EU request on spatial trade-off analysis between reducing the extent of mobile bottom-contacting gear (MBCG) disturbance to seabed habitats and potential costs to fisheries

Advice summary

ICES advises that fishing with mobile bottom-contacting gears (MBCG) in EU marine waters of the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast areas is spatially aggregated into core areas that account for most of the total landings weight and landings value and peripheral areas accounting for a small proportion of total landings weight and landings value. On average, for the years 2017–2022, and given the available data, ICES finds that 90% of MBCG landings value comes from less than 50% of the fished area when the percentages are evaluated at scale of c-squares (grid cells of 0.05° latitude × 0.05° longitude).

Core fishing grounds are defined as the smallest area yielding 90% of the landings value, evaluated annually at the c-square scale. ICES advises that locations of core MBCG fishing grounds vary from year to year. For individual MBCG métiers, less than 50% of the c-squares fished at any time from 2017–2022 were classified as core fishing grounds in every year in EU waters of the Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast areas.

ICES conducted trade-off analyses to estimate the potential costs to MBCG fisheries in terms of reductions in MBCG fishing intensity, landings weight, and landings values to achieve a defined percentage of each Marine Strategy Framework Directive (MSFD) Broad Habitat Type (BHT) that is unfished (range of percentages 10–90%, in increments of 10%).

For the Greater North Sea and the Celtic Seas areas, ICES advises that maintaining a persistently unfished state in 50% of the extent of all MSFD BHTs within the overall area is associated with an estimated reduction of 20% of the annual mean MBCG landings value. Maintaining 70% of BHTs in a persistently unfished state in the Greater North Sea and the Celtic Seas areas is associated with estimated reductions in landings values of 31.6% and 36.7% per year respectively. Results for individual subdivisions and BHTs are provided in this document and the accompanying interactive documents.

For the Baltic Sea area, ICES advises that maintaining a persistently unfished state in 70% of the extent of all BHTs within the overall area leads to an estimated reduction of less than 7% of the annual mean MBCG landings value. This is much lower than for the Greater North Sea and Celtic Seas areas, consistent with the absence of MBCG fishing in much of the Baltic Sea. For the Bay of Biscay and the Iberian Coast area, landings value reductions were not estimated because of data deficiencies.

Limitations apply to the input data, analyses, and advice. These include the omission of data for most < 12 m MBCG fishing vessels, the effects of analytical scale, the use of landings value rather than gross value added (GVA) as a measure of economic impact, not accounting for the ecological and fisheries consequences of displacement or landings value by displaced vessels, and incomplete vessel monitoring system (VMS) data submissions to ICES. The consequences of these limitations are elaborated in the 'Limitations of the advice' section.

Request

ICES is requested to build upon their 2021 ICES advice (eu.2021.08), with a particular focus on extending the established approaches to the EU waters[1] of the Mediterranean and Black Seas, and further developing the approaches and updating the data for the Baltic and North-east Atlantic regions. This should:

Provide analyses of the economic value of the bottom fisheries linked spatially to their distribution, in order to define the distribution of fishing value and distinguish 'core' and 'peripheral' fishing grounds per métier following the approach of ICES 2021 advice, and determine the spatial variation in 'core fishing grounds' over time. The analysis should assess, as far as possible, the gross (landings value and weight) and net (revenues, profits, contribution margin, accounting for fuel, salaries, maintenance costs and fishing effort/time) value of each fishery.

Provide a trade-off analysis of the potential costs to fisheries of achieving various proportions, expressed in 10% intervals (as % reduction in effort, and in euros), of each MSFD broad habitat type per MSFD subdivision[2] free from bottom fishing. The trade-offs should maximise overall gain in benthic sea-floor status and minimise lost revenue/profit (catch/value). The analysis should include scenarios for a) displacement of fishing effort from peripheral to core fishing grounds and b) removal of fishing effort.

[1] As declared by Member States for MSFD implementation purposes, including continental shelf areas beyond territorial waters and EEZs (MSFD Marine waters, v1.0, May 2020, to be updated in 2022). Fishing activity by non-EU states in EU waters should be included, wherever possible.

[2] The analysis should be done for the 22 MSFD Broad Habitat Types (Table 2 of Commission Decision (EU) 2017/848) and using the latest version of the EUSeaMap habitat map from EMODnet (September 2021, based on 2019 EUNIS classification), or higher quality maps from other sources. The analysis should use regionally agreed subdivisions of the MSFD (sub)regions, such as those being used for the 2023 quality status reports of the Regional Sea Conventions; in the absence of regionally agreed subdivisions, it should use the subdivisions of the ICES 2021 Advice (for Baltic and Atlantic) and from DG ENV (for Mediterranean and Black Seas).

Note: the EU request included an item on scoping and exploration of the spatial and temporal distribution and intensity of fishing using bottom-contacting fishing gears, relating to the Mediterranean and Black seas and vessels < 12 m in length or without VMS. These topics were addressed by ICES Workshop on Small Scale Fisheries and Geo-Spatial Data 2 (ICES, 2023a). Data limitations precluded development of the workshop outcomes into ICES advice.

Format of the advice

This advice consists of the main advice document (this document) and four interactive documents for the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast areas respectively. This main advice document should be read in conjunction with the interactive documents and vice-versa. The interactive documents describe the distribution, intensity, impacts, and landings weight and value of MBCG fisheries in the four areas and associated subdivisions and BHTs, the estimated consequences and costs (loss of landings weight and value) of limiting the relative extent of MBCG fisheries, and assessment of the effects of reducing the depletion rate of fauna through gear modification. Limitations applying to all analyses and advice presented in both this document and the four interactive documents are summarized in the "Limitations of the advice" section.

Geographical boundaries

The analyses and advice for the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast area are restricted to EU marine waters, as defined by EU Member States for MSFD implementation purposes. Descriptions of the boundaries of these waters are collated by the European Environment Agency (EEA). These boundaries are adopted by ICES for the purposes of addressing this EU request. ICES has no competence to take a position, directly or indirectly, on the definition and location of maritime boundaries either of, or between, EU Member States or between EU Member States and non-EU states. As fishing with MBCG is prohibited in depths of more than 800 m by Regulation (EU) 2016/2336 (EU, 2016) in the areas considered in this advice, ICES limits this advice on MBCG fishing and impacts to waters shallower than 800 m.

The extents of EU marine waters, and depth zones within these waters, in the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast areas are summarized in Table 1. EU marine waters as defined account for 34% of the area of the Greater North Sea, 53% of the Celtic Seas and ≥ 90% of the area of the Baltic Sea and Bay of Biscay and the Iberian Coast. For the Bay of Biscay and the Iberian Coast only a small proportion of the area of EU marine waters is accessible to MBCG because most of the area is deeper than 800 m. Table A1.1 provides details of extents by MSFD subdivisions and depth zones.

Table 1 Extent of and depth zones within EU marine waters in the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and Iberian Coast areas.

Area		Baltic Sea	Greater North Sea	Celtic Seas	Bay of Biscay and the Iberian Coast
Extent of area (km²)		389 991	651 069	930 940	768 067
Extent of EU marine waters (km²) (% of area)		350 930 (90%)	220 762 (34%)	492 673 (53%)	753 778 (98%)
Extent of EU marine waters by depth (km²)	0 – 200 m	349 025	218 310	194 772	130 885
	200 – 400 m	1 872	1 848	41 599	18 721
	400 – 800 m	32	604	34 649	24 913
	≥800 m	0	0	221 651	579 259
Percentage extent of EU marine waters by depth (%)	0 – 200 m	99.5	98.9	39.5	17.4
	200 – 400 m	0.5	0.8	8.4	2.5
	400 – 800 m	0	0.3	7.0	3.3
	≥800 m	0	0	45.0	76.8

Definitions

Mobile bottom-contacting gears (MBCG): mobile gears that contact the seabed during deployment, including bottom otter trawls, bottom seines, dredges, and beam trawls.

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 25 km² at 36°N to less than 13 km² 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.

Broad Habitat Type (BHT): refers to Marine Strategy Framework Directive (MSFD) broad habitat types as defined in EU (2017).

Métier: for the purposes of this advice the references to "métiers" are to ten MBCG métiers, defined by fishing gear and target species group (Table 5).

Core fishing ground: for the purposes of this advice "core fishing ground" refers to the smallest area yielding 90% of landings value, evaluated annually at the c-square scale. A core fishing ground is characterized for a defined group of MBCG (e.g. a métier) within a defined area (e.g. MSFD subdivision).

Elaboration of the advice

Note: This "Elaboration of the advice" extracts and synthesizes results from the four interactive documents. The interactive documents present results at the scale of the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast areas and associated MSFD subdivisions, depth strata, and BHT.

Fishing by MBCG métiers within EU marine waters of the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast areas is spatially aggregated in core areas where fishing intensity and catch weight and value per unit area are high but extends to peripheral areas where fishing intensity and catch weight and value per unit area are low.

