**(max = 15)**				
< 10 years ago	1		15	15	15		
> 10 years ago or unknown	2		5			10	10
Live/Dead	**4**	**10**	**(max = 10)**				
Live	1		10	10	10	10	
Dead/unknown	2		5				5
Overall score		**100**		**75**	**70**	**40**	**30**

Implementation of the MCA was done through the application of an SQL algorithm that assigned weighted values to each data record in the ICES VME database that belonged to the following VME indicator categories; Black coral, Gorgonian, Lace coral, Seapen, Sponge and Stony coral. The MCA was not appropriate to the other categories of VME indicators and so they were left unranked (but still considered valid data observations).

4.3 Results

The performance of the weighting criteria was assessed by plotting the results in ARC GIS and inspecting these with respect to the original data and expert judgment. The results for the Hatton-Bank-West Rockall area are shown in Figure 18. It is useful to compare this to the previous way of presenting the same unweighted data by species (Figure 19). The weighting method clearly identifies those records where confidence is high that there is a strong likelihood of the presence of VME, for example, large bycatch of sponges in the Hatton Basin area, areas of where gorgonians were bycaught in the SW area and the visual records of live *Lophelia* reefs in the NW Rockall closure.

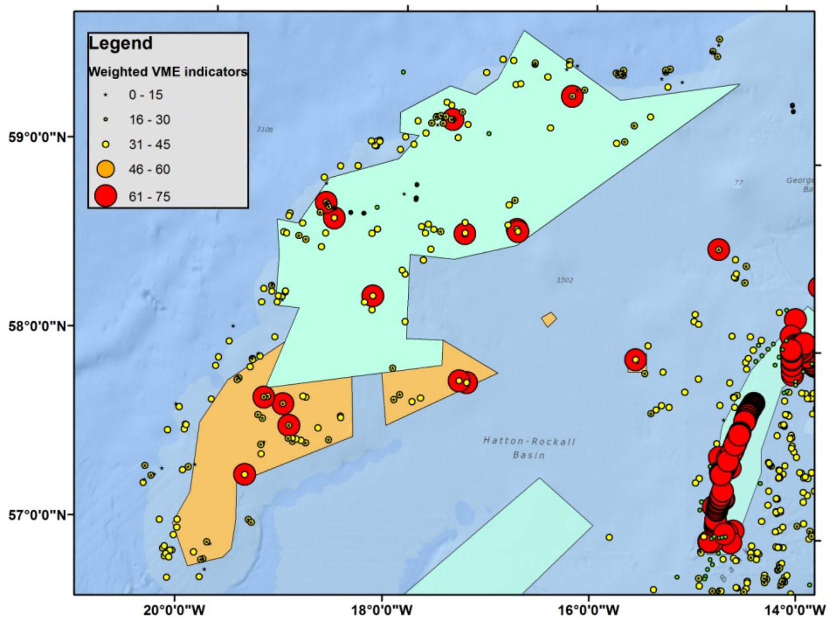

Figure 18. Map showing distribution of VME indicator records having been weighted according to the MCA system. The blue areas are current NEAFC closed areas. The orange areas are proposals recommended by ICES WGDEC (2013) for closure to bottom fisheries. Those records with the highest weight (red) can be seen to lie largely within the areas but the analysis also highlights some areas (for example in the Hatton-Rockall Basin) that should be considered in greater detail. Acoustic criteria to detect VMEs features were not used in this analysis.

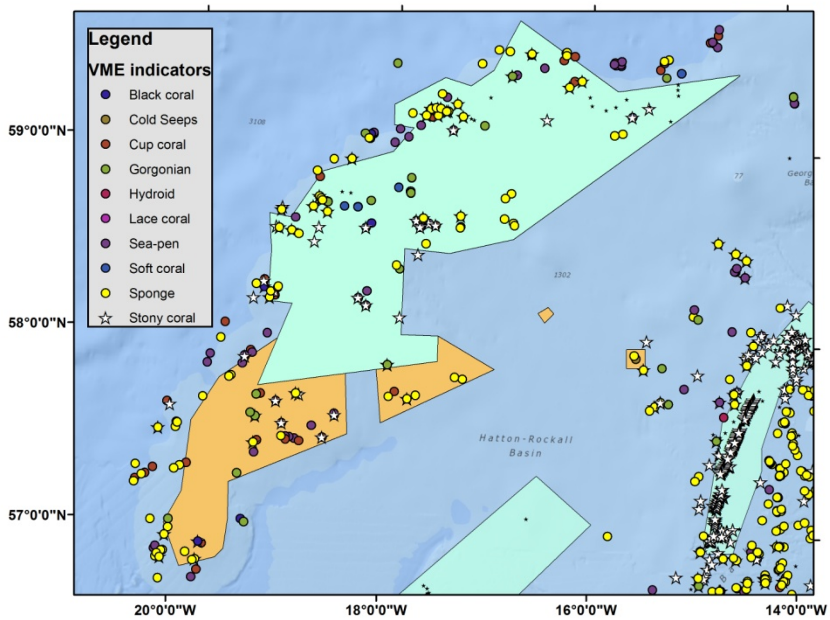

Figure 19. The traditional way of presenting VME indicator record data (by species only) that fails to illustrate which records are considered to be most likely to represent VMEs.

This weighting method therefore provides a relatively simple means of assessing qualitatively different types of information on different types of VME indicator species. This is increasingly important as the ICES VME database grows and it becomes increasingly difficult to evaluate every record using expert judgment. Furthermore it provides clear indications of which records are most important when boundaries for closures to bottom fisheries are being considered.

4.4 Discussion and problems with the approach and future directions

WGDEC identified several problems with the approach that need to be addressed including how to assign a score to the volume of material for visual survey methods and for records for which count data are available, rather than weight data. Attempts will be made to rectify these problems in time for the next meeting.

One further important issue that WGDEC identified in assessing how likely a VME indicator species is to be of an actual VME is its proximity to other records of the same VME indicator; many VME indicators records in the same locality are more indicative of a VME than scattered solitary records (this assumes sample density is relatively equal and isolated records are surrounded by actual or inferred absences). Hence higher weighting should be given to records in close proximity to one another, while those far apart should receive no weighting. The proximity of one record to another can be worked out and attempts to do this were tried. A higher weight can be applied to record that fell within 5 km of another VME indicator of the same type, etc. This goes some way to resolving the issue of visual surveys that have no weight estimates because many individuals close together receive a higher weighting. It is also important to resolve how high resolution information on VMEs features (FAO, 2009) from acoustic surveys (multibeam, side scan-sonar, sub-bottom profilers, etc.) can be used to develop the MCA matrix. As this is a work in progress, no firm conclusions should be drawn from it for now and further tests of its sensitivity to parameter inputs need to be carried out.

4.5 References

FAO. 2009. *International guidelines for the management of deep-sea fisheries in the high seas*. Rome: Food and Agriculture Organization of the United Nations, 73 pp.

5 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

5.1 Introduction

Work was undertaken by WGDEC in 2013 to identify and map VME elements in the NEAFC regulatory area (RA), in order to harmonize with existing NAFO RA VME elements. VME elements are physical habitat and landscape features where VME species have a high likelihood of occurring (NAFO SCS Doc. 12/19, 2012; page 39). The aim of this Term of Reference was to develop a catalogue of multibeam surveys for deep-water areas in the North Atlantic so that the data can be more readily accessed and used by WGDEC to develop future advice.

5.2 Catalogue of multibeam datasets

During plenary, the Group agreed that the multibeam data catalogue should focus on multibeam surveys within the NAFO and NEAFC RAs. There are existing, extensive multibeam catalogues from within member states EEZs, such as EMODNET (http://www.emodnet-bathymetry.eu/). EMODNet Bathymetry and SeaDataNet is of particular interest to WGDEC with respect to this ToR, as they are compiling and publishing a detailed inventory and access service for all bathymetric surveys from European organizations on a global scale. Other data collection projects such as Mareano (http://mareano.no/en/maps/viewer.php) and the Irish National Seabed Survey (http://spatial.dcenr.gov.ie/wmsconnector/com.esri.wms.Esrimap/INFOMAR?) also have data portals; it was agreed that these would be utilized and drawn upon for developing any future advice within these waters. This existing information would then be supplemented by knowledge of new areas of multibeam bathymetry within the NEAFC and NAFO RA brought to WGDEC by its members.

