Advice on areas where Vulnerable Marine Ecosystems (VMEs) are known to occur or are likely to occur in EU waters

Advice summary

ICES uses five scenarios to advise on areas (polygons) where Vulnerable Marine Ecosystems (VMEs) are known to occur or are likely to occur and applies these scenarios separately to EU waters of the Celtic Seas and the Bay of Biscay and Iberian Coast.

For the Celtic Seas, the total number of VME polygons within the 400–800 m depth zone ranged 57–62, and the areal extent ranged 4 559–5 896 km^2 among scenarios. For the Bay of Biscay and the Iberian Coast, the figures were 51–64 (total number of VME polygons) and 7 821–9 619 km^2 (areal extent).

Changes to VME polygons relative to previous advice (ICES, 2023a) include additions, expansions, and reductions in the number, size, and shape of VME polygons. These changes are based on new or updated evidence of VME occurrence and/or on new or updated evidence of mobile bottom-contacting gears (MBCG) fishing intensity, resulting in a change in risk of further Significant Adverse Impacts (SAIs) to VMEs where they co-occur with fishing activity.

Request

As per article 9(4) Regulation (EU) 2016/2336, called the "Deep-sea access regulation", ICES is requested to carry out an annual assessment of areas where VMEs are known to occur or are likely to occur in EU waters. Therefore, ICES will evaluate annually the applicability of the latest relevant advice. This recurring advice should be building on the advice provided on 5 January 2021, which established a list of VMEs occurrences and likely occurrences for regulatory purposes. Revision or update of this advice shall be made considering new and updated science and data reported to ICES, methodological developments (latest benchmark), and further implementation of the FAO International Guidelines for the management of deep-sea fisheries in the high seas (FAO, 2009).

Format of the advice

This advice consists of a) the main advice document (this document), b) an interactive document (vme.eu.pdf, https://doi.org/10.17895/ices.advice.26983726), and c) data products (EU VME Advice Data Products.zip, https://doi.org/10.17895/ices.advice.26983726). This main advice document should be read in conjunction with the interactive document and vice versa.

The interactive document presents the distribution of VME polygons in EU waters of the Celtic Seas and the Bay of Biscay and the Iberian Coast, based on five spatial management scenarios. It shows the available evidence on the spatial occurrence of VMEs in 2023, the distribution and intensity of MBCG fishing activity over 2009–2022, and the location of VME areas established by the EU to protect VMEs (Regulation [EU] 2022/1614 [EU, 2022]). It also compares the properties and locations of the VME polygons presented in the ICES (2023a) advice and this 2024 advice.

The data product comprises maps of VME polygons and co-ordinates for polygon boundaries.

Limitations that apply to all analyses and advice in this document, the interactive document, and the data product are summarized in the "Quality of the assessment" section.

Definitions

Mobile bottom-contacting gears (MBCG): mobile fishing gears that contact the seabed during deployment, primarily bottom otter trawls in the context of this request, but also applying to bottom seines, dredges, and beam trawls in other contexts.

C-square: for the purposes of this advice, "c-square" refers only to a grid cell of dimensions 0.05° latitude × 0.05° longitude (extent varies from approximately 25 km^2 at 36°N to less than 13 km^2 at 66°N).

Swept-area ratio (SAR): the sum of the area swept by a defined set of MBCG in a defined area (usually one c-square) in a defined period (usually one year) divided by the extent of the defined area.

VME habitat records: VME records that are generally derived from visual survey data (e.g. remotely operated vehicle [ROV] or towed/drop camera seabed imagery) that demonstrate the presence and location of a VME with a high degree of confidence and spatial accuracy. For this advice, ICES limited its use of VME habitat records to those VME taxa listed in Annex III of EU (2016).

VME indicator records: VME records of indicator species from data sources for which there is a degree of uncertainty about whether a VME is, or was, present. Typical examples are trawl-survey or static longline bycatch records. For this advice, ICES limited its use of VME indicator records to those VME taxa listed in Annex III of EU (2016).

VME physical elements: seabed topographic features, readily identified using high-resolution multibeam data, with which VME are often associated. Examples include seamounts, coral mounds, and banks.

VME Index: a categorical measure that combines the strength of evidence for the presence of a VME with their sensitivity. It takes values of 'high', 'medium', or 'low' likelihood of VME presence (ICES, 2022b). For this advice, ICES limited its use of VME indicator records to those VME taxa listed in Annex III of EU (2016).

VME polygons: defined areas within which VME are known to occur or are likely to occur with an associated buffer. VME polygons are generated following the five scenarios described in Table 1. VME polygons presented in the interactive document are clipped to the boundaries of the 400–800 m depth zone, as defined at the c-square scale.

Buffer: A precautionary area included in the VME polygons. This area is added along the outer edges of the c-squares or set of c-squares meeting the criteria for inclusion in a VME polygon based on the presence of VME habitat, VME index categories and/or VME elements, and the history of MBCG fishing. The precautionary area has a width of one half of a c-square (0.025° latitude or longitude). If a VME polygon is closed to MBCG by managers, the buffer provides one way to reduce the probability of MBCG interactions with those c-squares within the polygon where VME are known to occur or are likely to occur. Note that c-squares are not buffered when selected under the criteria of "includes c-squares that contain selected VME physical elements associated with any records of VME indicator taxa or VME habitat" (Scenarios B and E) (ICES, 2022b).