On average, over the six-year assessment period 2017–2022, ICES estimates that 72% of EU marine waters of depths 0–200 m in the Greater North Sea were fished with MBCG each year. Corresponding estimates for the Baltic Sea and Celtic Seas areas were 8% and 56% (Table 2). The value for the Bay of Biscay and the Iberian Coast area was 67%, but this was calculated with incomplete VMS data (see "Limitations of the advice" section). The level of fishing activity aggregation can be inferred from the difference between the area fished and the smallest proportion of the area with 90% of fishing intensity (Table 2). The fishing aggregation is strongest in the Greater North Sea, where a drop from 72% to 46% is observed in fished extent when comparing 100% and 90% of the fishing effort at depths of 0–200 m (Table 2), while this drop is much smaller in the Baltic Sea (from 8.4% to 7.8%, Table 2). Table A1.2 provides estimates of fished areas and the aggregation of fishing activity by depth zone for all subdivisions in the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast areas.

Core fishing grounds are defined as the smallest area yielding 90% of the landings value, evaluated annually at the c-square scale. Spatial stability of core fishing grounds was assessed as the number of years within the six-year assessment period that a given c-square was identified as a core fishing ground. Spatial stability of core fishing grounds varied among métiers, areas, and subdivisions (see figures 3 and 4 in all interactive documents). Typically, less than 50% of the c-squares that were fished at any time during the assessment period by individual métiers were classified as core fishing grounds in every year in EU waters of the Greater North Sea and Celtic Seas areas (Figure 3, interactive documents). In the Baltic Sea area, for all MBCG métiers, less than 5% of the c-squares that were fished at any time in the assessment period were classified as core fishing grounds in every year of the assessment period (Figure 3, Baltic Sea interactive document). The stability of core fishing grounds from year to year will, in part, be influenced by management actions. For example, in the Baltic Sea, the 2019 closure of the fishery targeting Eastern Baltic cod reduced the MBCG footprint. In the Bay of Biscay and the Iberian Coast area, core fishing grounds are not identified in the "Gulf of Cadiz", "North-Iberian Atlantic", or "South-Iberian Atlantic" because VMS data were incomplete.

Some areas are persistently unfished at the scale of the c-square over the six-year period. Proportions of persistently unfished c-squares at depths of 0–200 m in the Greater North Sea and Celtic Seas areas were estimated to be 6% and 14% respectively. For the Bay of Biscay and the Iberian Coast area 19% was persistently unfished, but this will be an overestimate because of incomplete VMS data (Table 3 in all interactive documents). In the Baltic Sea, 76% of c-squares were persistently unfished (Table 3 in the Baltic Sea interactive document). This is because MBCG is not deployed in most of the central and northern Baltic Sea areas. The method for defining persistently unfished areas does not include unfished areas within c-squares, so the method generates minimum estimates.

Table 2 Values of indicators for the mean proportion of the area fished by year (Indicator I–3, see Table 6) and the smallest proportion of area with 90% of fishing intensity, evaluated at c-square scale (Indicator I–4, see Table 6) by depth zone in the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast areas. For the Bay of Biscay and the Iberian Coast area, the VMS data were incomplete. n/a: not applicable.

Area		Baltic Sea	Greater North Sea	Celtic Seas	Bay of Biscay and the Iberian Coast
Proportion of area fished by year (Indicator I–3), expressed as %	0–200 m	8.4	72	56	67
	200–400 m	0	97	73	73
	400–800 m	0	40	47	30
Smallest proportion of area with 90% of fishing intensity, evaluated at c-square scale (Indicator I–4), expressed as %	0–200 m	7.8	46	41	46
	200–400 m	n/a	72	51	47
	400–800 m	n/a	27	33	24

To achieve good environmental status for MSFD Descriptor 6 (D6) on seabed integrity, the EU Member States, through an EU cooperation process under the MSFD Common Implementation Strategy, defined the maximum proportion of a benthic BHT in an assessment area that can be adversely affected as 25% of its natural extent (≤ 25%; EC, 2024). The values in Table 3 indicate the extent of each BHT in the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast areas that was persistently unfished by MBCG during the six-year assessment period 2017–2022. For example, 12% of circalittoral mud in the Greater North Sea was persistently unfished over the assessment period. Highlighted in bold are those habitats which do not meet the MSFD extent threshold (expressed as < 75% unfished by MBCG) because of fishing by MBCG in each of the four assessment areas. This indicative assessment does not take account of the extent of habitat fished by MBCG before the assessment period, most of the MBCG fishing activity by < 12 m vessels, or the fishing intensity over time on infrequently fished habitats, and how this affects their state. In addition, the assessment does not consider that fishing activity in c-squares with multiple BHTs could be aggregated to a subset of BHTs, with some BHTs remaining unfished. Further, infrequently fished areas may ultimately contribute to reported extent, depending on the threshold for quality of the seabed habitat. Such a threshold has yet to be adopted for D6 and may be less than 1, as assumed in this indicative assessment and which corresponds to the persistently unfished state. Threshold values below 1 would be associated with SAR > 0 and would thus include infrequently fished areas as areas not adversely affected. As such, the values in Table 3 only provide an indicative assessment of which habitats may or may not achieve the MSFD extent threshold.

Sediment habitats in the circalittoral, offshore circalittoral, and upper bathyal zones of the Greater North Sea, Celtic Seas and Bay of Biscay and the Iberian Coast areas are often impacted by MBCG, and < 75% of the extent of BHT is persistently unfished by MBCG. For the Baltic Sea many BHTs are less affected by MBCG (greater unfished extent), because MBCG fishing is concentrated in southern and western parts of this area. The extent of fishing by MBCG on habitat types in the shallower infralittoral and circalittoral zones is likely to be underestimated because of a lack of data from vessels < 12 m in overall length. Table A3 presents the extents of BHTs which were persistently unfished in the years 2017–2022 for all subdivisions in the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast areas.

Table 3 Estimates of the extent of MSFD Broad Habitat Type (BHT) which were persistently unfished in the years 2017–2022, expressed as a percentage of the extent of each BHT in EU marine waters at depths of 0–800 m in the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast areas. Values in bold **do not** meet the MSFD extent threshold of 75% (based on an assumption that the quality threshold is 1, see text). For the Bay of Biscay and the Iberian Coast area the VMS data were incomplete. n/p: MSFD BHT not present in that area. n/a: not applicable (no data in EUSeaMap [2021] for littoral habitats).

MSFD Broad Habitat Type (BHT)	Area			
	Baltic Sea	Greater North Sea	Celtic Seas	Bay of Biscay and the Iberian Coast
Littoral rock and biogenic reef	n/a	n/a	n/a	n/a
Littoral sediment	n/a	n/a	n/a	n/a
Infralittoral rock and biogenic reef	93.8	**17.4**	**19.7**	**66.1**
Infralittoral coarse sediment	**74.6**	**23.9**	**12.4**	**41.6**
Infralittoral mixed sediment	86.1	**60.8**	**33.6**	**52.3**
Infralittoral sand	**40.6**	**42.9**	**9.1**	**64.5**
Infralittoral mud	**68.5**	**44.5**	**35.2**	**62.1**
Infralittoral mud or infralittoral sand	97.4	n/p	n/p	n/p
Circalittoral rock and biogenic reef	97.4	**19.0**	**28.3**	**47.1**
Circalittoral coarse sediment	84.0	**3.0**	**32.2**	**3.9**
Circalittoral mixed sediment	90.4	**17.9**	**41.2**	**79.3**
Circalittoral sand	**54.5**	**3.1**	**22.9**	**26.5**
Circalittoral mud	79.3	**12.0**	**10.5**	**32.9**
Circalittoral mud or circalittoral sand	86.2	n/p	n/p	n/p
Offshore circalittoral rock and biogenic reef	99.2	**4.1**	**21.7**	**18.1**
Offshore circalittoral coarse sediment	84.9	**0.1**	**15.5**	**1.1**
Offshore circalittoral mixed sediment	**58.4**	**1.0**	**34.2**	**14.2**
Offshore circalittoral sand	**11.5**	**0.2**	**2.0**	**3.7**
Offshore circalittoral mud	**41.3**	**0.2**	**1.7**	**16.4**
Offshore circalittoral mud or offshore circalittoral sand	77.3	n/p	n/p	n/p
Upper bathyal rock and biogenic reef	n/p	**0.0**	**7.0**	**37.6**
Upper bathyal sediment	n/p	**7.9**	**13.9**	**19.7**
Upper bathyal sediment or upper bathyal rock and biogenic reef	n/p	n/p	**22.7**	**40.9**
Lower bathyal rock and biogenic reef	n/p	n/p	n/p	**30.5**
Lower bathyal sediment	n/p	n/p	**37.6**	**28.3**
Lower bathyal sediment or lower bathyal rock and biogenic reef	n/p	n/p	**15.7**	**43.2**
Abyssal	n/p	n/p	n/p	**3.4**
Unknown	n/p	**0.5**	**29.5**	**56.9**

The trade-off analyses estimated the potential costs to fisheries – in terms of reductions in fishing intensity, landings weight, and landings values – to achieve a defined proportion of every BHT that is unfished by area and subdivision (values tested from 10% to 90% in 10% increments). Reductions in fishing intensity, landings weight, and landings values were calculated following the stepwise removal of c-squares based on their contribution to total swept area over the six-year assessment period, starting with unfished c-squares and c-squares with the lowest swept area. Results are presented by BHT in the interactive documents for each area, while reductions in the mean annual absolute (in euros) and relative (percentage) landings value are summarized for the four areas in tables 4a and 4b. Table A1.4 presents the estimated reductions in mean annual absolute landings value (in millions of euros) associated with realizing a minimum percentage extent of unfished BHT by MSFD subdivision in the Baltic Sea, Greater North Sea, and Celtic Seas areas. Results are not presented for the Bay of Biscay and the Iberian Coast area because data deficiencies did not allow for the estimation of landings value reductions.