The catalogue comprises a spatial data layer showing extents of multibeam bathymetry data as polygons. WGDEC members will be asked to submit updates to this layer six months prior to each Working Group meeting. A summary of the attribution within this layer is shown in Table 3, and will meet the minimum mandatory requirements laid out under the SeaDataNet Common Data Index (CDI) format (based upon ISO 19115 content standard). With the data owner's permission, it may be possible to feed this new information on multibeam bathymetry extents back into the EMODNET process.

Information collated to date by WGDEC showing multibeam data extents for the North Atlantic (NEAFC and NAFO areas) is shown in Figure 20 and 21 respectively.

Table 3. Recommended attribution for the ICES WGDEC multibeam bathymetry extent layer.

Field name	Description
Dataset-name	Provide a short unique name for the dataset.
Geographic Coverage (bounding box)	What are the geographic coordinates for the bounding box containing the dataset?
Measuring area type	What spatial form is the dataset?
Start date	Start and end date/time of collection of data contained within the dataset.
Parameters	What parameters are contained within the dataset?
Abstract	Short descriptive abstract of the dataset.
Platform class	What survey platform was used?
Originator centre	Name and contact details of the organization who created the dataset.
Point of contact (holding centre)	Name and contact details of the organization who is to hold the dataset.
Data access restriction	Does the survey/contract originator want any data restrictions applied?
Cruise information /Station information	For either cruise and/or the station, provide name, short name and start date.
Data format	What format are the data files in?

5.3 References

NAFO. 2012. Scientific Council Meeting 2012. NAFO SCS Doc 12/19.

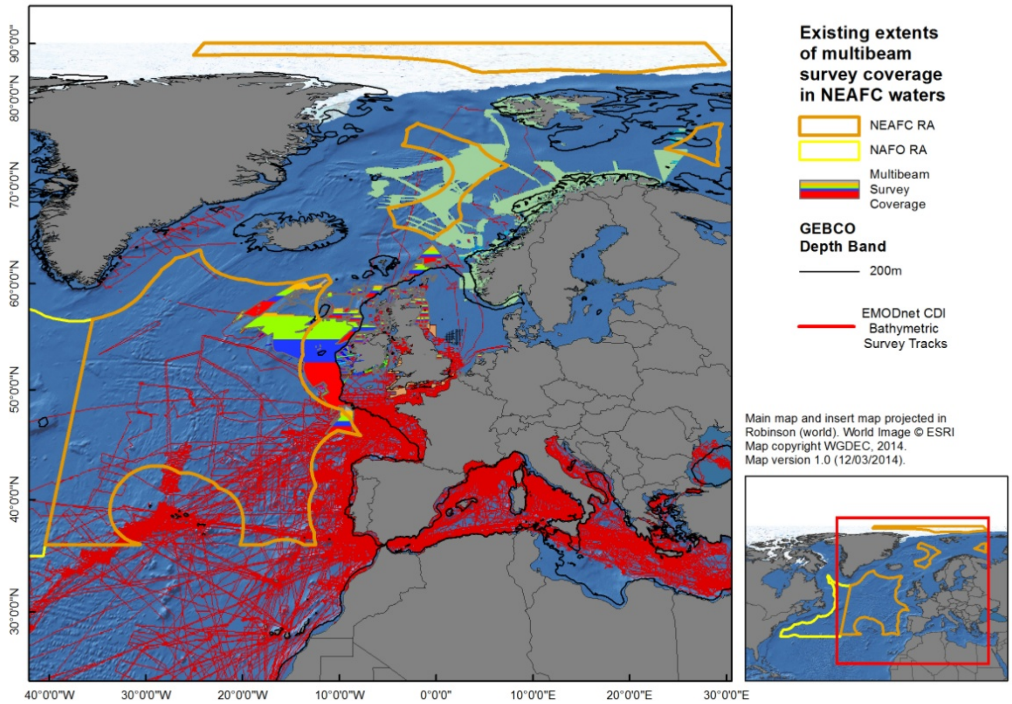

Figure 20. Existing multibeam bathymetry data extents from various sources within the NEAFC RA, including EMODNET, Mareano, Infomar and JNCC. Different colours are not representative, but are due to pulling data off Web Mapping Systems.

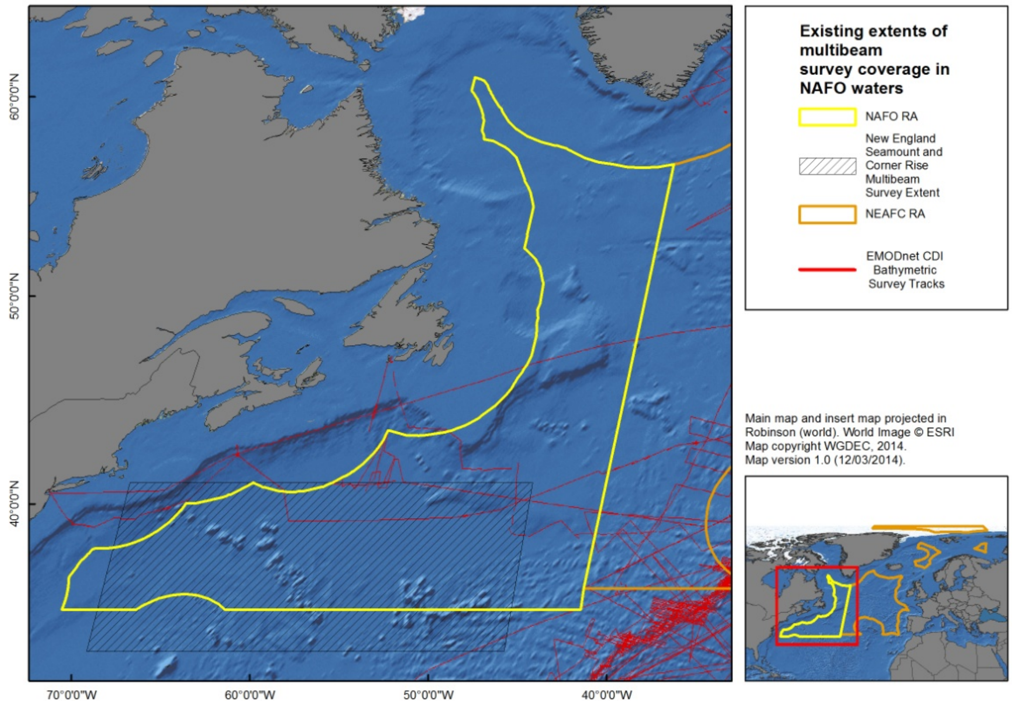

Figure 21. Existing multibeam bathymetry data extents from various sources within the NAFO RA.

6 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

6.1 Predictive modelling approaches

Species distribution models (SDM) are widely used in conservation ecology and environmental management. Examples include but are not limited to: identification of priority areas for conservation (Rodriguez-Soto *et al.*, 2013), inferring potential climate change-induced range shifts in species distributions (Cheung *et al.*, 2009; Bond *et al.*, 2011; Hare *et al.*, 2012), evaluating management scenarios and economic valuation (Bergström *et al.*, 2013; Lindegarth *et al.*, 2014), predicting the spread of alien invasive species (Ficetola *et al.*, 2007). There are a number of reviews focused on use of species distribution models, discussing potential applications, critical limitations and decisions inherent in the construction and evaluation of SDMs (Loiselle *et al.*, 2003; Guisan and Thuiller, 2005; Jiménez-Valverde *et al.*, 2008; Wisz *et al.*, 2008; Lobo *et al.*, 2010; Robinson *et al.*, 2011; Guisan *et al.*, 2013).

The application of SDMs to the deep-sea environment is relatively new (e.g. Vierod *et al.*, 2014 and references therein). The potential for SDM to 'fill the data gap' in this poorly sampled ecosystem has obvious appeal. SDMs allow us to maximize the use of available data providing a robust defensible means to develop complete coverage distribution maps on which to base management decisions. The construction of models requires data on the presence of a species/ habitat, and complete coverage layers of relevant environmental parameters. Models can then be developed that formalize the relationship between species (or habitat) presence and the environmental drivers (or surrogates for those drivers) of their distribution within a statistical framework. SDM modelling has great potential for use in the deep-sea environment where areas are vast and data availability is poor. The relative stability of the deep-sea ecosystem (compared to shallow water and terrestrial environments) may lend itself well to modelling approaches.

Many journals now provide the option to include links to supplementary data. We recommend that best practice when publishing predictive modelling studies is to include links to both output model layers and input predictor layers in freely available databases (e.g. Pangaea), for use by the wider community. Such data archived in the Panagaea database is accorded a unique Digital Object Identifier code that is citable.