Scenarios (A-E): Five scenarios for creating VME polygons, developed by ICES (2022b). Each scenario gives different weightings to VME index categories and/or VME physical elements, as well as the history of MBCG fishing, evaluated at the c-square scale. This variability in weightings results in different levels of stringency in the definition of where VME occur or are likely to occur.

Overlapping VME polygons: VME polygons are described as overlapping the 400–800 m depth zone when any part of a polygon overlaps the 400–800 m depth zone as defined at the c-square scale. Unique numeric identifiers are assigned to all overlapping polygons.

Clipped VME polygons: VME polygons are described as clipped when they have been clipped to the boundaries of the 400–800 m depth zone as defined at the c-square scale. Clipped polygons are therefore within the 400–800 m depth zone defined at the c-square scale. Clipping will occasionally split a single overlapping polygon into two or more clipped polygons.

Elaboration on the advice

The assessment area relevant for this advice comprises EU waters of the Celtic Seas and Bay of Biscay and Iberian Coast. The rationale for not including deep-sea areas in the Swedish and Danish EEZs (limited fishing) still applies (ICES, 2021a). The EU waters in the outermost regions of the EU (Azores, Madeira, Canary Islands, Reunion, Mayotte, French Guiana, Martinique, Guadalupe, and Saint Martin) are also not included but are covered in a separately reported technical service

that reviews and reports on the knowledge base for where VMEs are known to occur or are likely to occur, as well as on deep-sea fishing activity in each region (ICES, 2024a).

ICES delineates VME polygons following five spatial management scenarios (termed Scenarios A–E; Table 1). These scenarios all rely on VME data, in some cases combined with information on VME physical elements and the history of MBCG fishing. Input data for the entire assessment area is used to delineate the VME polygons. VME polygons overlapping the 400–800 m depth zone (evaluated at the c-square scale) are identified and given unique numbers. These overlapping polygons are subsequently clipped to the boundary of the 400–800 m depth zone (evaluated at the c-square scale). The clipped polygons are presented in this advice. The clipping process may split a single overlapping polygon with a unique numeric identifier into two or more clipped polygons. In the data product, split overlapping polygons are identified by an additional character identifier (a, b, c….) in the VME polygon ID number.