Tables 4a and 4b show that achieving 50% of the extent of all BHTs within the Celtic Seas area in a persistently unfished state is associated with a reduction of €36.4 million in annual mean landings value or 18.6% of the total landings value of €195.7 million. For the Greater North Sea, achieving 50% of the extent of all prevailing BHTs in a persistently unfished state is associated with a reduction in landings value of 14.6% per year (Table 4b). These estimates and conclusions do not take account of pressures that affect the habitats in each assessment area other than MBCG fishing

Obtaining 70% of the extent of all BHTs in the Greater North Sea and Celtic Seas areas in a persistently unfished state would be associated with reductions in mean annual landings values of 31.6% and 36.7% respectively. For the Baltic Sea area, the reductions in absolute and relative landings value associated with obtaining a given proportion of persistently unfished area for BHT are far lower (6.9%) than for the Greater North Sea and Celtic Seas areas. This is because MBCGs are not deployed in most of the central and northern Baltic Sea.

Results in the interactive documents illustrate the considerable variation in the percentage reductions in landings values associated with meeting the extent threshold (> 75% not adversely affected [EC, 2024]) for different BHTs (Table 8 in all interactive documents). However, since a threshold for quality of the seabed habitat has yet to be adopted for D6, and the value of this threshold may be less than 1, lightly fished areas as well as persistently unfished areas may ultimately contribute to areas meeting the extent threshold.

ICES advises that these absolute and percentage reductions are maximum estimates of costs for the vessels included in the analyses because i) they are expressed as landings value rather than GVA (see “Gross Value Added [GVA]” section in the Annex), ii) they assume that the quality threshold is set at 1, and iii) vessels displaced from closed areas may access, and continue to land, fish from other fishing grounds. ICES emphasizes that costs linked to the exclusion of < 12 m MBCG vessels that are prevalent in coastal fisheries will be insufficiently represented in the analyses (see “Gross Value Added [GVA]” section in the Annex).

Table 4a Reductions in absolute landings value (in millions of euros) per year associated with realizing a minimum percentage unfished extent of all MSFD Broad Habitat Types (BHTs) in the Baltic Sea, Greater North Sea and Celtic Seas areas. The stepwise exclusion of c-squares is conducted per BHT in 10% increments, based on their contribution to total swept area over the six-year assessment period and starting with unfished c-squares and c-squares with the lowest swept area.

Area	Proportion of all MSFD BHT persistently unfished 2017–2022 (%)									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Baltic Sea	0	<0.1	<0.1	<0.1	0.2	0.6	1.5	3.2	6.8	21.8
Greater North Sea	5.8	16.3	31.3	49.9	77.1	113.5	166.2	241.3	342.7	526.5
Celtic Seas	0.9	5.8	12.9	23.3	36.4	52.2	71.8	97.4	133.1	195.7

Table 4b Reductions in (b)relative landings value (%) per year associated with realizing a minimum percentage unfished extent of all MSFD Broad Habitat Types (BHT) in the Baltic Sea, Greater North Sea and Celtic Seas areas. The stepwise exclusion of c-squares is conducted per BHT in 10% increments, based on their contribution to total swept area over the six-year assessment period and starting with unfished c-squares and c-squares with the lowest swept area.

Area	Proportion of all MSFD BHT persistently unfished 2017–2022 (%)									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Baltic Sea	0	<0.1	<0.1	0.2	0.7	2.6	6.9	14.6	31.2	100
Greater North Sea	1.1	3.1	5.9	9.5	14.6	21.5	31.6	45.8	65.1	100
Celtic Seas	0.4	3.0	6.6	11.9	18.6	26.7	36.7	49.8	68.0	100

The effects of gear modifications were assessed, based on the assumption that gears may be modified to achieve a 5%, 10%, or 20% reduction in the depletion of benthic faunal biomass per gear pass (% reductions in the depletion rates are given in Table 7). Reductions in depletion may also be achieved by changes in gear deployment by fishers. Effects were calculated as changes in habitat "quality" (measured as 1−PD impact [population dynamics method, impact indicator] or 1−PDsens impact [population dynamics method, impact indicator for sensitive species]) in the fished area and expressed in terms of the increase in the quality of habitat meeting the extent threshold (> 75% of a BHT not adversely affected [EC, 2024]).

Basis of the advice

Introduction

ICES described the distribution and intensity of fishing with MBCG at the c-square scale in EU marine waters of the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast areas for the years 2017–2022. This information was used to estimate the values of five pressure and four impact indicators (Table 6). Pressure indicators describe the concentration and intensity of MBCG fishing and the extent of fished and unfished areas; impact indicators describe reductions in the relative abundance of benthic fauna resulting from MBCG fishing and the extent of areas where reductions in relative abundance of benthic fauna are less than 20%. Pressure and impact were linked to landings weight and landings value by c-square. ICES assessed the implications of excluding fishing from a proportion of MSFD subdivisions and BHT, beginning with unfished and peripheral areas. Implications are expressed as losses of fishing intensity, landings weight, and landings value. ICES assessed the effects of gear modifications – which reduce the depletion of benthic fauna per gear pass by 5%, 10%, or 20% – on the extent and status of impacted habitat for the most widespread habitat types in the assessment areas.

Assessment period

This advice is based on data for the years 2017–2022. This six-year period was selected to include the latest available VMS and logbook data rather than to match a specific MSFD assessment period.

Boundaries

This advice relates to EU marine waters shallower than 800 m in the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast areas and to 17 MSFD subdivisions within these areas. For the Baltic Sea, the subdivisions are as used in ICES (2021), based on HELCOM sub-basins in the Baltic (HELCOM, 2013). For the Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast areas, the subdivisions used are the assessment areas for benthic habitats used in the OSPAR Quality Status Report 2023 (OSPAR, 2023). Twenty-two BHTs defined in EU (2017) are assessed. Assessments are presented by area, MSFD subdivision, MSFD BHT and for depth strata 0−200 m, 200−400 m, and 400−800 m (strata > 200 m included as appropriate, given the bathymetry of the area considered).

Scales of analysis

The smallest assessment units are 0.05° latitude × 0.05° longitude c-squares. Centroid positions of the c-squares were used to allocate them to EU marine waters and to MSFD subdivisions.

Depths

Mean depths within c-squares were calculated with data sourced from the EMODnet Bathymetry Consortium (2018) and Baltic Sea Hydrographic Commission (2013). Mean depths in c-squares were used to allocate c-squares to depth strata of 0–200 m, 200–400 m, 400–800 m, and ≥ 800 m. (All depth strata of A–B m, include A and are up to, but not including, B.)

Métiers

Fishing vessels deploying MBCG were allocated to ten métiers (Table 5). The métier codes relate to the fishing gear and the target species assemblage group, and they have been grouped from EU Data Collection Framework (DCF) Level 6 métiers (EU, 2021) as reported in the ICES VMS data call. EU Member States have different rules for the thresholds for allocating to mixed métiers. This means métiers such as OT_MIX may have different characteristics among regions.

Table 5 Métier codes and characteristics of métiers included in the analyses.

Métier code	Main gear type	Target groups	Examples
DRB_MOL	Dredge	Molluscs	Scallops Pectinidae
OT_CRU	Otter trawl	Crustaceans	*Nephrops, Pandalus*, mixed fish
OT_DMF	Otter trawl	Demersal fish	Cod *Gadus morhua*, plaice *Pleuronectes platessa*
OT_MIX	Otter trawl	Mixed fish	Mixed fish
OT_SPF	Otter trawl	Small pelagic fish	Sprat *Sprattus sprattus*
SDN_DMF	Danish seine	Demersal fish	Cod, plaice
SSC_DMF	Flyshooter (seine)	Demersal fish	Cod, haddock *Melanogrammus aeglefinus*, flatfish
TBB_CRU	Beam trawl	Crustaceans	Brown shrimp *Crangon crangon*
TBB_DMF	Beam trawl	Demersal fish	Flatfish
TBB_MOL	Beam trawl	Molluscs	Whelk *Buccinum undatum*, snails, scallops

MSFD Broad Habitat Types

MSFD BHTs are defined in the Commission Decision (EU) 2017/848. A map of the distribution and extent of the 22 MSFD BHTs from EUSeaMap (2021) was used for the analyses. The map of BHTs provides higher resolution information than the c-square grid. The extent of each BHT within each c-square was calculated from the spatial overlay with the habitat map.