Within the North Atlantic region there are an increasing number of studies that have produced predictive models of the distribution of either VMEs or VME indicator species. Models range in spatial coverage from global to local and from very coarse resolution (1°) to very fine resolution (25m). Studies in the terrestrial environment have shown that model performance can vary as a result of a change in environmental data resolution, with both improvement, deterioration and little change in predictive accuracy and/or model gain reported in various studies as a result of decreasing resolution of predictor variables (Ferrier and Watson, 1997; Tobalske, 2002; Graf *et al.*, 2006; Guisan *et al.*, 2007). Recent studies from the deep-sea environment have highlighted an overall trend toward better model performance with increasing environmental data resolution, with significant differences in performance found between models of different resolution (Marshall, 2010; Rengstorf *et al.*, 2012).

Until recently, the lack of high-resolution environmental datasets has been a major restriction to the reliability and applicability of SDMs in the deep sea, as precise spatial matching between presence data and environmental variables is necessary in order to avoid an artificial expansion of the species niche width, especially when modelling the distribution of sessile organisms (Guisan and Thuiller, 2005). The emergence of large-scale multibeam derived high-resolution bathymetry surveys (e.g. the Irish National Seabed Survey, the UKs Maremap project, and the Norwegian 'Mareano' project) has provided practitioners with the means to greatly increase SDM model resolution. Multibeam derived bathymetry provides actual complete coverage data (unlike modelled environmental layers such as bottom temperature, bottom salinity, etc.), although it is subject to some level of error as with all data acquisition processes. These data can be analysed to produce terrain attributes that can be used in habitat classification and modelling studies where seabed morphology has been shown to play a crucial role in the distribution of benthic biota (Wilson *et al*., 2007; Dolan *et al*., 2008; Rengstorf *et al*., 2012). In a study of corals found off the west coast of Ireland, Wilson *et al*. (2007) calculated quantitative measures of slope, orientation, roughness and curvature from ROV multibeam bathymetry data across a range of spatial scales. These parameters were analysed for their ecological relevance to the distribution of the corals and used in an Ecological Niche Factor Analysis (ENFA) to identify the most suitable areas for coral colonization within the extent of ROV derived multibeam data. Cross-validation of the results with video data indicated that the predictions were reliable.

SDM (habitat suitability models) using terrain attributes generated from multibeam bathymetry data has also been shown to outperform comparable models based on coarser bathymetry data such as the General Bathymetric Chart of the Oceans (GEBCO) as a result of the higher resolution of the data (Rengstorf *et al*., 2012; Ross *et al*., unpublished). Using *Lophelia pertusa* as an example, Rengstorf *et al*., *loc cit*, investigated the effect of initial bathymetric grid resolution by comparing a range of bathymetry grid sizes: from 50 m x 50 m (multibeam derived) up to 1000 m x 1000 m (corresponding to the 30 arc-second GEBCO grid). Models using the coarser grids failed to detect many of the small carbonate mounds found in Irish waters (Figure 22). Bathymetry data of at least 250 m^2 resolution are recommended for SDMs used to resolve Irish coral habitat (Rengstorf *et al*., 2012).

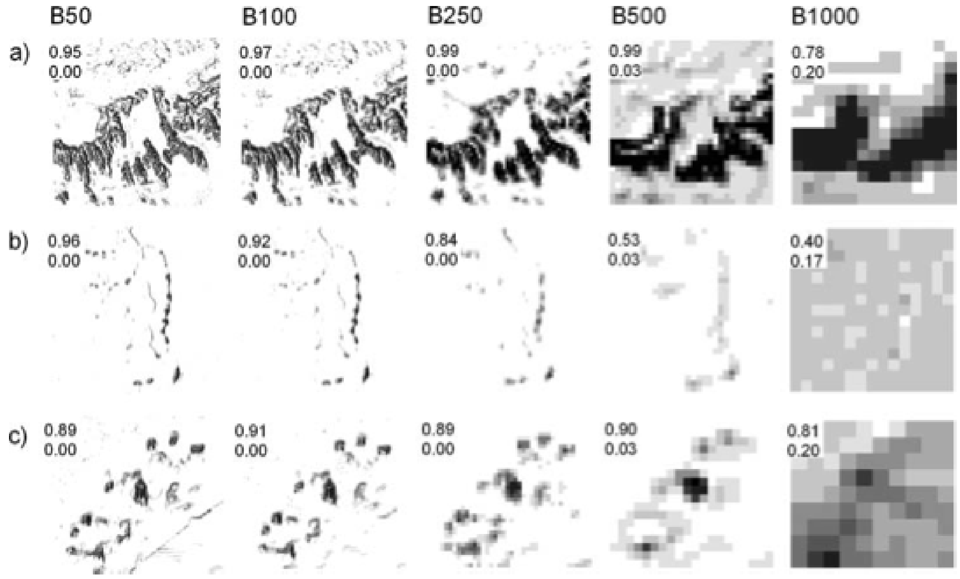

Figure 22. Terrain suitability maps for coral habitat in three different locations off the west coast of Ireland employing terrain variables based on five different (B50–B1000) bathymetry grid sizes. Terrain suitability ranges from low (0, white) to high (1, black). Maximum and minimum suitability values are indicated in each map (Rengstorf *et al.*, 2012).

This finding is supported by Ross and Howell (2012) who noted their model based on GEBCO bathymetry failed to predict known reef areas on the summit of Rockall Bank associated with small-scale iceberg ploughmark features. Ross *et al.*, (unpublished) also assessed the impact of scale on model spatial prediction. Here the distribution of Scleractinian reef has been predicted on terrain variables derived from the GEBCO grid and on multibeam bathymetry of 200 m grid cell size. The difference in the spatial prediction is clear, with areas of predicted suitable habitat contracting as grid cell size contracts (Figure 23).

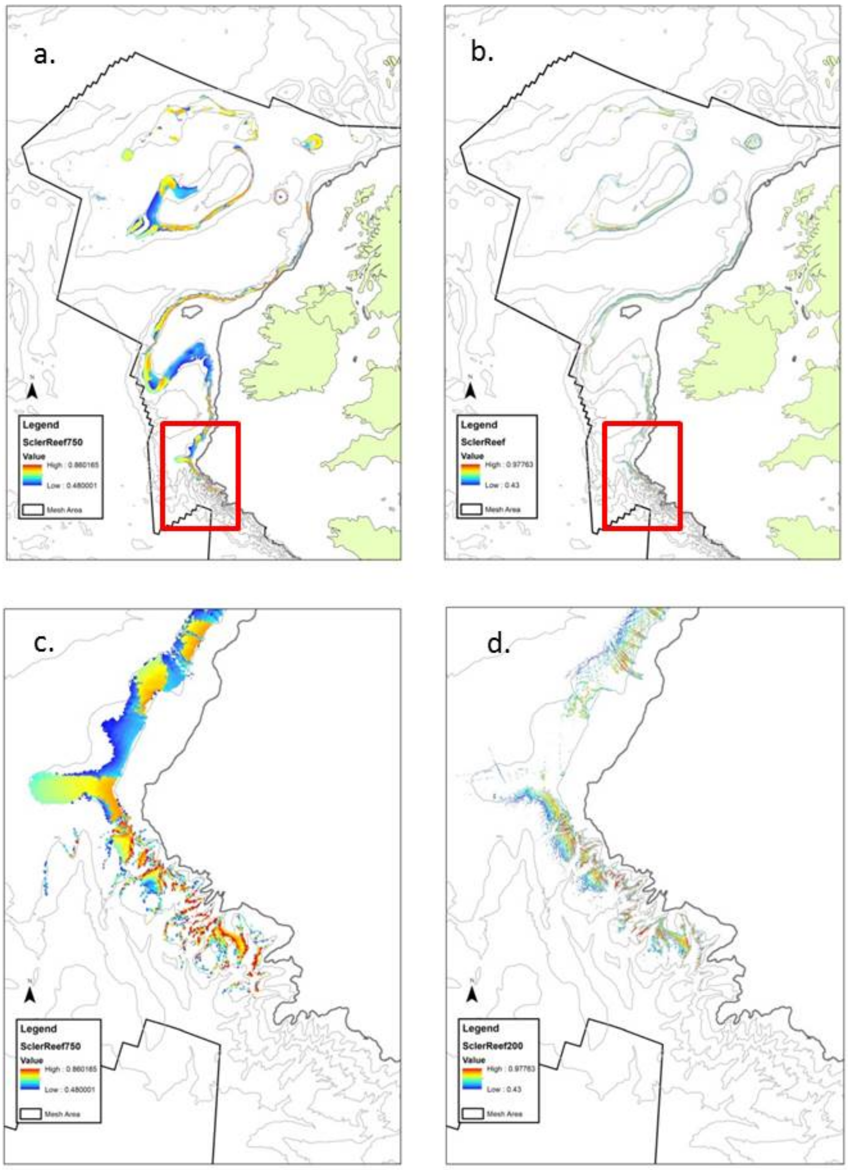

Figure 23. Predictive model of Scleractinian reef distribution in UK and Irish deep-sea areas for which multibeam data exist, showing areas of predicted presence with probability values retained. a) Full area from model built using GEBCO bathymetry of grid cell size ~750 m b) Full area from model built using multibeam bathymetry of grid cell size 200 m, c) and d) close up of areas indicated by extant rectangles. Courtesy of Ross *et al*. (unpublished).