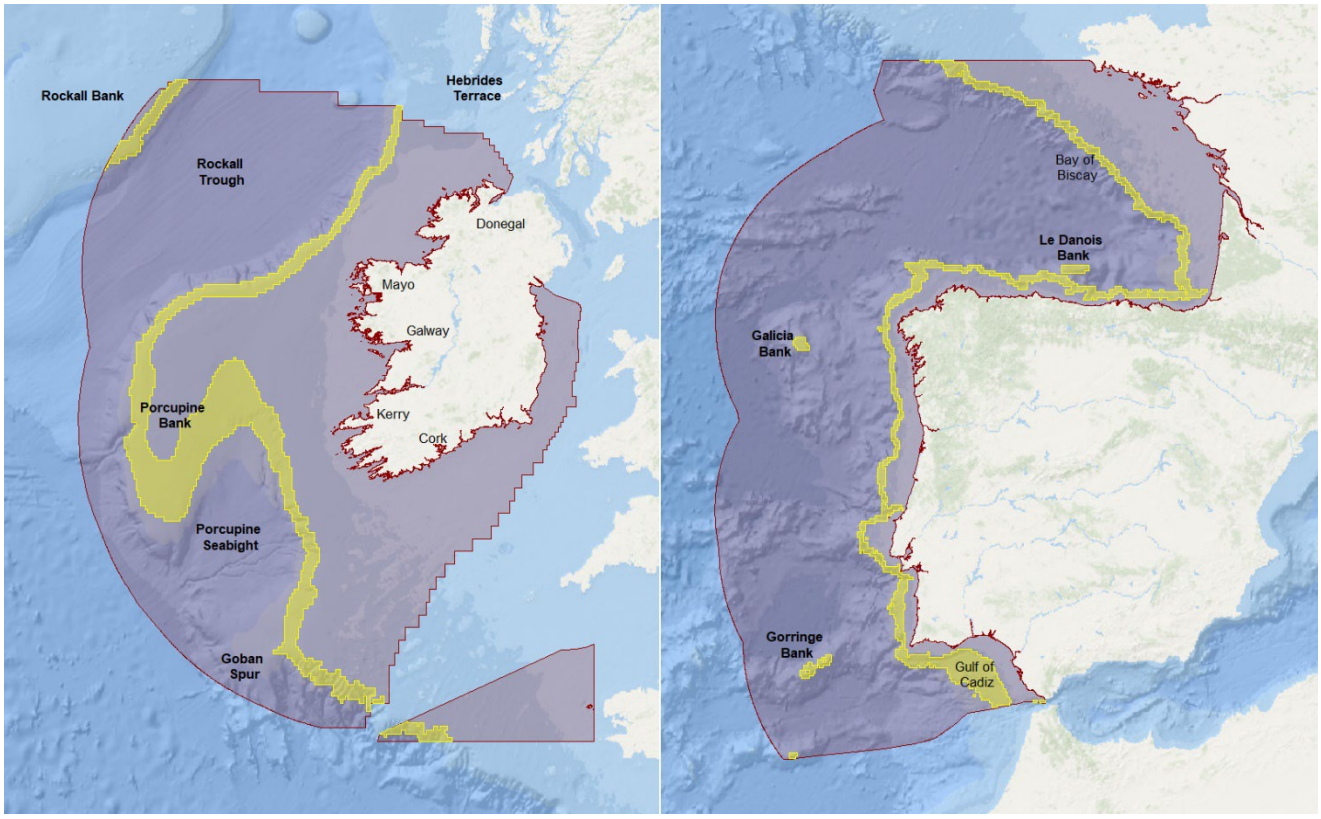

Figure 1. The assessment areas (purple) in the Celtic Seas (left) and the Bay of Biscay and the Iberian Coast (right) areas, indicating the areas assigned to the 400–800 m depth zone (yellow).

Celtic Seas

In comparison with the VME polygons described in previous advice (ICES, 2023a), the most notable change in 2024 is the removal (in scenarios C, D, and E) of a large VME polygon on the Porcupine Bank (Figure 1 and map CS1, interactive document). This VME polygon was associated with low VME Index c-squares, and its removal in 2024 is due to the updated VMS data, which now exceeds the 0.43 SAR threshold. Additional minor contractions and a few additions and extensions of VME polygons are found for all scenarios, especially in the northern part of the Celtic Seas area, along the Irish continental shelf margin; and around Porcupine Bank and southeast of Rockall Bank. New additions and extensions reflect the inclusion of new VME data in the assessment, while the (small) contractions are linked to updated and resubmitted evidence of VME records or corrections of positional data associated with some records in the ICES VME database. In the area to the west of Donegal, Mayo, and Galway, this results in some of the VME polygons described in earlier advice (ICES, 2023a) no longer being supported by the evidence base.

Between 9.1% (Scenario D) and 12.2% (Scenario C) of existing EU deep-sea fishing areas in the Celtic Seas were identified as VMEs polygons in 2024 (Table CS2, interactive document). The total areal extent of new and updated VME polygons

ranges from 4 559 km^2 (Scenario D) to 5 896 km^2 (Scenario C) (Table CS2, interactive document). Between ~ 70% (scenarios C, D, and E) and ~ 75% (scenarios A and B) of the updated VME polygons area overlaps with the VME areas currently established by the EU for VME protection.

Scenarios A and B, which are based on VME records, result in comparable outcomes owing to the limited occurrence of physical VME elements within the 400–800 m depth range of the Celtic Seas assessment area. Both scenarios generate 57 VME polygons, with Scenario A generating slightly larger ones than Scenario B (91.6 km^2 vs. 90.1 km^2), resulting in a larger total polygon area (5 220 km^2 vs. 5 134 km^2) (Table CS2, interactive document). Both scenarios include all VME habitat records and identical proportions of VME indicators records. However, scenarios A and B include a lower proportion (34.6%) of sea-pen records compared to scenarios C and E (Table CS3, interactive document).

Scenarios C and E, which are based on VME recordings and MBCG fishing intensity, result in 62 VME polygons that have a larger total area (5 896 km^2 and 5 810 km^2, respectively), a larger average areal extent of large polygons (373 km^2), and higher proportions of existing deep-sea fishing areas identified as VME polygons (12.2% and 12.1%, respectively) compared to other scenarios. Scenario C has a slightly larger average polygon areal extent (95 km^2 vs. 94 km^2) (Table CS2, interactive document). Scenarios C and E would maximize the inclusion of sea-pen records in the polygons relative to other scenarios (Table CS3, interactive document).

Scenario D, which applies the strictest definition of where VMEs without SAI are known to occur or are likely to occur, results in the smallest averages of both overall and large VME polygon extents (77 km^2 and 259 km^2, respectively), and the smallest total polygon area (4 559 km^2, Table CS2, interactive document). Scenario D has the lowest proportional overlap with existing deep-sea fishing areas (9.1%) and the lowest proportions of VME habitat and indicator records included in VME polygons (Table CS3, interactive document).

Bay of Biscay and the Iberian Coast

In comparison with previous (ICES, 2023a) VME polygons, there are very limited changes in this 2024 advice, and those changes made are due to updates to the VMS data (SAR values) used in the assessment. No new VME records were received for this area since the last ICES advice (2023) was issued.

In 2024, there are additions of VME polygons due to a reduction of SAR in areas within the 400–800 m depth zone to the north of Spain and west of Portugal (Scenario D) and in the Gulf of Cadiz (scenarios C, D, and E). In both areas, the new VME polygons extend already-existing VME polygons (ICES, 2021a, 2023a), which are also located within EU-established VME areas. These EU-established VME areas may have driven a reduction in SAR in the periphery of the established areas due to management restrictions in place, causing the expansion of these as presented here in the 2024 assessment.