Swept area and swept-area ratio (SAR)

The basic measures of MBCG fishing intensity used in this advice are swept area and swept-area ratio (SAR). Swept area is the sum of the area swept by a defined set of MBCG in a defined time period (usually one year) in a defined area (usually a c-square). SAR is the swept area divided by the extent of the area in which swept area is measured. 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 2 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.

VMS data

VMS data were used to estimate SAR in each c-square. These data are submitted by ICES Member Countries in response to an annual ICES VMS data call. Annual submissions can include new data as well as error corrections and resubmissions. VMS location records are allocated to "fishing" and "not fishing" based on vessel speed and other filters (ICES, 2022). The swept area and SAR calculations require that VMS records providing vessel identity, location, and speed are linked with logbook data providing a gear code and fishing activity (DCF level 4 and 6 respectively). The swept area is calculated as hours fished × average fishing speed × gear width. The gear width is estimated based on relationships between average gear widths and average vessel length or engine power (kW; Eigaard *et al*., 2016; ICES, 2022).

Landings weight and value estimation

VMS location records are linked to logbook data to associate a location with gear code and fishing activity with landings weight and landings value records. Landings weight and landings value are then allocated to the VMS location records allocated to fishing, based on the time interval between location records or an equal split among location records by day, by ICES rectangle, or by trip. Total landings weight or landings value by c-square, in a given time interval, is calculated as the sum of the allocations to each location record in that c-square. In the workflow for answering the ICES VMS data call, different rules may be used by different Member Countries to distribute landings weight and landings value among the VMS location records where fishing activity is assumed (e.g. based on time interval between location records or to split equally among location records and by day, by ICES rectangle, or by trip).

Indicators of MBCG pressure and impact

Values of five pressure indicators and four impact indicators are reported in this advice (Table 6). Values of the pressure indicators (I−1 to I−5) and impact indicators (I−6a, I−6b, I−7a, and I−7b) provide information on the distribution, intensity, and impact of MBCG fisheries.

Table 6 Pressure and impact indicators, including the spatial scale and period for which indicators are evaluated. C-square refers to a grid cell of dimensions 0.05° latitude × 0.05° longitude. Examples of the "defined area" referred to in the description would be an area within a specified depth range or an area with the same BHT.

Indicator code	Indicator name	Indicator type	Description	Spatial scale	Evaluation period
I−1	Average fishing intensity	Pressure	Average number of times a defined area is swept by mobile bottom-contacting gears (MBCG). Estimated as the sum of swept area for all vessels using MBCG divided by the total area of the defined area.	Absolute extent (km^2)	One year
I−2	Proportion of area fished, evaluated at c-square scale	Pressure	The sum of the area of c-squares fished at least once by MBCG in a defined area, divided by the sum of the area of all c-squares in the defined area	C-square	One year
I−3	Proportion of area fished	Pressure	The sum of MBCG swept area in all c-squares in a defined area (where any swept area > c-square area is set to c-square area), divided by the sum of the area of all c-squares in the defined area	Absolute extent (km^2)	One year
I−4	Smallest proportion of area with 90% of fishing intensity, evaluated at c-square scale	Pressure	The sum of the area of the smallest set of c-squares accounting for 90% of the total MBCG swept area in a defined area, divided by the sum of the area of all c-squares in the defined area	C-square	One year
I−5	Proportion of area persistently unfished, evaluated at c-square scale	Pressure	The sum of the area of c-squares not fished with MBCG at any time in the assessment period in a defined area, divided by the sum of the area of all c-squares in the defined area.	C-square	Six years (assessment period)
I−6a	Average PD impact	Impact	The annual mean PD impact (population dynamics method, impact indicator), evaluated for a defined area	C-square	One year
I−6b	Average PD-sens impact	Impact	The annual mean PD-sens impact (population dynamics method, impact indicator for sensitive species), evaluated for a defined area	C-square	One year
I−7a	Proportion of area with PD impact < 0.2, evaluated at c-square scale	Impact	The sum of the area of c-squares in a defined area with PD < 0.2 divided by the sum of the area of all c-squares in the defined area (values <0.2 define areas where predicted reductions in abundance of benthic fauna are <20%. The threshold of 0.2 is illustrative only)	C-square	One year

Indicator code	Indicator name	Indicator type	Description	Spatial scale	Evaluation period
I−7b	Proportion of area with PD-sens impact < 0.2, evaluated at c-square scale	Impact	The sum of the area of c-squares in a defined area with PD-sens < 0.2 divided by the sum of the area of all c-squares in the defined area (values <0.2 define areas where predicted reductions in abundance of benthic fauna are <20%. The threshold of 0.2 is illustrative only)	C-square	One year

Values of the four impact indicators are generated from estimates of PD and PD-sens. PD (population dynamics method) is used to estimate the loss of benthic biomass, relative to carrying capacity, from a defined area if the current MBCG fishing intensity continues indefinitely (Pitcher *et al*., 2017; ICES, 2018; Hiddink *et al*., 2019; ICES, 2022). PD-sens (population dynamics method for sensitive species) is used to estimate the loss of biomass of sensitive benthic fauna (the 10% most long-lived biomass fraction), relative to carrying capacity, from a defined area if the current MBCG fishing intensity continues indefinitely (ICES, 2024a). For this advice, PD and PD-sens are estimated at the c-square scale and the indicators reported for subdivision, BHT, depth strata, or the wider area, as defined.

PD and PD-sens are estimated from SAR and parameters for depletion (proportional mortality) per pass of a MBCG and the intrinsic rate of increase of biomass of the benthic community (Pitcher *et al*., 2017). Estimates of depletion were métier-specific (Table 7) and taken from Rijnsdorp *et al*. (2020). The intrinsic rate of increase of biomass is estimated from the predicted distribution of maximum ages in an unimpacted benthic community in the relevant grid cell (Rijnsdorp *et al*., 2018). When PD-sens rather than PD is calculated, only the 10% most long-lived biomass fraction of this community is used to estimate the intrinsic rate of increase, to address the component of the benthic biomass most sensitive to MBCG. Further details are provided in ICES (2024a).

Table 7 Estimates of depletion rates for the métiers adopted in this advice (Rijnsdorp *et al*. [2020]).

Métier code	Main gear type	Depletion rate
DRB_MOL	Dredge	0.020
OT_CRU	Otter trawl	0.010
OT_DMF	Otter trawl	0.026
OT_MIX	Otter trawl	0.074
OT_SPF	Otter trawl	0.009
SDN_DMF	Danish seine	0.009
SSC_DMF	Flyshooter (seine)	0.016
TBB_CRU	Beam trawl	0.060
TBB_DMF	Beam trawl	0.140
TBB_MOL	Beam trawl	0.060

Scenarios

For the “footprint reduction” scenario, reductions in effort (swept area), landings weight, and landings value to achieve a defined proportion of every BHT in each assessment area which is unfished (values tested from 10% to 90% in 10% increments) were calculated. Reductions in fishing intensity, landings weight, and landings values were calculated following stepwise removal of c-squares based on their contribution to total swept area over the six-year assessment period for each BHT, starting with unfished c-squares followed by c-squares with the lowest swept area. In the “gear modifications” scenario, effects of gear modifications were assessed, based on the assumption that gears may be modified to achieve a 5%, 10%, or 20% reduction in the depletion of benthic faunal biomass per gear pass (% reductions in the depletion rates given in Table 7). Reductions may also be achieved by changes in gear deployment by fishers. Effects were calculated as changes in habitat “quality” (measured as 1−PD impact or 1−PDsens impact) in the fished area and expressed in terms of the increase in the quality of habitat meeting the extent threshold (> 75% of a BHT not adversely affected [EU, 2024]).

Summary of data sources

Data sources used to develop this advice are summarized in Table 8.

Table 8 Sources of data used in the analyses and justifications for updates to data sources used in the ICES (2021) advice. n/a: not applicable.

Layer	Data	Type/ resolution	Source	Updated since ICES (2021)	Rationale for update
Habitats	MSFD broad habitat types	Shapefiles	EUSeaMap (2021), EMODnet seabed habitats.	Yes	Version requested by European Commission to be used for the purposes of this advice request
MBCG fishing activity	Métier-specific SAR	c-square	ICES 2022 VMS and logbook data call, with quality control by ICES Working Group on Spatial Fisheries Data	Yes	Additional responses to VMS data calls since development of ICES (2021) advice
Seabed sensitivity	Modelled estimates of median longevity of benthic community	c-square	ICES (2023b)	Yes	New information since development of ICES (2021) advice
Water depth	Bathymetry	Shapefiles	EMODNet Bathymetry Consortium (2018)	No	
Water depth (Baltic Sea)	Bathymetry	500 m grid	Baltic Sea Hydrographic Commission (2013). Baltic Sea Bathymetry (2013)	No	
EU marine waters	Boundaries as defined by EU Member States for MSFD implementation purposes	shapefiles	European Environment Agency	n/a	n/a
Subdivisions in Greater North Sea, Celtic Seas and Bay of Biscay and the Iberian Coast areas	Assessment areas for benthic habitats	shapefiles	OSPAR (2022) as adopted in OSPAR (2023)	Yes	Proposal from ICES (2024b)
Subdivisions in Baltic Sea	Subdivisions used in ICES (2021), based on Baltic subbasins defined by HELCOM (2013).	shapefiles	HELCOM (2013), ICES (2021)	No	n/a

Limitations of the advice

This section describes limitations of the input data, analyses, and advice, including limitations specific to the Baltic Sea, Greater North Sea, Celtic Seas, or Bay of Biscay and the Iberian Coast areas.