High resolution bathymetry can provide better predictive models both in terms of their accuracy and spatial precision than models based on coarser global bathymetric datasets such as GEBCO. Models created using multibeam bathymetry have the potential to be used to inform local scale management of sites although individual model performance is largely determined by the quality and the amount of data used to build the model and must be assessed on a model by model basis.

Multibeam bathymetry data are not available for large areas of the North Atlantic and here coarser resolution models can offer useful information on the distribution of VMEs and VME indicator species through highlighting areas where VMEs are 'likely to occur' (Davies and Guinotte, 2011; Ross and Howell, 2012; Rengstorf *et al*., 2012;

Yesson *et al*., 2012). This group has previously recommended that in the absence of reliable widespread biological sampling the use of predictive habitat models should be explored, and that management decisions made using coarse scale (≥1 km cell size) modelled habitat maps should be augmented with other finer scale information wherever available, including expert knowledge (ICES, 2009).

While the increasing availability of multibeam data is allowing ever more fine-scale predictive modelling to be undertaken, predictive models should always consider other important environmental drivers of deep-sea species distributions within the modelling process. For example, the distribution of 'Ostur' type deep-sea sponge aggregations described by Klitgaard and Tendal (2004) are thought to be strongly influenced by the presence of the Norwegian Atlantic Current and the Irminger Current in the Northeast Atlantic. Regional or basin scale models attempting to predict the distribution of Ostur would therefore need to incorporate oceanographic data in order to capture this relationship within the model (e.g. Knudby *et al*., 2013 for the Northwest Atlantic).

Collaboration between SDM modellers and oceanographic modellers to facilitate the production of better predictive maps is a topical area of study (Henry *et al*., 2013; Mohn *et al*., 2014; Rengstorf *et al*., submitted) and should lead to interesting developments in SDM modelling research over the next few years. Mohn *et al*., 2013, for example, reviewed hydrographic observations from numerous cold-water coral locations in the NE Atlantic and showed that a common feature of the hydrographic regime at individual coral mounds and mound clusters was the presence of energetic near-bottom flow dynamics. These dynamic conditions are largely controlled by tide-topography interactions that generate and enhance periodic (water) motions such as trapped waves, freely propagating internal tides and internal hydraulic jumps. To better understand the link between such benthic hydrodynamics and cold-water coral occurrences, a high-resolution hydrodynamic model was developed at three cold-water coral provinces off the west coast of Ireland. The model results showed intensified near-bottom currents in areas where living corals were observed by contrast with coral absence and random background locations. An analysis of the dynamical processes associated with oscillatory flow interacting with the local topography suggested that these motions provided a locally important food supply mechanism to cold-water corals by promoting large amplitude local vertical mixing and organic matter fluxes. It was shown that their presence varied considerably between area based on the interplay of topographic slope, flow magnitude and ambient stratification. Rengstorf *et al*. (submitted) in their paper, have developed high-resolution (250 m grid cell size) hydrodynamic variables based on the Mohn *et al*. (2013) model and incorporated them into a SDM to explore their model explanatory power.

While models predicting the distribution of VME indicator species are useful in identifying areas of interest, progress needs to be made in modelling the distribution of VMEs. This problem was recognized by Howell *et al*. (2011) who proposed an approach modelling the distribution of the habitat rather than species, and has led to further efforts in this area (Ross and Howell, 2012; Knudby *et al*., 2013). Other possibilities are to move from presence or presence/absence modelling to density/ abundance based modelling approaches, which will allow the identification of areas of high densities of VME indicator species and by inference VMEs. For VMEs composed of multiple species (e.g. coral gardens) an alternative approach has been taken whereby presence only models have been built for multiple species and the resulting maps overlaid to identify areas where multiple species are likely to be present (Tempera *et al*., 2013). All three approaches have merit and show promise for future development.

6.2 Potential use of modelling in the development of deep-sea spatial management advice

Predictive modelling has great potential for use in informing the provision of advice on the spatial management of the deep sea, and a number of examples where they have been used are beginning to emerge. Within the CoralFISH programme, a multi-criteria analysis compared modelled *Lophelia pertusa* distribution (Figure 24 below) with maps of fishing effort in order to assess risk to VMEs from fishing activities (Rengstorf *et al*., unpublished). A matrix of risk categories was developed and a colour coded risk map produced for an area of the Irish deep sea (Kenny *et al*., in prep.). Similar to the example of Irish coral conservation presented below, grids of 10 km x 10 km were used so that decisions per grid were visible for the area under consideration. These risk maps can be used to inform environmental managers of areas of potential concern. Also the predictive models of coral distributions in the Azores show that the protected deep-sea areas by the Azores government are effective at preserving the areas with the highest coral diversity (Tempera *et al*., unpublished). Ross and Howell (2012) have demonstrated how predictive models can be used to assess progress towards area based conservation targets for 'listed' deep-sea habitats. These authors show that existing marine protected areas in Irish and UK waters protect only 23% of *L. pertusa* reef habitat, 2.3% of *Pheronema carpenteri* aggregations (deep-sea sponge aggregation), and 6% of *Syringammina fragilissima* aggregations (Xenophyophore aggregation).

In Ireland, a high resolution coral reef habitat suitability model (HSM) has been used to assess the representativeness of the current protection regime for cold-water coral reefs. Four areas (Figure 24) covering some 2500 km^2 of the seabed were designated as Special Areas of Conservation (SAC) under the European Union Habitats Directive in 2006, based on a partial knowledge of the distribution of *L. pertusa* at the time. The output from their HSM (coarsened into 10 km x 10 km squares for clarity), show that the existing SACs cluster in the central portion of the predicted reef distribution and fail to encompass the likely bio-geographical variability of the reefs' associated fauna within Irish waters. In addition, the model predicts 2% (ca. 7000 km^2) of the study area to be suitable habitat for coral reefs while existing SACs account for merely 10% of this predicted distribution. Guidance has been provided by the European Commission on what proportion of the national representation for each habitat type might be considered sufficient according to the principle of sufficiency. This indicates that less than 20% of the national resource of a particular habitat represented within the site series would be likely to be considered insufficient, and that more than 60% of the national resource would be likely to be considered sufficient (JNCC, 2013). Therefore, the above findings strongly suggest that an increase of existing SACs in Irish waters is warranted.

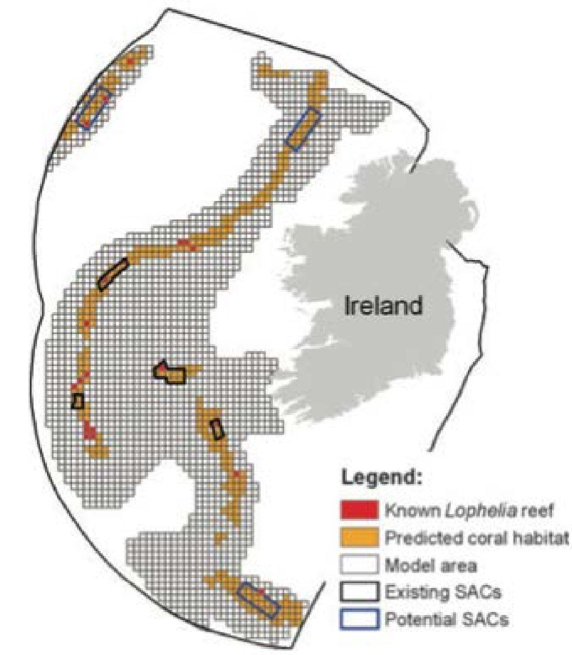

Figure 24. Map showing the distribution of known and predicted *Lophelia pertusa* reef habitat for the Irish continental margin, as well as existing and suggested (potential) coral Special Areas of Conservation (SACs) within the Irish Exclusive Fisheries Zone (solid black line).