Between 12.3% (Scenario D) and 18.9% (Scenario E) of existing EU deep-sea fishing areas in the Bay of Biscay and Iberian Coast area were identified as VME polygons in 2024 (Table BI2, interactive document). The total areal extent of new/updated VME polygons ranges from 6 422 km^2 (in Scenario D) to 9 619 km^2 (in Scenario E). Between 37.8% (Scenario B) and 50.7% (Scenario D) of the total polygons area overlaps with VME areas currently established by the EU for VME protection (Table BI2, interactive document).

Scenarios C and E, which consider both VME recordings and MBCG fishing intensity, result in a higher total number of VME polygons (64 and 62, respectively), a larger total area (9 005 km^2 and 9 619 km^2), and a higher proportion of existing deep-sea fishing areas identified as VME polygons (18.4% and 18.9%) compared to other scenarios (Table BI2, interactive document). These scenarios include all VME habitats records and the highest proportions of VME indicator records (Table BI3, interactive document).

Scenarios including VME physical elements, without and with considering MBCG activity (scenarios B and E, respectively), result in the highest average areal extent of individual polygons (166 km^2 and 155 km^2, respectively) and large polygons (777 km^2 and 759 km^2). Three VME physical elements are dominantly responsible for this: Le Danois Bank, Galicia Bank, and Gorringe Bank. Differences between these two scenarios depend on the differences in the inclusion criteria for low VME index C-squares in VME polygons. Thus, ten polygons identified under Scenario E are not identified under Scenario B (including two polygons in the Bay of Biscay, three in northern Spain, and five in the Gulf of Cadiz). Further, three large polygons encompassing each of the Le Danois, Galicia, and Gorringe Bank VME physical elements in scenarios B and E are split into five smaller polygons in Scenario C.

Scenario A, which is based solely on VME recordings, results in intermediate outcomes in terms of number and extent of VME polygons and is equal to the 2022 advice (ICES, 2023a), as there are no new VME records. Scenario D, which applies

the strictest definition of where VMEs without SAI are known to occur or are likely to occur, results in the lowest average size of polygons (111 km²), average size of large polygons (323 km²), total area identified as VME polygons (6 422 km²), and fraction of existing EU deep-sea fishing areas identified as VME polygons (12.3%) (Table BI2, interactive document).

Basis of the advice

Background

The existing deep-sea fishing areas referred to in this advice are those established in Annex I of EU (2022) for the reference period 2009–2011 and based on the analysis of VMS data by ICES (2021a). ICES notes that under the annual VMS data call, EU member states have the option to resubmit VMS data for all years, including the reference period (2009–2011).

The EU regulations on deep-sea fishing (EU, 2016) and the conservation of fisheries resources and the protection of marine ecosystems through technical measures (EU, 2019) apply to bottom-trawling gears fished deeper than 400 m and bottom-set gillnets deployed deeper than 600 m and limit fishing to a depth of 800 m. The EU regulation establishing existing deep-sea fishing areas and VME areas applies to depths deeper than 400 m (EU, 2022). Consequently, this advice primarily focuses on depths of 400–800 m.

New and updated VME records

In 2024, ICES received a total of 80 new VME occurrence records and 30 VME absences (i.e. non-detections of VME) in c-squares overlapping the 400–800 m depth zone of EU waters of the Celtic Seas. No new records from the Bay of Biscay and Iberian Coast were submitted to ICES in 2024. Of the updated records in 2024, 12 (one VME habitat and 11 VME indicator) records previously occurred within the 400-800 m depth zone of EU waters, which reduced to two (one VME habitat and one VME indicator) records with the update to positional information. New and updated records in Celtic Seas correspond to 25 new c-squares where VMEs are known to occur (VME habitat) or are likely to occur (high, medium, and low VME index). The new/updated VME data bring total numbers of VME habitat and VME index c-squares to 42 and 247 (respectively) for the EU waters of the Celtic Seas and to 39 and 161 (respectively) for the Bay of Biscay and Iberian Coast (ICES, 2024d).

The new/updated medium VME index c-square in the Celtic Seas occurs in the 400–800 m depth zone to the southeast of Rockall Bank. This new c-square is due to a correction of the positional data associated with an adjacent c-square located to the west. The 17 new/updated low VME index c-squares occur predominately in the 400–800 m depth zone on the Porcupine Bank to the west of Ireland, but also in the EU waters of the northern areas of the Celtic Seas.

In total, 84% of the new/updated VME c-squares occurring within the 400–800 m depth zone overlap with areas fished by MBCG. Five of the seven new/updated high and medium VME index c-squares overlap with fished areas. The new/updated VME habitat c-square is outside currently fished areas evaluated at the c-square scale.

Methods

ICES uses five scenarios (named A–E, Table 1) to delineate VME polygons where VMEs are known to occur or are likely to occur. The assessment method creates these VME polygons from VME records and VMS data following the method described in ICES (2022b), based on the input data described in Annex 1.

