

## 1.4 Definition and rationale for ICES ecoregions

### The concept of ecoregion

ICES uses ecoregions as the spatial units to synthesize the evidence for the ecosystem approach (ICES, 2014a). They enable ICES network to monitor, assess, address, and solve regional scientific challenges (Figure 1). The ecoregions are used for geographical allocation and reporting of ICES advice. All ICES advice is now linked to an ecoregion, or a collection of ecoregions. The current ecoregions were instigated in 2015 after a process that began in 2004. ICES process of developing ecoregions has influenced many spatial management definitions and supra-national legislation (e.g. the EU Marine Strategy Framework Directive, MSFD). Once defined, the ecoregions adapt slowly and occasionally in response to changes in management areas and through dialogues with regional managers. The ICES system of ecoregions is different from the ICES fishing area system, and reflects ICES move toward providing the evidence for ecosystem-based management. The use of consolidated ecoregions enhances ICES ability to research ecosystem and social dynamics and translate those findings into consolidated ecosystem-based advice.



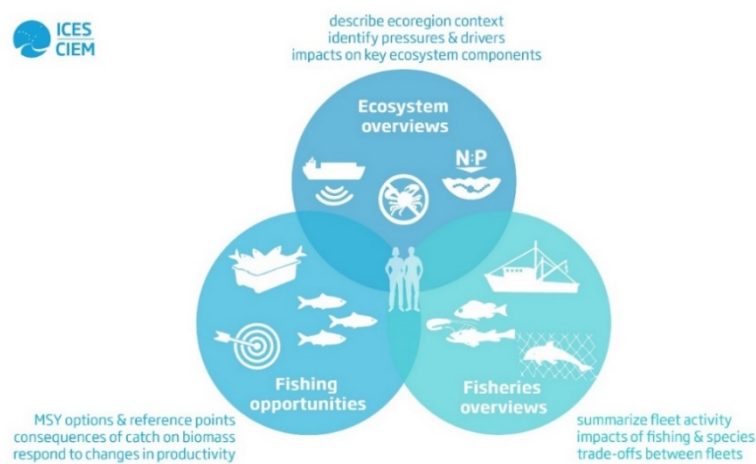
**Figure 1** The ICES ecoregions.

### The use of ecoregions

The individual characteristics of ecoregions are used to provide regional advice and to steer regional integrated approaches, and ecoregions are the primary geographical units for ICES in developing science, new techniques, and monitoring programmes. The use, names, and delineations of ecoregions evolve with the changes in ecosystems. Ecoregions provide the broad-scale spatial framework for the knowledge base to address management challenges and monitor the changing ecology of the Northeast Atlantic.

The iterative dialogue to define and delineate ecoregion boundaries has been very useful to ICES. Although the biology, ecology, and sociology of ecosystems does not completely conform to these ecoregions, this lack of conformity makes researchers look for pragmatic solutions to spatial challenges when providing the evidence for management. Thus linking all the advice and advice products through our data management and GIS systems is extremely useful when adhering to archiving standards and EU directives on metadata. Once defined, the ecoregions adapt slowly and occasionally in response to changes in management areas and through dialogues with regional managers.

All advice is linked to an ecoregion, or to a collection of relevant ecoregions. ICES working groups on [integrated ecosystem assessments](#) (IEA) are based around areas or subareas of an ecoregion. Each fish stock in the ICES stock assessment database, and the associated advice on fishing opportunities, is associated with the relevant ecoregion. As fish stocks move, or there is a change in productivity in certain areas, the associated ecoregion(s) will change. In 2014, ICES provided advice to the EU about how to combine/allocate fish stocks to ecoregions (ICES, 2014b). This has been adopted by many EU Member States and by the EEA (European Environment Agency). ICES has a rolling programme to produce ecosystem and fisheries overviews for each of ICES ecoregions (Figure 2).



**Figure 2** The main recurrent ICES advice products that are published associated with each ecoregion.

The ecosystem overviews focus on regional manageable pressures and describe their implications of variability on the system. Ecosystem overviews have been developed through workshops with requesters of advice, reviewed by ICES integrated ecosystem assessment expert groups, and finally adopted by ACOM. The contents of the ecosystem overviews are based on information provided by expert groups that specialize in state descriptors, published data products, and GIS layers from reliable sources.

The fisheries overviews provide management advice on the trade-offs linked to mixed-fisheries scenarios, summarize activities of different fishing fleets, provide information on the composition of catches and bycatches, introduce fisheries management frameworks/agreements/measures, and evaluate ecosystem effects of fishing activities. The fisheries overviews also deal with technical interactions occurring in different fisheries by areas and species.