In Spain, García-Alegre *et al*. (in press) used habitat modelling techniques to create predictive maps of six species of conservation concern for the Le Danois Bank (El Cachucho Marine Protected Area in the South of the Bay of Biscay). They used these maps to show that the species characterizing the habitat of two communities included as part of the OSPAR and NATURA marine protected networks were adequately protected by the management measures applied at present in this area.

Predictive models also have great potential is assessing the impacts of climate change on the distribution and state of VMEs. Jackson *et al*. (unpublished) have examined the potential impacts of ocean acidification on cold-water coral reefs in the NE Atlantic through examining the interaction between predicted distribution of reef habitat and the shoaling of the Aragonite Saturation Horizon as predicted under climate change scenarios. This study is intended to inform the assessment of ‘Good Environmental Status’ under the Marine Strategy Framework Directive within European waters.

With growing interest by other sectors in developing deep-sea living and non-living resources, predictive modelling approaches to mapping can offer one option in the application of the precautionary approach to identify areas where VMEs are known *or likely to occur* (*sensu* FAO, 2009). Predictively modelled maps can form one layer of data in multi-criteria assessments of spatial use and environmental management. It is important to note that all predictively modelled maps will include some level of error resulting in both false positives and false negatives.

6.3 Conclusions

1) Published (and therefore peer reviewed) predictive models of the distribution of VMEs or VME indicator species should be taken into consideration in management decisions regarding human use of the deep-sea ecosystem.

2) Predictive models based on high resolution multibeam bathymetry data offer finer resolution predictive models (maps of VME suitable areas) that can be used to inform the provision of advice on spatial use of the deep-sea ecosystem.

3) In regions where published predictive models indicate a high likelihood of VME presence we suggest survey effort is required to discount presence in order to implement a bottom contact fishery.

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Annex 2: WGDEC terms of reference for the next meeting

The **Working Group on Deep-water Ecology (WGDEC)**, chaired by Neil Golding, UK will meet in xxx, XXX, xx March 2015 to:

a) Provide all available information on distribution of VMEs in the North Atlantic with a view to advising on any new closures to bottom fisheries or revision of existing closures to bottom fisheries (NEAFC standing request). In addition, provide new information on location of habitats sensitive to particular fishing activities (i.e. vulnerable marine ecosystems, VMEs) within EU waters (EC request);

b) Build on the work undertaken at WGDEC 2014 and continue the development of 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) In light of two deep-sea mining exploration licences that have been granted by the International Seabed Authority (ISA) along the mid-Atlantic Ridge, review the sensitivity of vulnerable deep-water habitats to these activities and make recommendations for their protection;

d) Review new evidence of ecosystem functioning of VME indicators in the North Atlantic arising from the CORALFISH project and recent scientific literature.

WGDEC will report by xx March/April to the attention of the Advisory Committee.

Supporting Information

Priority	High as a Joint group with NAFO and is essential to feeding information to help answer external requests
Scientific justification	Term of Reference a) This ToR is required to meet the NEAFC request " to continue to provide all available new information on distribution of vulnerable habitats in the NEAFC Convention Area and fisheries activities in the vicinity of such habitats" and part of the European Commission MoU request to "provide any new information regarding the impact of fisheries on ..... sensitive habitats". The location of newly discovered/mapped sensitive habitats is critical to these requests. It is essential that ICES/WG Chair asks its Member Countries etc. to supply as much information that they have by one month in advance of the WGDEC meeting. b) Some excellent work was completed at WGDEC 2014 on developing a weighting system for VME indicator records. Through further development of this system, information underpinning any new recommendations on closures, or modifications to existing closures, can be assessed and weighted based on reliability and significance. c) WGDEC consider deep-sea mining activities a significant future risk to vulnerable deep-sea habitats in the North Atlantic; especially considering that two prospecting licences have been let on the Mid-Atlantic Ridge by the ISA. WGDEC members have significant expertise on deep-water habitats, and this could be utilized effectively to provide advice to ICES on this activity that is still in relative infancy. d) Assessment of significant adverse impacts (SAI) of bottom fishing activities requires an understanding of impairment of ecosystem function under the FAO guidelines. Little is known about the ecosystem functioning of most of the VME indicators in the North Atlantic as noted by WGDEC in their last review of this topic approximately 5 years ago. Since that time a major EU project, CORALFISH, has been completed and results have been published. New work on benthic pelagic coupling has also been reported from Norway and elsewhere. An update on this new information would be very useful for both assessment of SAI and for EBFM
Resource requirements	The usual helpful support from the Secretariat and the ICES Data Centre will be appreciated.
Participants	The Group is normally attended by some 15–20 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to advisory committees	ACOM is parent group. WGDEEP is related, but no explicit overlap in work this year.
Linkages to other committees or groups	
Linkages to other organizations	

Annex 3: Recommendations

Recommendation	Adressed to
1. WGDEC recommends that the ICES Data Centre continue to assist in developing an online GIS functionality for the ICES VME database.	ICES Data Centre
2. WGDEC recommends that the ICES Data Centre provide assistance in the preparation of VMS data (provided by NEAFC and EC Member States) for use by the WG to carry out its Terms of Reference	ICES Data Centre
3. WGDEC recommends that 2014 VMS data are provided to ICES in advance of the 2015 WGDEC meeting. This VMS data should include information on fishing gear type (e.g. bottom trawl), and should be resolved to the finest possible temporal and spatial scales (not aggregated)	NEAFC and EC
4. Following the OSPAR data call (Data call for VMS/logbook data for fishing activities in the OSPAR areas I-V in support of ICES advice on the spatial and temporal bottom fishing intensity as requested by OSPAR and standing requests from NEAFC and the EC), WGDEC recommends that these data (separate spatial data layers for 2009 through to 2012, filtered by relevant gear types and speeds (tbc)) is made available in advance for consideration at the 2015 WGDEC meeting. These data will be used to respond to the standing EC request regarding impact of fisheries on other components of the ecosystem such as cold-water corals and sponges within EU waters.	ICES Data Centre
5. WGDEC recommends that ICES considers the development of closer links with the International Seabed Authority, in a similar vein to the MoU that currently exists between OSPAR and the ISA. This is in light of a draft Terms of Reference proposed by WGDEC for 2015: *'In light of two deep-sea mining exploration licences that have been granted by the International Seabed Authority (ISA) along the mid-Atlantic Ridge, review the sensitivity of vulnerable deep-water habitats to these activities and make recommendations for their protection'*	ACOM

Annex 4: A French guide to the identification of species (or groups of species) characteristic of VMEs in the Northeast Atlantic

Annabelle Aish, a WGDEC member from the Natural Heritage Service ('Service du Patrimoine Naturel') of the French Natural History Museum (MNHN), presented work being undertaken to develop a guide to the identification of VMEs in the Northeast Atlantic.

Specifically, in 2012, the French Department of Fisheries and Aquaculture approached the MNHN for information about VMEs in the Northeast Atlantic with which French fishing vessels may come into interaction. The MNHN was asked to develop a list of VMEs and the species that characterize them, as well as a guide to their identification for potential use by 'OBSMER' (the French Observers at Sea programme, coordinated by Ifremer). To this end, the MNHN set up an expert working group of French deep-sea scientists (from Ifremer and the French Natural History Museum), with a focus on offshore Irish and Scottish waters where French fishing vessels operate. This guide was presented to the 2014 WGDEC meeting.

The French expert working group drew extensively from existing guides on VMEs in terms of layout, species identification characteristics and illustrations. These guides included those published by NAFO (Kenchington *et al*., 2009 and Best *et al*., 2010), SEAFO (Ramos *et al*., 2009), CCAMLR (CCAMLR, 2009) and NIWA (Tracey *et al*., 2011), as well as the WGDEC report from 2013 (Chapter 5). French scientific information was then added to a standardized template. The seven main types of VME identified by WGDEC 2013 were retained although, following French scientists' recommendations, *Madrepora oculata* reefs were added as a cold-water coral reef type (1) and cup-coral fields and cauliflower coral fields were added as subtypes of hard-bottom coral gardens (2A).