Because the VMS data is processed at the c-square scale, this is the spatial resolution used in the assessment, and the VME records are aggregated at this scale. Fishing intensity (SAR) is assumed to be uniformly distributed within c-squares. Additional consequences of conducting the assessment at c-square scales are explained in the “Quality of the assessment” section of this document.

The assessment is performed based on all VME and VMS data available for the entire assessment area, which covers the EU waters in the Celtic Seas and Bay of Biscay and the Iberian Coast. VME polygons overlapping the 400–800 m depth zone are identified and subsequently clipped to the boundaries of the 400–800 m depth zone within the assessment area, as that is the area of interest for this advice. The depth zone is determined using EMODnet Bathymetry Consortium (2018) depth data, which are available at a much finer resolution than the c-squares. Hence, each c-square has many EMODnet depth records. ICES defined the 400- 800 m depth zone as those c-squares i) where the minimum EMODnet depth is ≥ 400 m and ≤ 800 m, ii) where the maximum EMODnet depth is ≥ 400 m and ≤ 800 m, or iii) where the minimum EMODnet depth is ≤ 400 m and the maximum is ≥ 800 m. C-squares are allocated to EU waters when centroid coordinates are located within EU waters.

ICES collates and makes available records of VMEs, their types and distributions across the North Atlantic in the ICES VME database[*] to support VME research and provide inputs to analyses underpinning ICES advice. ICES uses these data to identify c-squares that contain or are likely to contain VMEs. The VME database contains quality-controlled data submitted by ICES Member Countries and is updated following annual ICES VME data calls (ICES, 2024b). Data submissions can include new and updated/revised VME information. Data contained in the VME database up to and including those submitted in 2023 are included in this advice.

Two types of data are submitted to the ICES VME database. The first type is data that confirm the presence of VMEs on the seabed. These are referred to as "VME habitats" and include e.g. video observations of cold-water coral reefs or deep-sea sponge aggregations from dedicated deep-sea surveys with accurate positioning. VME habitats represent C-squares where VMEs "are known to occur". The second type of data consists of presence records of VME indicator taxa, without full certainty of VME presence. These include e.g. records of soft coral or sea pen bycatch in trawls. For data of the second type, ICES developed a method to aggregate records of VME indicator taxa at the c-square level into a "VME index" using FAO criteria and available abundance information (ICES, 2022b). The VME index indicates c-squares where VMEs "are likely to occur" and distinguishes between high, medium, and low likelihood of VME occurrence (ICES, 2022b). VME habitats and indicator taxa considered in this assessment are limited to those listed in Annex III of Regulation (EU) 2016/2336 (EU, 2016).

Following the January 2024 VME Data Call (ICES, 2024b), there were 1 038 presence records and 32 absence (non-detection) records accepted by the VME Data Quality Assurance sub-group for inclusion into the ICES VME database (ICES, 2024d). Two VME indicator records were removed from the database as a result of database curation. This brings the total number of records in the ICES VME database to 73 380, of which 57 842 are VME indicator records, 9 902 are VME habitat records, and 5 636 are absence records.

VME physical elements are defined in the FAO Deep-sea Fisheries Guidelines (FAO, 2009) as topographical, hydrophysical, or geological features, including fragile geological structures that potentially support VMEs. Examples are seamounts, coral mounds, and banks. ICES uses the presence of VME physical elements to predict the likely occurrence of VMEs in a given c-square. Note that a single VME physical element can span multiple c-squares, in which case all these c-squares will be considered when predicting the occurrence of VMEs per c-square.

ICES uses VMS data to determine the presence or absence of MBCG fishing within a c-square. VMS data are submitted by ICES Member Countries in response to the annual ICES VMS data call (ICES, 2023b). Annual submissions can include new data as well as error corrections and resubmissions. For c-squares where MBCG fishing occurs, fishing intensity (SAR) is calculated using vessel speed and gear width estimates based on both fishery and vessel length (Eigaard *et al.*, 2016). The SAR expresses the proportion of the seabed in each c-square assumed to have come into contact with MBCGs. The assessment uses average SAR values calculated for each c-square, using VMS data from 2009–2022. A threshold SAR value of 0.43 is used to distinguish c-squares in which the risk of SAI from MBCG fishing is considered low (SAR ≥ 0.43) or relatively high (SAR < 0.43) (van Denderen *et al.*, 2022). The evidence basis for the SAR threshold value is described in ICES (2022b).

This advice considers broad-scale spatial management scenarios consistent with United Nations General Assembly (UNGA) resolutions, FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas (FAO, 2019), and Regulation (EU) 2016/2336 (EU, 2016) through the application of the five scenarios. These scenarios emphasize different aspects of the UN Resolutions by applying different weightings to the VME index categories and/or VME physical elements, as well as the history of MBCG fishing (Table 1). Scenarios A and B determine VME polygons solely on evidence of VMEs occurrence, while scenarios C through E consider evidence of both VME occurrence and MBCG fishing intensity. In all scenarios, VME polygons are created by selecting c-squares according to a set of criteria (Tables 1 and 2). A buffer rule is applied to account for uncertainties in the exact location of the VME record or the location of the MBCG relative to vessels position. A buffer of one-half of a c-square (0.025° latitude or longitude) is added along the outer edges of the selected c-square or set of c-squares. Note that this buffer is not applied to c-squares selected based on the presence of VME physical elements.