Limited coverage of small-scale fisheries

A proportion of vessels < 12 m overall length fish with MBCG and are not represented in this advice because they are not monitored systematically with VMS. Consequently, MBCG pressure and impacts will be underestimated, especially in coastal waters (ICES, 2023b). To provide an indication of the contribution of < 12 m vessels to total MBCG fishing effort, STECF Fisheries Dependent Information (FDI) data were used to estimate the proportion of kW × days attributed to these vessels in ICES areas that intersect with the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast assessment areas (Table A1.6, Figure A1.1). In FAO Area 27 (Northeast Atlantic Ocean) overall, 8.2 % of the kW × fishing days are from < 12 m MBCG fisheries during the years 2017–2022, although in several coastal ICES areas < 12 m MBCG fisheries accounted for > 50% of the kW × fishing days (Table A1.6). More highly resolved analyses are not provided because FDI fishing effort data are compiled at larger scales than those used for the analyses based on VMS data.

Assessment of the economic importance of small-scale fisheries at these larger scales will underestimate their economic and social importance in some smaller coastal regions.

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 then this will result in overestimation of the distribution and intensity of fishing activity. In the workflow for answering the ICES VMS data call, different rules may be used by different Member Countries to distribute vessel landings or value of landings among the VMS location records where fishing activity is assumed (e.g. based on time interval between location records or to split equally among location records and by day, by ICES rectangle, or by trip). This may introduce biases that have not been quantified. MBCG are currently the only gear type for which ICES has information on the spatial intensity of fishing activity from VMS data. Other bottom-contacting gears may also impact seabed habitats (e.g. pots and traps, gillnets, and longlines) and are not considered in this advice. VMS data for Portugal were not included in the analyses as they were not submitted for most years in the assessment period. VMS data for Spain did not include information on the landings value.

Spatial resolution of analyses

ICES adopted c-squares of 0.05° latitude × 0.05° longitude for VMS analyses because they represent a suitable scale at which to grid VMS position records, predominantly but not exclusively reported at two-hour intervals. C-squares nest directly within the larger ICES rectangles (0.5° latitude × 1° longitude) used for the reporting and collation of the vessel, landings and other fisheries data in the logbooks that are linked to the VMS records. The variation in c-square extent (smaller extent with increasing latitude e.g. from 25 km^2 at 36°N to less than 13 km^2 at 66°N) results in higher numbers of VMS position records per c-square at lower latitudes (for a given overall distribution of position records) and may increase the prevalence of persistently unfished c-squares at higher latitudes. Estimates of area impacted and not impacted by MBCG depend on the spatial resolution of analysis. This is because MBCG fishing activity is often aggregated within c-squares, whereas the methods assume that MBCG fishing activity is uniformly distributed within the c-squares. Adoption of larger grid cells would increase estimated extents of fished areas and reduce estimated extents of unfished areas. Adoption of smaller grid cells would have the opposite effect.

Coastal c-squares

A proportion of c-squares in each assessment area contains coastline. For these c-squares, the land area was not subtracted from the total area of the c-square. This leads to an underestimation of SAR for these c-squares. This is because the estimate of swept area can only apply to the marine area while the denominator used in the SAR calculation is the sum of land area and marine area. If c-squares straddling the coastline are present, the extent of any area calculated from the sum of the areas of c-squares assigned to that area will differ from the extent of the area calculated using a shapefile. Further, since the extents of BHTs in c-squares straddling the coast are described by the EMODnet shapefiles, and do account for the location of the coastline, the calculated SAR will be lower for these BHT.

Geographic coverage

A small area in the south of the Exclusive Economic Zone (EEZ) of Portugal was not included in the analyses as it is outside the area covered by the sensitivity maps underlying the analyses (ICES, 2024a).

Broad habitat types

Variable levels of confidence are associated with the distribution and classification of BHTs, including the EUSeaMap (2021) data product used in this advice. The majority of habitat and boundary information in EUSeaMap (2021) underpinning the assessments is classified as either medium or low confidence. When several habitats are present within a c-square, the assumption of a uniform distribution of MBCG fishing in a c-square results in the assignment of MBCG fishing to all habitats within c-squares with recorded fishing activity, even to habitat types that may not be fished.

MBCG fishing intensity and impact

Methods of assessing fishing intensity (and thus pressure indicators) and impacts make assumptions about gear dimensions and benthic biomass depletion for entire métiers when there is significant unaccounted variation in these parameters within métiers. Intrinsic rates of increase of biomass are estimated from longevity distributions of benthic fauna, that are modelled based on data types and models that vary among areas (ICES, 2023b). The effects of these uncertainties on the outcomes of the analyses have not been quantified.

Interpretation of impact

The PD impact and PD-sens impact indicators (I−6a and I−6b in Table 6) are calculated with the PD method (ICES, 2022, 2023b). This is an equilibrium method, which estimates the relative abundance of benthic fauna lost from the c-square when a given MBCG fishing intensity is maintained over the long-term. For this reason, the annual values for the impact indicators do not indicate the impact resulting from one year of MBCG fishing but indicate the equilibrium impact resulting from the fishing intensity in the one year (expressed as SAR) continuing for many years.

Landings value

Landings value is estimated in different ways by ICES Member Countries responding to the VMS data call. For example, it may be derived from sales notes from individual fishing trips or calculated at lower resolution from prices × weight. Landings values do not account for the costs of fishing, and for this reason GVA, see “additional considerations” provides a more informative measure of economic losses resulting from the exclusion of MBCG fishing activity. Losses estimated from past landings values or GVA will not account for future changes in fish prices and costs incurred by the fishing industry.

Core fishing grounds

The identification of core fishing grounds was based on landings values for each métier, evaluated at the c-square scale. Within métiers there remain differences in vessels, gear types and fishing activities. For this reason, a core fishing ground for a métier may not be representative of core fishing grounds for individual vessels.

Footprint reduction scenarios

Analyses of the effects of excluding MBCG fishing (footprint reduction) do not take account of the spatial distribution of c-squares in peripheral areas or the spatial distribution of unfished c-squares. Consequently, the assumed exclusion areas are not contiguous and comprise patchworks of c-squares and portions of c-squares. Estimated reductions in landings weight and landings value following footprint reduction may be affected by changes in stock status.

Displacement

ICES was unable to assess the effects of displacement in the scenarios for fishing footprint reductions. For this reason, the estimated reductions in landings weight and landings value are maxima, and a proportion of these reductions may be compensated by the relocation of MBCG fishing vessels. Displacement will also lead to additional pressures and impacts on BHT elsewhere, as well as changes in impacts on fish stocks and changes in interactions between vessels and between métiers.

Additional considerations

Gross value added (GVA)

ICES was asked to advise how the economic value of each fishery (gross and net) is related spatially to the distribution of the fishing activity. Gross value added (GVA) is a more appropriate metric than landings value for assessing the economic status of the fisheries. To estimate net value, ICES (2024c) demonstrated an approach for disaggregating GVA (based on high-level economic reporting) to the c-square scale. The disaggregated GVA analysis were not used as a basis for this advice, however, owing to biases introduced by the disaggregation process. The “Gross Value Added (GVA)” section in the Annex describes the calculation of GVA, the disaggregation process, and potential steps towards reporting GVA at c-square scales in future. Comparisons of GVA and landings value at the scale of FAO areas, show that GVA is a relatively consistent proportion of landings value for MBCG fisheries involving vessels > 12 m in length. Thus, for FAO Area 27 (Northeast Atlantic Ocean) and FAO Area 37 (Mediterranean and Black Sea) GVA was 52–62% of landings value (Table A1.5).

Mediterranean Sea and Black Sea

ICES was unable to provide advice for the Mediterranean Sea and Black Sea. Investigation of available data and information was conducted by ICES (2023b) and demonstrated the availability of relevant studies. However, data were not available on sufficient scales or from enough EU Member States to provide analyses and advice for the Mediterranean Sea and Black Sea in a comparable manner to that for the Baltic Sea and Northeast Atlantic areas presented here (ICES, 2023b).

Macaronesia

EU marine waters include Macaronesia (Azores, Madeira, and Canary Islands), where a very narrow continental shelf limits bottom-fishing grounds. For instance, in the Azores, only 1% of the EEZ is available for bottom fishing, with the remaining area averaging 3000 m depth. As such, fishing vessels operating in Macaronesia tend to be small (< 12 m) and equipped with static gear. MBCG fishing is understood to be generally low or absent (e.g. bottom trawling is banned in the Azores), but very limited information is available. EU marine waters of the Azores, Madeira, and Canary Islands are not covered in this advice.