In total, 117 taxa, 42 at genera level and 75 at species level were listed for the seven VMEs identified. These belong to 54 families, seven classes and six phyla. 33 taxa, comprising 25 species and eight genera are described in the guide. 13 species can be recognized using a description of a species of the same genus (which was felt to be sufficient according to French experts) and four genera listed can equally be recognized using a description of a species belonging to the same genus. 52 taxa listed in the guide are not yet described.

The guide will be published by the MNHN in mid-March 2014 and will then be available via the website of the Service du Patrimoine Naturel. Comments on the species listed and their identification characteristics were requested from WGDEC 2014 within this time frame. The guide will subsequently be considered for possible use under Ifremer's OBSMER programme with an associated on-board protocol for its application.

References

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Tracey, D.M.; Anderson, O.F.; Naylor, J. R. (Comps.). 2011. A guide to common deepsea invertebrates in New Zealand waters. New Zealand Aquatic Environment and Biodiversity Report No. 86. 317 p.

Annex 5: Agreed modifications to the WGDEC VME database

Table 4. Proposed data format for the WGDEC vulnerable marine ecosystem database; in the 'Obligation' column, M stands for mandatory, O stands for optional and C stands for conditional.

Field name	Field type	Obligation	Description	Guidance
WGDECGUI	Text	M	Globally Unique ID for each dataset	Format: "WGDECHab" + year + 2-letter country code (corresponding to ISO 3166-1) + 1 alpha/numeric digit (different for each dataset) + "v" + version of dataset, e.g. if the UK supplied 2 datasets, they may be called WGDECHab2010UK1v1 and WGDECHab2010UK2v1.
Sample	Number	M	Unique number for each Indicator record	Sequential number for identifying individual records within WGDECGUI dataset
RecordKey	Text	M	Unique key for each Indicator record	May be numeric, text or a combination of numbers and text, which may relate back to original data management convention for traceability
VME_Indicator	Text	M	Grouping of species/habitats used by WGDEC.	Choose from: • Black coral • Cold Seeps • Cup coral • Gorgonian • Hydroid • Lace coral • Oceanic ridges with hydrothermal vents/fields • Sea-pen • Soft coral • Sponge • Stony coral

Field name	Field type	Obligation	Description	Guidance
VME_HABITAT_TYPE	Text	M	VME habitat types used by WGDEC.	Choose from: • Cold-water coral reef • Coral Garden • Deep-sea Sponge Aggregations • Seapen fields • Tube-dwelling anemone patches • Mud and sand emergent fauna
VME_HABITAT_SUBTYPE	Text	M	VME sub-habitat types used by WGDEC.	Choose from: • *Lophelia pertusa* reef • *Solenosmilia variablis* reef • Hard-bottom coral garden • Soft-bottom coral garden • Ostur sponge aggregations • Hard-bottom sponge aggregations • Glass sponge communities
Status	Text	M	Presence or absence of habitat or species	Choose either Present or Absent
GeneralTaxonDescriptor	Text	M	Most detailed name of taxon (according to Highest Taxonomic Resolution)	e.g. Porifera, *Lophelia pertusa*, soft coral
HighestTaxonomicResolution	Text	C	Highest taxonomic resolution described in GeneralTaxonDescriptor	Only use if a scientific taxon name is given. E.g. order, species, genus.
Order	Text	C	Order of taxon, if known	If not known, use “NA”
Genus	Text	C	Genus of taxon, if known	If not known, use “NA”
Species	Text	C	Species of taxon, if known	If not known, use “NA”
Dead_alive	Text	O	Indication of whether most of sample was dead or live	Choose either “Dead” or “Alive”

Field name	Field type	Obligation	Description	Guidance
Number	Double	O	Number of individuals associated with record	If not known, leave blank
Weight_kg	Double	O	Mass of Indicator, in kg, associated with record	If not known or not relevant, leave blank
Density	Double	O	Number of individuals per metre squared	If not known or not relevant, leave blank
% Cover	Double	O	Percentage cover of Indicator (relevant to observation data)	If not known or not relevant, leave blank
SACFOR	Text	O	Semi-quantitative abundance scale (relevant to observation data)	If not known or not relevant, use “NA”
TaxonDeterminer	Text	M	Name of organization that identified the GeneralTaxonDescriptor.	Free text; e.g. JNCC
TaxonDeterminationDate	Date	M	Date of identification of the GeneralTaxonDescriptor.	All dates must be supplied as text in the format YYYY-MM-DD (ISO date format).
ObsDate	Date	M	Date the habitat or species was recorded.	All dates must be supplied as text in the format YYYY-MM-DD (ISO date format).
ObsDateType	Text	M	A one or two character code that identifies the type of dates used ObsDate. Explicitly stating the code avoids any ambiguity, which might lead to subtly different interpretations.	Choose from: D - Dates specified to the nearest day. O - Dates specified to the nearest month Y - Dates specified to the nearest year ND - No date U - Unknown
StationID	Text	O	ID of the survey station, if known.	May be numeric, text or a combination of numbers and text.

FIELD NAME	FIELD TYPE	OBLIGATION	DESCRIPTION	GUIDANCE
SurveyKey	Text	O	Unique key for each dataset making up the country submission to WGDEC (e.g. representing actual separate surveys, data from different sources, museum collections, etc.). SurveyKey links to the Survey Key Metadata worksheet, where survey details are described in full.	Each SurveyKey must refer to a record in the SurveyKey Metadata worksheet.

Field name	Field type	Obligation	Description	Guidance
SurveyMethod	Text	O	A description of the survey method(s) used.	Choose one or more from: • Multibeam echosounder • Single beam echosounder • Sidescan sonar • Interferometric sonar • AGDS • Multibeam ground discrimination • 3D seismic imagery • Sub bottom profiling • Grab • Core • Trawl • Commercial trawl bycatch • Survey trawl bycatch • Survey longline bycatch • Dredge • Particle size analysis • Geotechnical measurements • Towed camera • Drop camera • ROV • Sediment profile imagery
PlaceName	Text	O	Name of place in reference to the record collection.	Free text; e.g. “Rockall Bank”

Field name	Field type	Obligation	Description	Guidance
StartLatitude	Double	M	Starting latitude of the record, if line (if point, use MidLatitude and leave this blank).	Use World Geodetic System 1984 (WGS84) geographic coordinate system, and decimal degrees.
StartLongitude	Double	M	Stating longitude of the record, if line (if point, use MidLongitude and leave this blank).	Use World Geodetic System 1984 (WGS84) geographic coordinate system, and decimal degrees.
EndLatitude	Double	M	Ending latitude of the record, if line (if point, leave blank).	Use World Geodetic System 1984 (WGS84) geographic coordinate system, and decimal degrees.
EndLongitude	Double	M	Ending longitude of the record (if point, leave blank).	Use World Geodetic System 1984 (WGS84) geographic coordinate system, and decimal degrees.
MidLatitude	Double	M	Midpoint Latitude of the record if line (if point, use this field for position).	Use World Geodetic System 1984 (WGS84) geographic coordinate system, and decimal degrees.
MidLogitude	Double	M	Midpoint longitude of the record if line (if point, use this field for position).	Use World Geodetic System 1984 (WGS84) geographic coordinate system, and decimal degrees.
GeometryType	Text	M	Point or line	Enter "point" or "line"
RecordPositionAccuracy	Integer	O	Accuracy of spatial position of record.	Value in metres; e.g. "10" means the given position of the habitat is accurate to ± 10 metres.
ShipPositionPrecision	Integer	O	An estimate of the precision of the lat/long coordinates relative to the benthic Indicator. Relevant to bycatch records	Calculated or estimated precision of the benthic feature in metres. Take into account whether position is determined from the ship position or from ROV.
Reference	Text	M	A reference to the data source	Complete citation for the data source e.g. "Mortensen et al., 2006"
Filename	Text	O	Name of the excel or shape file submitted	
DataOwner	Text	M	Name of person or organization that owns the data.	Free text; e.g. "JNCC"
DataAccess	Text	M	Data access constraints	e.g. "public" or "restricted"

Field name	Field type	Obligation	Description	Guidance
Depth Upper	Double	O	For transect data (video or trawl) indicate the shallowest depth in metres	e.g. 110
Depth Lower	Double	O	For transect data (video or trawl) indicate the deepest depth in metres	e.g. 150
Comments	Text	O	Any other comments or information	e.g. “sample was 60% live coral and 40% dead”

Table 5. Proposed data format for the 'survey key metadata' table of the WGDEC VME indicators database; in the 'Obligation' column, M stands for mandatory and O stands for optional.