[*] Vulnerable Marine Ecosystems. 2024. ICES, Copenhagen, Denmark. https://ices.dk/data/data-portals/Pages/vulnerable-marine-ecosystems.aspx

Table 1. Scenarios used to create Vulnerable Marine Ecosystem (VME) polygons. SAR: Swept Area Ratio, which represents the MBCG fishing intensity. SAI: Significant Adverse Impacts. Relationships between these scenarios and the scenarios and options in Table 2.1 of ICES (2022b) are Scenario A = scenario 1 option 1; Scenario B = scenario 1 option 2; Scenario C = scenario 2 option 1; Scenario D = scenario 2 option 2; Scenario E = combined scenarios.

Scenario	Description of VME polygons	Interpretation
A	• Includes c-squares with VME habitat and c-squares with high VME index or medium VME index. • C-squares with low VME index are only included if they are adjacent to c-squares with VME habitat, high VME index, or medium VME index.	Creates polygons that include all c-squares with VME habitat, high VME index, or medium VME index. In addition, polygons include low VME-index c-squares that are adjacent to a c-square with VME habitat, high VME index, or medium VME index, regardless of MBCG fishing intensity.
B	• Includes c-squares with VME habitat and c-squares with high VME index or medium VME index. • C-squares with low VME index are only included if they are adjacent to c-squares with VME habitat, high VME index, or medium VME index. • In addition, includes c-squares that contain selected VME physical elements associated with any records of VME indicator taxa or VME habitat.	Creates polygons following Scenario A, with the addition of c-squares including VME physical elements associated with evidence of VME presence, regardless of MBCG fishing activity.
C	• Includes c-squares with VME habitat and c-squares with high VME index, or medium VME index. • C-squares with low VME index are included if SAR < 0.43. • C-squares with low VME index and SAR ≥ 0.43 are only included if they are adjacent to c-squares with VME habitat, high VME index, or medium VME index, or if they are adjacent to c-squares with low VME index with SAR < 0.43.	Creates polygons that include all c-squares with VME habitat, high VME index, or medium VME index (as in Scenario A), but also includes c-squares with low VME index after accounting for MBCG fishing intensity. Low VME index c-squares are included (i) if MBCG fishing intensity is unlikely to have led to SAI on the VME, (ii) if adjacent to c-squares with VME habitat, high VME index, medium VME index, or to c-squares with low VME index where MBCG fishing intensity is unlikely to have led to SAI.
D	• C- squares with VME habitat and c-squares with high VME index, medium VME index, or low VME index are only included if SAR < 0.43.	Creates polygons that include c-squares with VME habitat, high VME index, medium VME index, or low VME index, only where MBCG fishing intensity is unlikely to have led to SAI on the VME.
E	• Includes c-squares with VME habitat and c-squares with high VME index or medium VME index. • C-squares with low VME index are included if SAR < 0.43. • C-squares with low VME index and SAR ≥ 0.43 are only included if they are adjacent to c-squares with VME habitat, high VME index, or medium VME index, or if they are adjacent to c-squares with low VME index with SAR < 0.43. • In addition, includes c-squares that contain selected VME physical elements associated with any records of VME indicator taxa or VME habitat.	Creates polygons based on a combination of Scenarios B and C. This scenario applies the broadest definition of where VMEs are known to occur or are likely to occur.

Table 2. Criteria for delineating VME polygons in scenarios A to E. The half c-square buffer applies in all cases, except for c-squares selected based on the presence of VME physical elements (green).

Scenario	Known VME occurrence		Likely VME occurrence						Potentially supports VME
	VME Habitat		VME Index						VME Physical Element
			High		Medium		Low		
	SAR < 0.43	SAR ≥ 0.43	SAR < 0.43	SAR ≥ 0.43	SAR < 0.43	SAR ≥ 0.43	SAR < 0.43	SAR ≥ 0.43	
A									
B									
C									
D									
E									

Quality of the assessment

Swept area ratio

The measure of MBCG fishing intensity used in this advice is swept-area ratio (SAR). SAR is the sum of the area swept by a defined set of MBCG (here, all MBCG métiers) in a defined area (here, one c-square) in a defined period (here, one year) divided by the extent of the defined area. Therefore, the SAR indicates the theoretical number of times a defined area is swept per unit time if MBCG fishing is assumed to be uniformly distributed within that defined area. For example, a SAR of two means that each location within the defined area is fished two times over the year, and a SAR of 0.5 means that each location is fished once in two years. However, these are mean rates; in practice, fishing intensity is patchy, and some areas of the c-square may remain unfished while others are fished more intensively than the mean rate.