Marine protected areas (MPAs)

ICES was unable to advise on the fishing intensity, impact, and weight and value of landings inside and outside MPAs. This is because ICES is not aware of any database providing comprehensive information on regulations, and specifically the treatment of MBCG fisheries, for the many MPAs located in EU marine waters. Along with higher resolution information on vessel locations, such a database would be a prerequisite for assessing the contributions of MPAs to unimpacted seabed areas. Further, the boundaries of MPAs often cross c-squares and the available allocation rules may falsely allocate fishing activity to inside an MPA boundary when it is not fished. ICES (2024c) conducted preliminary analyses to assess the potential contributions of MPAs to unimpacted seabed, although the analysis was only indicative given the boundary issue described. Regulations for MPAs may exclude MBCG, and these MPAs will contribute to the proportion of seabed extent unimpacted by MBCG in any six-year assessment cycle. Similar issues exist in relation to assessing the effect of other areas closed to MBCG fisheries, such as areas used for offshore renewable energy generation.

Frequency of fishing location records

Many of the VMS position records used to calculate SAR and to allocate landings weight and landings value are received from fishing vessels at two-hour intervals, consistent with EU (2011). In part, ICES adopted c-squares of 0.05° latitude × 0.05° longitude for VMS analyses because they represented a suitable scale at which to grid two-hourly VMS position records. Higher frequency position records would enable higher resolution analyses and improved capacity to separate "fishing" and "not fishing2 activity. Collectively, this would provide more highly resolved MBCG footprints and more precise understanding of the spatial and temporal relationship between MBCG footprint and habitat. Higher frequency position records, including from AIS, are already available for some vessels in some areas, and have provided a basis for comparative studies. However, high frequency position records would be needed for a very high proportion of all MBCG vessels to enable higher resolution analyses at the scale of MSFD subdivisions (ICES, 2019).

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Annex

Table A1.1 Extent of and depth zones within EU marine waters in the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast and associated subdivisions.

Area Subdivision	Extent of area (km^2)	Extent of EU marine waters (km^2) (% of area)	Extent of EU marine waters by depth (km^2)				Percentage extent of EU marine waters by depth (%)			
			0–200 m	200–400 m	400–800 m	≥ 800 m	0–200 m	200–400 m	400–800 m	≥ 800 m
Baltic Sea	**389 991**	**350 930 (90%)**	**349 025**	**1 872**	**32**	**0**	**99.5**	**0.5**	**0**	**0**
Bothnian area	115 830	109 722 (95%)	109 276	446	0	0	99.6	0.4	0	0
Gulf of Finland	29 710	16 419 (55%)	16 419	0	0	0	100	0	0	0
Gulf of Riga	18 685	17 966 (96%)	17 966	0	0	0	100	0	0	0
Baltic Proper	147 625	131 811 (89%)	130 352	1 426	32	0	98.9	1.1	0	0
Arkona & Bornholm Basin	59 395	57 006 (96%)	57 006	0	0	0	100	0	0	0
Western Baltic Sea	18 746	18 006 (96%)	18 006	0	0	0	100	0	0	0
Greater North Sea	**651 069**	**220 762 (34%)**	**218 310**	**1 848**	**604**	**0**	**98.9**	**0.8**	**0.3**	**0**
Kattegat	23 412	23 197 (99%)	23 197	0	0	0	100	0	0	0
Norwegian Trench	86 250	9 484 (11%)	7 031	1 848	604	0	74.1	19.5	6.4	0
Central North Sea	282 324	18 991 (7%)	18 991	0	0	0	100	0	0	0
Southern North Sea	205 717	143 002 (70%)	143 002	0	0	0	100	0	0	0
Channel	53 366	26 089 (49%)	26 089	0	0	0	100	0	0	0
Celtic Seas	**930 940**	**492 672 (53%)**	**194 772**	**41 599**	**34 649**	**221 651**	**39.5**	**8.4**	**7**	**45**
Northern Celtic Sea	596 115	245 686 (41%)	74 533	30 019	16 240	124 895	30.3	12.2	6.6	50.8
Southern Celtic Sea	334 825	246 986 (74%)	120 240	11 580	18 409	9 676	48.7	4.7	7.5	39.2
Bay of Biscay and the Iberian Coast	**768 067**	**753 777 (98%)**	**130 885**	**18 721**	**2 491**	**579 259**	**17.4**	**2.5**	**3.3**	**76.8**
Gulf of Biscay	84 312	84 068 (98%)	77 542	5 928	599	0	92.2	7.1	0.7	0
North-Iberian Atlantic	401 992	388 826 (97%)	23 713	6 861	11 057	347 197	6.1	1.8	2.8	89.3
South-Iberian Atlantic	269 415	268 678 (100%)	22 631	4 665	10 095	231 289	8.4	1.7	3.8	86.1
Gulf of Cadiz	12 348	12 204 (99%)	7 000	1 268	3 163	774	57.4	10.4	25.9	6.3

Table A1.2 Values of indicators for the mean proportion of the area fished by year (Indicator I–3, see Table 6) and the smallest proportion of c-squares with 90% of fishing intensity (Indicator I–4, see Table 6) by depth zone in the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast areas and associated subdivisions. For the Bay of Biscay and the Iberian Coast area the VMS data were incomplete. n/a: not applicable, n/p: not present.

Area Subdivision	Mean proportion of area fished by year (Indicator I–3), expressed as %.			Smallest proportion of area with 90% of fishing intensity, evaluated at c-square scale (Indicator I–4), expressed as %.		
	0–200 m	200–400 m	400–800 m	0–200 m	200–400 m	400–800 m
Baltic Sea	8	0	0	8	n/a	n/a
Bothnian area	0	0	n/p	1	n/a	n/p
Gulf of Finland	0	n/p	n/p	n/a	n/p	n/p
Gulf of Riga	0	n/p	n/p	n/a	n/p	n/p
Baltic Proper	6	0	0	7	n/a	n/a
Arkona & Bornhom Basin	28	n/p	n/p	26	n/p	n/p
Western Baltic Sea	25	n/p	n/p	19	n/p	n/p
Greater North Sea	72	97	40	46	73	30
Kattegat	38	n/p	n/p	26	n/p	n/p
Norwegian Trench	79	97	40	55	73	27
Central North Sea	82	n/p	n/p	41	n/p	n/p
Southern North Sea	74	n/p	n/p	57	n/p	n/p
Channel	78	n/p	n/p	46	n/p	n/p
Celtic Seas	56	73	47	41	51	33
Northern Celtic Sea	17	66	47	13	47	32
Southern Celtic Sea	81	89	48	60	65	33
Bay of Biscay and the Iberian Coast	67	73	30	46	47	24
Gulf of Biscay	86	90	72	60	69	61
North-Iberian Atlantic	61	84	31	44	55	24
South-Iberian Atlantic	11	30	24	12	19	20
Gulf of Cadiz	68	91	39	39	47	28

Table A1.3 Extent of MSFD broad habitat types (BHTs) which were persistently unfished in the years 2017–2022, expressed as a percentage of the extent of each BHT in EU marine waters at depths 0–800 m in the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast areas and associated subdivisions. For the Bay of Biscay and the Iberian Coast area the VMS data were incomplete. n/p: MSFD BHT not present in that area. n/a: not applicable (no data in EUSeaMap [2021] for littoral habitats).