Field name	Field type	Obligation	Description	Guidance
SurveyKey	Text	M	Unique key to divide up the dataset in any way you wish (e.g. representing actual separate surveys, data from different sources, museum collections, etc.). SurveyKey links to the SurveyKey in the data worksheet.	Each record must be referred to in the SurveyKey field in the data worksheet (see Table 1).
Country	Text	M	2-letter country code (corresponding to ISO 3166-1 standard)	Choose from: • BE Belgium • CA Canada • DE Germany • DK Denmark • ES Spain • FI Finland • FO Faroe Islands • FR France • GB United Kingdom • GB-ENG England • GB-NIR Northern Ireland • GB-SCT Scotland • GB-WLS Wales • GL Greenland • IE Ireland • IS Iceland • NL Netherlands • NO Norway • PT Portugal • SE Sweden • US United States
Institute	Text	M	Institute that collected the data.	For European data, please use institute name as in the European Directory of Marine Organisations: http://seadatanet.maris2.nl/edmo/
VesselName	Text	O	Name of vessel on which survey was carried out.	e.g. "RV Scotia"
VesselCode	Text	O	Unique code for vessel on which survey was carried out.	Search http://vocab.ices.dk/ to find ICES platform (SHIPC) code. E.g. "748S"
CruiseID	Text	O	ID of survey cruise, as assigned by the surveyors.	e.g. "1205S"

StartDate	Date	M	Start date of survey	All dates must be supplied as text in the format YYYY-MM-DD (ISO date format).
EndDate	Date	M	End date of survey	All dates must be supplied as text in the format YYYY-MM-DD (ISO date format).
ScientistInCharge	Text	O	Name of scientist-in-charge of survey.	e.g. "John Smith"
FundingProject	Text	O	Name of project funding the survey, if relevant.	e.g. "HERMES"
SurveyReport	Text	O	Link to online cruise report.	Link to SeaDataNet Cruise Summary Report if relevant. Find here: http://seadata.bsh.de/csr/retrieve/V1_index.html

Annex 6: Technical Minutes from the Vulnerable Marine Ecosystems Review Group (RGVME)

Review of ICES WGDEC Report 2014 (ICES CM 2014/ACOM:29)

Special requests:

> NEAFC requests ICES to continue to update cold-water coral and sponge maps and the information underpinning such maps. This should include any new information pertinent to the boundaries of existing fisheries closures for sensitive habitats/vulnerable marine ecosystems (VME).
>
> EC requests ICES to provide new information regarding the impact of fisheries on other components of the ecosystem including small cetaceans and other marine mammals, seabirds and habitats. This should include any new information on the location of habitats sensitive to particular fishing activities.

Reviewers:	Leonie Dransfeld, Ireland (chair)
	Margaret McBride, Norway
Chair WG:	Neil Golding
Secretariat:	Claus Hagebro

Written for ADGVME

General Comments

- This 2014 WGDEC response does not directly address the EC request to provide new information on the impact of fisheries on other components of the ecosystem (particularly cetaceans/marine mammals, seabirds, and habitats). Perhaps, reasons for this omission should be given/discussed in the Executive Summary.
- There appears to be some inconsistency between areas in WGDEC recommendations for fishing closures based on the reporting/updating of indicator species. For example, on the Southern Mid-Atlantic Ridge, even if there were no documented records within the current area of closure on the Southern MAR, it was recommended that the closure be maintained and even extended based on records shown in Figure 2. In contrast, WGDEC does not recommend new bottom fishing closures to encompass clear VME indicators observed during a 2013 research cruise on East Rockall Bank. Likewise, no WGDEC recommendation for bottom fishing closure was made to encompass areas within the Faroe-Shetland Channel where indicator species were observed during a dedicated JNCC survey conducted in 2012. Perhaps state jurisdictional and/or political issues are at play here, which constrain NEAFC's recommending closure of fishing areas outside its regulatory area. If this is the case, it could be stated in the WGDEC response. Also, it would be good to clarify if areal closures have been implemented, or will be implemented, by the appropriate regulatory authority.
- When recommending closures of fishing areas, it makes a difference whether reported observations of indicator species are of organisms which

are living, dead, or rubble. This should always be made obvious in the actual reporting, and clearly stated in the text of descriptions/discussions.

- The section on new records of VMEs in the NEAFC, EU and national areas has very much improved from previous years: Maps with old information and new information overlaid is very useful, as it is possible for the reader to evaluate whether data are confirming potential VMEs where records of corals or other indicators species already exist, or show new areas.
- However, consistency checks are required; the legends and figure captions differ in the various geographic areas and sometimes there are also inconsistencies between the legend and the figure caption, e.g. in the Bay of Biscay the transparent symbols reflect OSPAR data, while the bold symbols reflect the ICES VME indicator database, while on Josephine seamount, these are used to visualize old and 2014 data.
- RGVME welcomes the availability and use of VMS data from NEAFC to estimate spatial distribution of fishing activity, but notes that data issues have been highlighted. It would be useful to add the percentage of data that is available for analysis after filtering for speed/gear in order to establish the representativeness of the data.

1 NEAFC requests ICES to continue to update cold-water coral and sponge maps and the information underpinning such maps. This should include any new information pertinent to the boundaries of existing fisheries closures for sensitive habitats/vulnerable marine ecosystems (VME)

1.1 Josephine Seamount

WGDEC response: New “historic records” support the ICES 2013 advice of a bottom closure around the Josephine Seamount. Additional VME indicator records presented this year at WGDEC include two species of black corals and eleven species of gorgonians between 170 and 500 m with most VME indicator species found between 200 m and 300 m. These new historic records support the ICES 2013 advice for a closure to bottom fishing. Analysis of the VMS data from 2013 showed no records of bottom fishing activity within the proposed closure area on Josephine Seamount.

RGVME comment

- RGVME supports the conclusion of WGDEC to reiterate the advice of a closure for bottom contacting fisheries on Josephine mount. New records confirm the presence of VMEs while analysis of fisheries data suggests the absence of fishing bottom impacting activities in the area in 2013.
- A sentence should be added to confirm that the current MPA boundary would be adequate as a boundary for the exclusion of bottom contacting fishing operations.
- **Please see figure heading**: “Figure 1. Map of Josephine Seamount showing the ICES advised closure to bottom fishing as a black line (June, 2013) and new ‘historic’ VME indicator records (bold) presented alongside existing data (transparent) for the Josephine Seamount area.” There is no black line. **It should be clarified whether the purple line also refers to the existing MPA boundary and the proposed closure (i.e. the black line in the figure caption).**

1.2 Southern Mid-Atlantic Ridge

WGDEC response: Recommendation to extend the current Southern MAR bottom fishing closure southwards as outlined in Figure 2 to include VME indicator records (Mortensen *et al*., 2008).

WGDEC recommends that the current Southern MAR closure be maintained; this should be stated in the response stated above. Even though there are no documented records of VME indicators within the current closure, WGDEC states that it remains likely that distributions of the taxa observed to the south also extend into the closure. To be consistent with current procedures, WGDEC recommends an extension of the Southern MAR closure southwards to comprise sites documented in Figure 2; this recommendation applies the established WGDEC procedure to delineate candidate bottom fishing closures (incl. the application of buffer zones).

RGVME comment

Based on the information presented, this recommendation seems reasonable and justifiable.

Please see General Comments with regard to inconsistencies in recommendations made by WGDEC between areas.

1.3 Hatton Bank

WGDEC Response: Bycatch data from observer programmes indicate the presence of stony corals and gorgonians north of the current Hatton Bank closure.

RGVME comment

No additional closure or a revision of the boundaries is advised, the quantities are low and the evidence comes from bycatch of commercial vessels. Based on the MCA methodology in the following section, this evidence would receive a low weighting. The map does not indicate whether this would support existing findings of VME indicator species, i.e. no records of the ICES VME database are displayed.

1.4 Rockall Bank

WGDEC response: In spring 2013, a bottom fishery using trawls and longlines with observer participation recorded no observations of VME indicator species.

RGVME comment

To bring the absence of data into context, map should display the existing records e.g. in faded or transparent symbols to indicate whether the absence of VMEs within the observer programme would add to existing evidence of no VMEs.

Map would be clearer if hauls and area boundaries are different colours.