Swept area ratio, threshold value

The scenarios that account for MBCG fishing activity use a SAR fishing intensity threshold value of 0.43. For c-squares where fishing intensity exceeds this threshold, ICES assumes that the risk of significant adverse impacts (SAI) experienced is low. The value of the threshold is based on evidence from the NAFO area for sea pens, which are the least sensitive (i.e. most resilient) VME taxa to bottom trawling in this area. ICES uses this threshold value because there is no defined threshold value for EU waters. ICES has not evaluated the effects of changes in the threshold value on the outcome of the assessment. The risk of SAI cannot be assumed to be nil within c-squares where SAR exceeds the threshold value. This is because VMEs and/or VME indicator species may be present in such c-squares, especially if fishing activity was aggregated within parts of the c-square and unfished or very infrequently fished locations persist.

Static gear

Bottom fishing in existing EU deep-sea fishing areas includes fishing with MBCG and fishing activity using static gear. At present, fishing with static gear is not included in the assessment scenarios. The interaction between static gear and the seabed is variable among gear types (e.g. gillnets, pots, longlines). Available evidence suggests that static gears have a lower impact on VME habitats than MBCG, but further investigations are required to understand the risk of SAI from static gear fishing on VMEs.

Spatial resolution

The assessment is conducted at the c-square scale, where c-squares are grid cells of dimensions 0.05° latitude × 0.05° longitude. C-square extent varies with latitude, from 25 km^2 at 36°N to less than 13 km^2 at 66°N. Since buffer zones, which are included in the VME polygons, are based on c-squares (0.025° latitude or longitude), their extent also varies as a function of latitude. Consequently, similar VME records would result in larger VME polygons at a more southerly latitude.

Rationale for spatial resolution

The assessment performed to derive VME polygons is performed at the c-square scale because c-squares are the basic units used for VMS data. The c-square scale is adopted for VMS data (a) because there are constraints on finer scale analyses imposed by the frequency of VMS position records and the typical speeds of vessels during fishing operations, and (b) because c-squares nest directly into ICES rectangles (a grid system also based on fixed intervals of latitude and

longitude) that are used for reporting the catch and effort data that are linked to VMS position records. To allow fishing intensity (SAR) and VME data to be combined at the same scale, VME were also allocated to c-squares.

Description of depth zones
C-squares are allocated to the 400 –800 m depth zone, based on depth data from the EmodNet Bathymetry Consortium (2018), i) when the minimum EMODnet depth is ≥ 400 m and ≤ 800 m, ii) when the maximum EMODnet depth is ≥ 400 m and ≤ 800 m, or iii) when the minimum EMODnet depth is ≤ 400 m and the maximum is ≥ 800 m. Depths in c-squares are variable, depending on seabed topography and especially in slope areas. Consequently, parts of a c-square allocated to the 400–800 m depth zone may be deeper than 800 m or shallower than 400 m.

VMS data
The completeness and quality of the VMS data is dependent on the responses of ICES Member Countries to the ICES VMS data calls. Responses to annual calls may include corrections to data for preceding years. ICES undertakes some routine quality checks on submitted national data. Vessel speeds are used to differentiate whether the vessel is fishing or not fishing. When vessels are traveling at speeds within the range used to differentiate MBCG fishing activity, this will result in overestimation of the distribution and intensity of fishing activity.

VME data
Following recommendation by the ICES/NAFO Joint Working Group on Deep-water Ecology (WDGEC) in 2020 (ICES, 2020), submissions to the VME data call are subject to quality assurance/quality control (QA/QC) checks (ICES, 2024c). Prior to this, historic data included published and grey literature records that included minimal and/or approximated spatial and temporal information. Owing to the nature of VMEs, i.e. their relative scarcity and typical temporal stability, historic records have been retained.

Following a quality review in 2024 (ICES, 2024d), further database standardization operations were conducted, with quality checks of associated geometry and positional data flagging incomplete records. For analytical purposes, many of these were inconsequential to analysis and results. Positional errors, of varying degrees, were corrected for 93 VME indicator records arising from 28 sampling events (bottom-trawl tows) across four surveys in the ICES VME database. One station containing two records (dead *Lophelia pertusa* and *Funiqulina quadrangularis*) was removed, as the positional data were erroneous and could not be confirmed. One VME habitat record from one sampling event was also corrected.

VME Index
The VME Index is a categorical measure that combines the strength of evidence for the presence of a VME with their sensitivity, and takes values “high”, “medium”, and “low”. While a high value of the VME index is likely associated with high abundance of VME indicator taxa, as a two-component index, the value will not be directly associated with VME abundance. Thus, high VME index values may arise from a high number of records of VME indicator taxa of low sensitivity or from a low number of records of highly sensitive taxa (ICES, 2022b).

Changes of VME polygons since ICES (2023a)
The method underlying polygon creation in this advice is the method used in the ICES 2023 advice (ICES, 2023a). As such, any changes in the VME polygons are driven by changes in the VME data and/or changes in the VMS data. New submissions of both types of data in response to ICES data calls for VME (e.g. ICES, 2024b) and VMS (e.g. ICES, 2023b) include data collected since the preceding call as well as updates to data for earlier years in the time-series.