Broad habitat type	**Area** / Subdivision																				
	Baltic Sea	Bothnian area	Gulf of Finland	Gulf of Riga	Baltic Proper	Arkona & Bornholm Basin	Western Baltic Sea	**Greater North Sea**	Kattegat	Norwegian Trench	Central North Sea	Southern North Sea	Channel	**Celtic Seas**	Northern Celtic Sea	Southern Celtic Sea	**Bay of Biscay and the Iberian Coast**	Gulf of Biscay	North-Iberian Atlantic	South-Iberian Atlantic	Gulf of Cadiz
Littoral rock and biogenic reef	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Littoral sediment	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Infralittoral rock and biogenic reef	93.8	99.8	100	100	99.9	61.9	90.9	17.4	41.0	35.1	n/a	1.2	0	19.7	35.1	16.9	66.1	39.9	84.9	99.8	89.1
Infralittoral coarse sediment	74.6	96.5	100	100	95.3	67.1	37.1	23.9	72.9	11.3	0	0.2	0	12.4	30.5	8.1	41.6	44.7	78.4	n/p	21.3
Infralittoral mixed sediment	86.1	96.6	100	100	98.9	68.3	54.7	60.8	63.8	86.5	n/p	14.7	0	33.6	82.4	1.7	52.3	77.1	88.8	97.5	2.3
Infralittoral sand	40.6	96.1	100	100	83.4	27.4	44.8	42.9	77.4	2.4	0	7.8	0.1	9.1	27	3.8	64.5	36.5	88.1	99.9	37.6
Infralittoral mud	68.5	99.7	100	100	97.4	7.6	51.4	44.5	70.8	88.3	n/p	31.4	0	35.2	43.6	23.9	62.1	60.1	94.2	97.6	33.7
Infralittoral mud or Infralittoral sand	97.4	93.3	100	100	96.2	100	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p
Circalittoral rock and biogenic reef	97.4	99.5	100	100	97.1	33.2	100	19.0	30.9	26.0	n/p	34.4	0	28.3	46.9	6.7	47.1	5.2	64.8	93.5	61.1
Circalittoral coarse sediment	84.0	97.7	100	100	83	53.1	15.4	3.0	42.3	3.2	0	1.3	0	32.2	54.2	1.8	3.9	0.9	50.8	100	5.1
Circalittoral mixed sediment	90.4	98.0	100	100	87.4	54.4	30.2	17.9	44.7	39.6	0	1.6	0	41.2	41.3	18.5	79.3	3.3	69.0	90.9	0.6
Circalittoral sand	54.5	98.7	100	100	55.6	18.0	22.3	3.1	30.1	3.7	0	1.8	0	22.9	30.8	4.4	26.5	1.5	64.8	95.1	19.2
Circalittoral mud	79.3	93.5	100	100	75.6	3.3	6.3	12.0	18.9	72.8	0	2.3	0	10.5	13.7	6.1	32.9	5.8	68.6	93.9	2.6
Circalittoral mud or Circalittoral sand	86.2	93.9	100	100	72.3	18.7	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p
Offshore circalittoral rock and biogenic reef	99.2	100	100	n/p	99.5	0	n/p	4.1	1.7	3.4	n/p	31.1	0	21.7	35.9	1.4	18.1	0.1	14.9	42.7	n/p
Offshore circalittoral coarse sediment	84.9	100	100	n/p	89.3	3.6	50.8	0.1	0	1.9	0	0.5	0	15.5	43.4	0.1	1.1	0	7.3	87.2	0
Offshore circalittoral mixed sediment	58.4	100	100	100	69.1	7.1	61.4	1.0	0.7	2.7	0	0.8	0	34.2	35.1	0	14.2	0	4.3	70.5	0
Offshore circalittoral sand	11.5	100	100	n/p	14.3	7.6	32.7	0.2	1.7	0.1	0.3	0.2	0	2.0	14.2	0	3.7	0	3.3	46.3	0

Broad habitat type	**Area** / Subdivision																				
	Baltic Sea	Bothnian area	Gulf of Finland	Gulf of Riga	Baltic Proper	Arkona & Bornholm Basin	Western Baltic Sea	**Greater North Sea**	Kattegat	Norwegian Trench	Central North Sea	Southern North Sea	Channel	**Celtic Seas**	Northern Celtic Sea	Southern Celtic Sea	**Bay of Biscay and the Iberian Coast**	Gulf of Biscay	North-Iberian Atlantic	South-Iberian Atlantic	Gulf of Cadiz
Offshore circalittoral mud	41.3	100	100	100	62.9	2.1	1.1	0.2	0.7	0.9	0	0.1	0	1.7	7.8	0	16.4	0.1	1.1	58.4	0
Offshore circalittoral mud or Offshore circalittoral sand	77.3	94.0	100	n/p	79.7	23.1	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p
Upper bathyal rock and biogenic reef	n/p	n/p	n/p	n/p	n/p	n/p	n/p	0	n/p	0	n/p	n/p	n/p	7.0	60.1	0	37.6	0	28.9	67.6	39.0
Upper bathyal sediment	n/p	n/p	n/p	n/p	n/p	n/p	n/p	7.9	n/p	7.9	n/p	n/p	n/p	13.9	16.3	4.9	19.7	0	10.4	35.6	35.6
Upper bathyal sediment or Upper bathyal rock and biogenic reef	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	22.7	27.2	21.7	40.9	0	42.8	40.6	n/p
Lower bathyal rock and biogenic reef	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	30.5	n/p	30.5	n/p	n/p
Lower bathyal sediment	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	37.6	43.8	0	28.3	n/p	28.2	100	n/p
Lower bathyal sediment or Lower bathyal rock and biogenic reef	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	15.7	n/p	15.7	43.2	n/p	48.0	32.0	n/p
Abyssal	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	n/p	3.4	n/p	0	58.3	n/p
Unknown	n/p	n/p	n/p	n/p	n/p	n/p	n/p	0.5	83.7	67.2	n/p	0.1	0	29.5	36.4	1.2	56.9	25.0	13.1	94.0	61.3

Table A1.4 Reductions in absolute landings value (in millions of euros) associated with realizing a minimum percentage unfished extent of all BHT in the Baltic Sea, Greater North Sea and Celtic Seas areas and associated subdivisions and for one subdivision in the Bay of Biscay and the Iberian Coast area. The stepwise exclusion of c-squares is conducted in 10% increments (by subdivision or area), The exclusion of c-squares is based on their contribution to total swept area over the six-year assessment period, starting with unfished c-squares and c-squares with the lowest swept area. The sum of the reductions in absolute landings values calculated for all subdivisions in an area will differ from the reductions calculated directly for an area because different c-squares are excluded during the calculations. For the Bay of Biscay and the Iberian Coast area data deficiencies did not allow for the estimation of landings value reduction for all subdivisions or for the area overall.

Area Subdivision	Proportion of habitat persistently unfished 2017–2022 (%)									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Baltic Sea	0	< 0.1	< 0.1	< 0.1	0.2	0.6	1.5	3.2	6.8	21.8
Bothnian area	0	0	0	0	0	0	0	0	0	3.0
Gulf of Finland	0	0	0	0	0	0	0	0	0	0
Gulf of Riga	0	0	0	0	0	0	0	0	0	0
Baltic Proper	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1	0.4	1.2	4.4
Arkona & Bornholm Basin	< 0.1	< 0.1	0.1	0.3	0.6	1.1	1.9	3.0	4.7	8.6
Western Baltic Sea	< 0.1	< 0.1	< 0.1	0.2	0.3	0.7	1.3	2.4	3.6	5.9
Greater North Sea	5.8	16.3	31.3	49.9	77.1	113.5	166.2	241.3	342.7	526.5
Kattegat	0.3	1.4	2.9	4.5	6.7	9.1	12.1	15.4	19.8	25.2
Norwegian Trench	0.5	1.6	3.6	6.6	10.3	14.3	18.8	23.8	29.8	36.7
Central North Sea	0.8	1.9	3.2	4.9	7.4	10.9	15.4	21.4	30.0	45.6
Southern North Sea	5.4	15.9	28.4	43.8	60.7	82.4	108.2	141.1	188.6	277.1
Channel	1.7	5.0	9.4	16.5	26.3	39.9	63.2	88.0	113.1	154.3
Celtic Seas	0.9	5.8	12.9	23.3	36.4	52.2	71.8	97.4	133.1	195.7
Northern Celtic Sea	< 0.1	0.8	2.8	4.8	8.4	14.1	20.2	29.6	43.3	68.0
Southern Celtic Sea	3.0	8.5	15.0	22.9	31.7	42.6	56.0	73.1	94.6	127.7
Bay of Biscay and the Iberian Coast	(insufficient data to provide estimates for the overall area and some subdivisions)									
Gulf of Biscay	1.8	5.0	9.5	15.7	22.5	30.5	39.5	51.2	68.3	101.0

Gross Value Added (GVA)

Gross value added (GVA) is defined as outputs minus intermediate consumption. GVA can be broken down by industries or sectors. For MBCG fisheries GVA may be calculated using the methodology agreed on in the Annual Economic Report (AER) of the EU Scientific, Technical and Economic Committee for Fisheries (STECF).

GVA = income from landings + other income – energy costs – repair and maintenance costs – other variable costs – other non-variable costs

where:

- Income from landings: the revenues from fishing activity,
- Other income: income not related to the sale of landings (e.g. sale for quotas, fishing rights),
- Energy costs: costs of fuel consumption,
- Repair and maintenance costs: the maintenance and repairs of fishing equipment, gears, and vessel parts,
- Other variable costs: all purchased inputs (goods and services) related to fishing effort and/or catch/landings excluding energy costs, personnel costs, repair and maintenance costs.
- Other non-variable costs: fixed costs sustained by vessels independently on the fishing activity (e.g. administration, obligatory insurance, fishing licence, harbour charges)

The sum of GVA over all industries or sectors, plus taxes on products minus subsidies on products, gives gross domestic product (GDP) and so provides a proxy of an individual sector's contribution to the GDP.

To estimate GVA, values of landings would need to be combined with other economic performance indicators for the national fishing fleets to subtract the costs associated with fishing. The economic indicators needed to estimate GVA are reported to the STECF AER.

If GVA is to be disaggregated to the fine-scale ICES VMS data on the c-square level needed for the current assessment, then the GVA in the AER would need to be joined with STECF FDI data and ICES VMS data. Economic indicators as reported by fleet segment (country, supra-region, fishing technique, vessel length group, geo-indicator), can be taken from STECF AER data. These would be merged with STECF FDI data by fleet segment and disaggregated using fishing effort (kW × fishing days). The merged AER and FDI data would then be joined with ICES VMS data, by country, métier, FAO area, and vessel length group and disaggregated according to the kW × fishing hours. This process is achievable because the 2023 métier codes have been harmonized between the FDI and ICES VMS data calls, based on the work of the Regional Co-ordination Group (RCG) Intersessional Subgroup on Métier and Transversal variables. An example of the allocation of GVA to c-squares is provided in ICES (2024c).