2 EC requests ICES to provide new information regarding the impact of fisheries on other components of the ecosystem including small cetaceans and other marine mammals, seabirds and habitats. This should include any new information on the location of habitats sensitive to particular fishing activities

2.1 East Rockall Bank

WGDEC Response: A 2013 research cruise revealed significant coverage of *Lophelia pertusa* colonies along the shallowest of video transects (250 m). ICES reiterates the boundary modification to this bottom fishing closure as advised in 2012/2013 but does not recommend a new bottom fishing closure to encompass these records.

RGVME comment

There is no explanation why the new findings support the existing advice for closures and why the new evidence of VME does not support any further closures although the report states that the shallowest transect revealed significant coverage of *Lophelia pertusa* colonies along the transect. In addition the section on MCA suggests that this data source of video footage should receive high weighting while continuous occurrence suggests the close proximity of indicator species. If the precautionary principle was to be applied, then an extension of the boundary should be considered.

2.2 Faroe-Shetland Channel

WGDEC Response: WGDEC discusses historic records of deep-sea sponge aggregations on the margin of the Faroe-Shetland Channel, and VME indicator species (cup corals, gorgonians, hydroids, soft corals, sponges, and stony corals) observed during a 2012 JNCC survey of the Wyville-Thomson Ridge. No recommendations were made.

RGVME comment

Please see General Comments with regard to inconsistencies in recommendations made by WGDEC between areas.

2.3 Bay of Biscay

WGDEC response: Surveys using photo and/or video transects revealed that VME indicator species occur in all canyons of the Bay of Biscay explored so far with scleractinian cold-water coral habitats distribution skewed towards the northern half of the Bay. Historic data records were in many cases confirmed as coral rubble.

RGVME comment

No advice is given on possible closures or boundary changes. It is not clear from the text, whether this is due to insufficient evidence or for other reasons. Figure caption is slightly confusing as it does not correspond to the legend. In the legend, the transparent symbols reflect OSPAR data, while the bold symbols reflect the ICES VME indicator database. In the caption it states that the transparent symbols are used to visualize existing data and bold symbols indicate new Ifremer data.

2.4 Norwegian waters

WGDEC Response: WGDEC makes some general statements about the MAREANO (*Marine AREA database for Norwegian coastal and sea areas)* project, and presents a map of Norwegian waters illustrating the data submitted to WGDEC from the MAREANO project.

No recommendations were made.

RGVME comment

- Please see General Comments with regard to inconsistencies in recommendations made by WGDEC between areas.
- The date shown in the legend of the figure present (from the OSPAR 2013 habitat database) gives an indication that the figure was likely to have been modified recently. MAREANO has been collecting these data since 2006, however, and there is no way to distinguish between older and newly observed VME indicator species.
- During a brief investigation, I learned that during 2012 MAREANO recorded three previously unknown coral reefs outside Frohavet in Trøndelag (mid-Norway). One of the coral reefs is approximately 200–250 meters long; the other two appear to be a few tens of meters in extent. These coral reefs were comprised largely of the stone coral (*Lophelia pertusa*) but other coral species grow in between. Scattered colonies of the corals Paragorgia and Primnoa were also observed at several locations. Large quantities of various species of sponges were also observed in the area surveyed (IMR, 2012). http://www.imr.no/nyhetsarkiv/2012/mai/koraller/en.
- During the 2013 MAREANO survey, a well-developed reef area was encountered at Skjoldryggen with several elongated live reefs of stone coral (*Lophelia pertusa*) aligned side by side. The reefs were located between 325 and 375 meters depth (IMR, 2013). **http://www.mareano.no/en/news/news_2013/coral_reefs_at_skjoldryggen**

2.5 Faroe Islands

WGDEC response

WGDEC reports on a single observation of *Lophelia pertusa* made onboard a Russian bottom trawler fishing within the Faroese EEZ during April–May 2013 on the slopes of the Louzy and Bill Baileys Banks between 60°57'N, 11°05'W and 60°56'N, 10°42'W at 590–630 meter depths. The catch of *Lophelia pertusa* weighed less than 1 kg. Other VME indicator species were not encountered. Figure 9 shows the haul tracks, site of the observation, and boundary of the 200-mile zone.

No recommendations are made.

RGVME comment

No comment.

2.6 Greenland

WGDEC response

WGDEC reported on one catch containing approximately 100 kg of sponge (genus *Geodia*). The information was received through onboard observers in Russian halibut fishery (Divisions 1C/D (63°40'–64°30'N, 54°57'–57°58'W). Fishing was conducted at the 800–1300 m depths in July–October 2013 (Figure 10), trawling between 64°22'N, 54°57'W and 64°28'N, 55°14'W at 831–900 m depth (Vinnichenko, Kanishchev and Fomin, 2014). Indicator species were not found in the other catches taken there, as well as in Division 1A between 69°15'–70°05'N, 58°54'–60°59'W, at 700–1300 m depths (Figure 11).

No recommendations were made.

RGVME comment

A cursory investigation on the Internet revealed that Canadian researchers had, by coincidence, discovered a reef of living cold-water corals in waters off southwest Greenland. This first-ever Greenland reef is located approximately at Lat: 60.3647, Long: -48.4488 between 670 and 1050 m depth and was formed by cold-water corals (*Lophelia pertusa*) with hard limestone skeletons. The temperature was 4.86°C, the water mass being of Atlantic origin. Several species of coral have been reported in Greenland, but this is the first time that an actual reef has been found. During September–October 2012, staff from the Bedford Institute of Oceanography, Dartmouth, secured *in situ* photographs of parts of this reef. The area is a current-swept steep part of the continental slope. (ICES Insight, Issue No. 50, 2013; Science Daily, Technical University of Denmark DTU), 2014).

References

Tendal, O.S., Jorgensbye, H.I.Ø., Kenchington, E., Yashayaev, I., and Best, M. 2013. Greenland's first living deep-water coral reef. ICES Insight, Issue No. 50.

http://ices.dk/sites/pub/Publication%20Reports/ICES%20Insight/Insight%20Issue%2050.pdf

http://www.sciencedaily.com/releases/2014/01/140128094334.htm

2.7 NAFO

WGDEC response: Bycatch data from bottom trawlers of corals and other VME indicator species did not exceed 1 kg at any time and no closure is recommended.

RGVME comment

It is not explained in the figure legend or caption of Figure 13 what the transparent symbols mean; is it existing data or a different data source.

3 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

WGDEC response

WGDEC has made inroads to develop a system using multi-criteria assessment (MCA) to formalize expert opinion and utilize relevant information from the ICES VME database. In this way, an index can be produced to evaluate the likelihood of how representative a datapoint is of the presence of a VME. Using MCA, a matrix can be developed to evaluate the performance of VME indicator data using a ranking system to weight, aggregate, and evaluate them.

WGDEC agreed upon four main criteria to rank to apply weights to reported VME indicators:

1) Survey Method;
2) Volume of Material;
3) Date of observation;
4) Whether the specimen was dead or alive.

Basis

To illustrate how MCA works, a matrix was constructed. Results indicate that this method identifies records where confidence is high that there is a strong likelihood for the presence of VMEs.

RG comments

Investigating the potential of this method definitely seems to be a step in the right direction. Through MCA, the process becomes more systematic, but the input data remain subjective. Of course, the danger lies in the arbitrary assignment of weights and scores to evaluate VME indicators, I would not necessarily agree with WGDEC chosen four main criteria, or how they were ranked; perhaps knowing whether a specimen is dead or alive is the most relevant/important feature (indication whether or not it needs to be protected), that being followed closely by the date of observation to indicate the urgency for taking action. Method ranking-Very good development.

Methods- feasible, follows on from previous ICES advice.

For the weight, it is stated that three categories are derived, but only two are given.

It is not sure why dead or alive received such a low weighting as it differentiates between active coral reefs and rubble fields. Is there a way to give quantitative estimation from visual surveys, i.e. coral detected in length of video material?

Implementation appropriate to the following VME indicator categories; Black coral, Gorgonian, Lace coral, Seapen, Sponge and Stony coral, but not appropriate to other indicator species. Why not?

Figures 18 and 19 illustrate how the weighting system can improve the information displayed to help the decision-making process. It highlights the occurrence of multiple evidence and where data give support for potential closures. The figure caption says that "Acoustic criteria to detect VMEs features were not used in this analysis." although the survey weighting categories does contain multibeam surveys.

The limitations are addressed in Section 4.4 and suggestions are made to develop this method further. Preliminary figures suggest that the application of the MCA method has great potential and could already be used to support advice.