Changes in fishing intensity alone can alter the selection of VME-indexed c-squares that are included in the VME polygons under scenarios C, D, and E. Consequently, local increases of MBCG fishing activity, including resulting from displacements, may lead to the exclusion of indexed VME c-squares that were formerly included. This may result in partial or even complete removal of VME polygons compared to previous advice. Similarly, if polygons coincide with areas with changing MBCG management, for instance re-opening of previously closed areas, this could also lead to the (partial) removal of these VME polygons.

VME habitat and indicator taxa
For this advice, ICES was requested to use the VME habitat and indicator taxa listed in Annex III of the EU Deepsea Access Regulation (DSAR), Regulation (EU) 2016/2336 (EU, 2016), on fishing for deep-sea stocks. ICES suggests that Annex III be updated to include the VME habitats, subtypes, and VME indicator taxa identified in ICES (2021a) to ensure consistency with the criteria for identifying VMEs in the FAO guidelines (FAO, 2009).

Additional information

Annex 1 describes the data used in the assessment, the data presented in the interactive document and not used in the assessment, and the rationale for data updates. Annex 2 describes column headers in the data product.

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Annexes

Annex 1

Table A1. Description of data used in the assessment and the rationale for updates.

Name	Data	Datatype/ resolution	Source	Updated since ICES (2023)	Rationale for use or for update
VME index 2024	VME habitats and index (only VME taxa as described in Annex III of EU [2016])	c-square (0.05° × 0.05°)	ICES 2024 VME data call (ICES, 2024b) and quality control (QC) by WGDEC (ICES, 2024d)	Yes	The most recently collated and QC data
VME observations	VME indicator species and VME habitat observations (only VME taxa as described in Annex III of EU [2016])	Coordinates	ICES 2024 VME data call (ICES, 2024b) and QC by WGDEC (ICES, 2024d)	Yes	The most recently collated and QC data
VME physical elements	Seamounts, coral mounds, and banks (only VME physical elements as described in Annex III of EU [2016])	Polygons	Compiled by the ICES Working Group on Marine Habitat Mapping	No	No new information available
MBCG intensity	Mobile bottom fishing activity as average SAR based on VMS and logbook data for 2009– 2022	c-square (0.05°×0.05°)	ICES 2023 VMS and logbook data call (ICES, 2023b) and qc by ICES Working Group on Spatial Fisheries Data (WGSFD)	Yes	The most recently collated and QC data
MBCG activity	C-squares with mobile bottom fishing activity based on VMS and logbook data for 2020–2022	c-square (0.05°×0.05°)	ICES 2023 VMS and logbook data call (ICES, 2023b) and QC by WGSFD	Yes	The most recently collated and QC data
Depth zone 400–800 m	Bathymetry as minimum, maximum, and average depth per c-square	c-square (0.05°×0.05°)	EmodNet Bathymetry Consortium (2018)	No	
EU Assessment Boundary	EU waters of the Northeast Atlantic	Polygons	Flanders Marine Institute in the 2020 Union of the ESRI Country shapefile and the Exclusive Economic Zones (version 3) for Ireland, Portugal and Spain. Available at https://doi.org/10.14284/403	No	

Table A2. Description of data layers presented in the interactive document, which are not used as "input" data in the assessment.

Name	Data	Data type/ resolution	Source	Updated since ICES (2023)	Rationale for use or for update
C-squares with updated VME Index in 2024	Comparison between VME indices 2023 and 2024	c-square (0.05° × 0.05°)	VME Index (ICES, 2023a) and VME Index calculated for this advice	Yes	Comparison of the VME Index from 2023 with the one from 2024
EU fishable domain	Presence of bottom-contacting gear (static and mobile) based on VMS and logbook data for 2009–2011	c-square (0.05° × 0.05°)	ICES (2021a)	No	Footprint polygon from EU (2022) Annex I
EU established VME areas	Areas where fishing with bottom gears is prohibited (EU, 2022)	Polygons	EU (2022) Annex II, coordinates translated into polygons	No	Locations subject to prohibition of fishing with bottom gears (EU, 2022)

Annex 2 Column headers in the data products (.csv and .xlsx files) describing VME polygons**.** The .shp files have an "id" column that contains the same information as the "Polygon_Number" column described below.

Column header	Description
Polygon_Number	A unique identifier for the polygons, comprising a number denoting each overlapping polygon and a character that is added if clipping to the 400–800 m depth zone splits the overlapping polygon into two or more clipped polygons.
Coordinate_Order	A unique coordinate number for each polygon vertex, which can be used to connect the individual coordinates in each polygon
Coordinate_ID	A unique reference string identifying each individual vertex, following the format Polygon_Number_Coordinate_Order
Longitude	Longitude in decimal form according to the WGS84 coordinate system. The coordinates are rounded to 3 decimal places (note that trailing zeros may be removed).
Latitude	Latitude in decimal form according to the WGS84 coordinate system. The coordinates are rounded to 3 decimal places (note that the trailing zeros may be removed).