The practical challenge associated with adopting GVA in this advice is that estimates of GVA spanning large supra regions must be disaggregated and allocated to c-squares based on vessel kW × fishing hours as calculated from VMS records. The GVA estimates from the disaggregated analysis and the value of landings reported directly in the ICES VMS/logbook data call, are derived from very different processes. When comparing these metrics on the c-square scale, disaggregated GVA was in some cases larger than the value of landings reported in VMS data; this is not logical and is explained by the disaggregation of the high-level GVA calculation as opposed to the fine-scale landings value reported in the VMS data call. In addition, "other income" is included in the GVA and, consequently, in a small but currently not known proportion of these cases, GVA may correctly exceed landings value. Therefore, despite the benefits of GVA as a measure of the economic effects of the effort reduction scenarios, ICES do not present the disaggregated GVA in the advice, and the advice is based on the value of landings reported in the ICES VMS logbook data call.

Comparisons of GVA and landings value at the scale of FAO areas show that GVA is a relatively consistent proportion of landings value for MBCG fisheries involving vessels > 12 m length. Thus, for FAO Area 27 (North Atlantic Ocean) and FAO Area 37 (Mediterranean and Black Sea) GVA was 52–62% of landings value (Table A1.5).

ICES Workshop on trade-offs between the impact of fisheries on seafloor habitats and their landings and economic performance (WKTRADE4; ICES, 2024c) outlined methods that require national data processing to obtain more disaggregated economic data, e.g. SECFISH package developed to disaggregate DCF fleet segments, or national methods applied by different countries. Further investigation of the feasibility and comparability of application of these methods is required before GVA can be reported at the c-square resolution, with the main aim being to review economic data availability at different spatial scales and to test different economic data disaggregation methods.

Table A1.5 Average annual values of the economic indicators for vessels deploying MBCG: income from landings, other income, Gross Value Added (GVA), GVA to revenue (GVA/[income from landings + other income] × 100) and GVA to income from landings (landings value) for FAO Area 27 (Northeast Atlantic) and FAO Area 37 (Mediterranean and Black Sea) and by vessel length, for the years 2017–2021. Calculated based on EU STECF Annual Economic Report (AER) data.

FAO Major Fishing Area	Vessel length (length overall, m)	Annual average values 2017–2021			GVA to revenue	GVA to income from landings
		Income from landings (euro)	Other income (euro)	GVA (euro)		
27	< 10	63 882 481	977 496	46 852 785	72%	73%
	8–12	3 251 412	211 804	2 333 204	67%	72%
	10–12	79 992 672	2 312 301	48 851 448	59%	61%
	12–18	256 203 078	6 746 858	155 066 858	59%	61%
	18–24	345 110 183	7 414 265	178 703 411	51%	52%
	2–40	567 555 988	13 143 786	301 765 937	52%	53%
	> = 40	353 040 210	6 436 120	200 368 017	56%	57%
37	< 6	2 185 824	4 971 055	6 310 637	88%	289%
	6–12	12 839 479	1 602 592	8 301 818	57%	65%
	12–18	209 002 758	6 512 756	129 761 651	60%	62%
	18–24	238 594 925	2 299 989	123 999 390	51%	52%
	24–40	203 503 738	3 351 941	116 126 658	56%	57%

Table A1.6 Mean and ranges of percentage MBCG kW × fishing days attributed to EU vessels <1 2 m, from FDI data for the years 2017–2022. ICES areas and their intersections with the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast assessment areas are shown in Figure A1.1. Only those areas where average annual kW × fishing days with MBCG exceeded 2000 hours are shown. Data for Portugal are excluded.

ICES area	Total kW × fishing days: annual average (2017–2022)	Percentage of kW × fishing days from vessels < 12 m: annual average (2017–2022)	Range of percentage kW × fishing days from vessels < 12 m (2017–2022)
27.3.a.20	8589114	8	6–11
27.3.a.21	2933089	12	11–13
27.3.b.23	11237	42	7–75
27.3.c.22	746330	23	18–30
27.3.d.24	449996	12	11–13
27.3.d.25	695690	6	3–8
27.3.d.26	417785	0	0–0
27.3.d.27	37278	31	14–71
27.3.d.28.1	2092	100	100–100
27.3.d.28.2	83624	9	6–13
27.3.d.29	4063	65	18–100
27.3.d.30	30355	52	10–89
27.3.d.31	127202	58	53–63
27.4.a	6518051	0	0–0
27.4.b	24194203	1	1–1
27.4.c	19239402	0	0–0
27.5.a	80842	0	0–0
27.5.b	117908	0	0–0
27.6.a	2731463	0	0–0
27.6.b	748715	0	0–0
27.7.a	2532309	15	9–25
27.7.b	1297321	3	1–4
27.7.c	1490383	0	0–0
27.7.d	12365350	17	16–18
27.7.e	8267270	33	31–35
27.7.f	1463364	0	0 –0
27.7.g	8563633	0	0–0
27.7.h	4749564	0	0–0

ICES area	Total kW × fishing days: annual average (2017–2022)	Percentage of kW × fishing days from vessels < 12 m: annual average (2017–2022)	Range of percentage kW × fishing days from vessels < 12 m (2017–2022)
27.7.j	5220066	0	0–1
27.7.k	1726929	0	0–0
27.8.a	10411305	23	21–24
27.8.b	3154505	12	11–14
27.8.c	4221423	3	0–5
27.8.d	125039	1	0–2
27.9.a	7567816	23	2–34

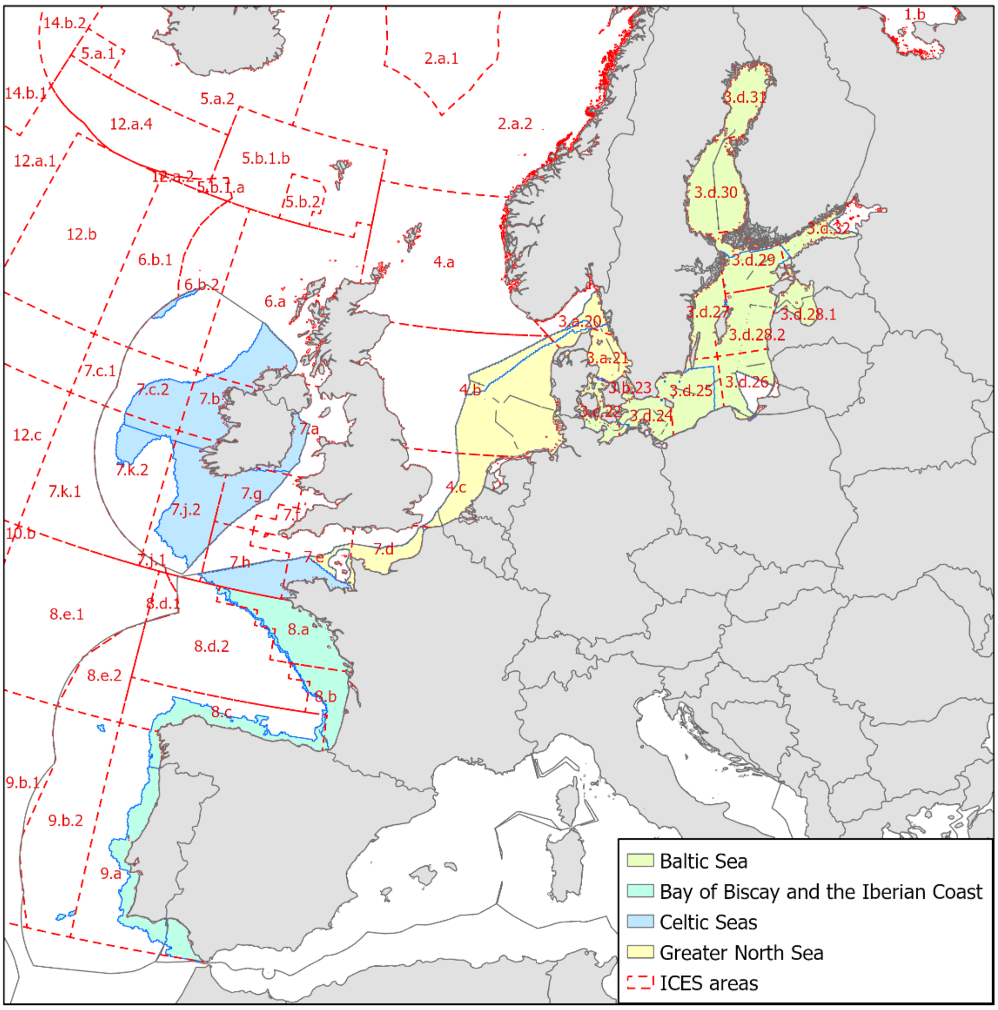

Figure A1.1 ICES areas referred to in Table A1.6 and their intersections with the Baltic Sea, Greater North Sea, Celtic Seas, and Bay of Biscay and the Iberian Coast assessment areas (colored areas).