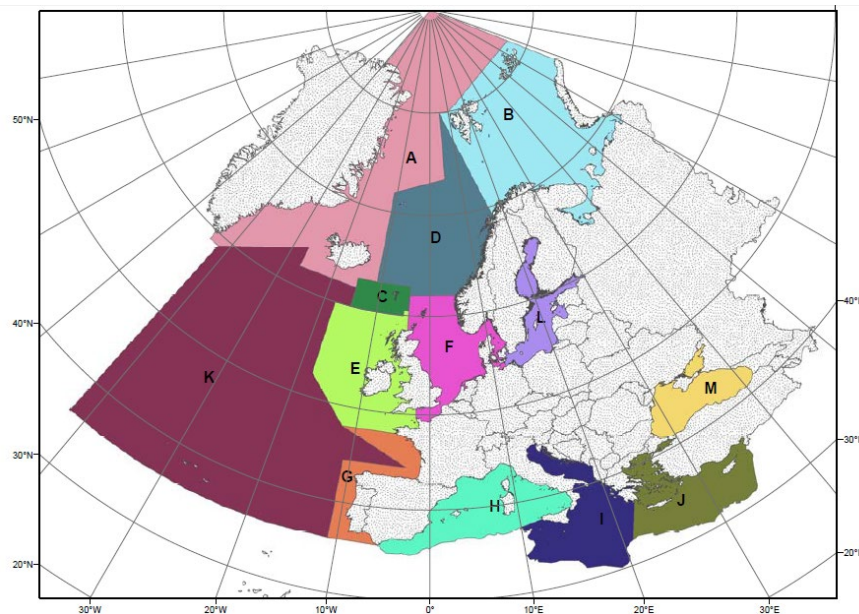
ICES provides science advice to environmental ministries and international agencies, (e.g. EU DG ENV, OSPAR, etc.) and to fisheries ministries, agencies, and regional fisheries organizations (e.g. EU DG MARE, NEAFC, etc.). The ICES ecoregions must be operational in both contexts, and consolidate the evidence base across environmental and fisheries issues.

## Defining the ecoregions

ICES developed the ecoregions in 2004 (ICES, 2004) in response to a request from the EU DG Environment (Annex 1). A series of evaluation criteria (Table 1) were used to evaluate the definitions and potential amalgamation of existing spatial systems. ICES proposed the ecoregions when it was concluded that no existing system of regionalization treated biogeographic/oceanographic/ecological and human impact/management issues more or less independently. The regionalization systems considered were: OSPAR regions, ICES fishing areas, large marine ecosystems (LMEs), Longhurst provinces, Dinter biogeographical regions, and EU Regional Advisory Council areas. The 2004 ecoregions were proposed based on biogeographic and oceanographic features, taking account of existing political, social, economic, and management divisions (Figure 3; see also ICES, 2004).

The ecoregions differ from the historical ICES fishing areas listed in FAO area 27 (see Annex 2). ICES fishing areas were developed in 1904 for the collection of fisheries catch data and are thus limited as a tool to provide evidence for ecosystem-based management.

The ecoregion delineations are not static, but are occasionally revisited in response to societal debate and the input from policy developers. The delineation of the ecoregions is an iterative process (Annex 3). The current ecoregions, defined in 2015, differ from the 2004 definitions. As the concept of ecoregions has passed into legislation, the basic structure proposed by ICES has been maintained, but the borders of the regions have been adjusted to account for additional policy objectives and reconciling of legislation (e.g. the MSFD and the EU water and habitats directives). Many non-EU countries, such as Iceland, Norway, and Turkey, are partners in this process, working with ICES through the European Environment Agency (EEA) and other organizations.



**Figure 3** The ICES ecoregions proposed in 2004. A: Greenland and Iceland Seas, B: Barents Sea, C: Faroes, D: Norwegian Sea, E: Celtic Sea, F: North Sea, G: South European Atlantic Shelf, H: Western Mediterranean Sea, I: Adriatic-Ionian Seas, J: Aegean-Levantine Seas, K: Oceanic Northeast Atlantic, L: Baltic Sea, and M: Black Sea.

The 2015 ecoregions used four principles to adapt the 2004 delineations:

1. Within the EU accept the MSFD regional and subregional definitions.
2. Separate Icelandic Seas from those around Greenland.
3. Use recent LME agreements to define the Arctic Ocean.
4. Use the accepted Norwegian regional management plan definitions of the Norwegian and Barents seas.

Principle 1 reconciles the ICES ecoregions with the same regions being used by the MSFD and the EEA. It also prevents confusion when describing regions and working with regional seas conventions (such as OSPAR and HELCOM). Principles 2 to 4 are based on recommendations by ACOM members and national scientists working in the Arctic, Norwegian Seas, and the Iceland/Greenland areas. The ICES spatial facility has been working for the last three years with the European Commission, EEA, and national authorities to ensure that the proposed boundaries are appropriate and reflect the ethos of the ICES ecoregions whilst accounting for the current societal and political context.

The georeferences for these areas will be provided through the [ICES spatial facility webpage](#). Details of the boundary definitions are provided in Annex 3.

### Experience of developing ecoregions

Many lessons have been learned through the development and application of ICES ecoregions. The ecoregions are mere technical devices, as the ecosystem does not conform to any super-imposed human boundaries, especially with respect to climate change. This challenges researchers to consider the interface between oceanography/ecology and management in the development of applied science solutions.

The multidisciplinary nature of the ecoregions can produce tensions with some stakeholders and researchers. The naming of ecoregions can be problematic as different disciplines/stakeholders have different expectations, sense of ownership, or a pre-established meaning of certain names.

Many disciplines are wedded to their existing regional approaches and there is a strong need for regular scoping and iterations to build an acceptance for the ecoregion framework. Introducing the management–social/political context can be controversial, even though the original ICES fishing areas (Annex 2) were, in fact, oriented towards statistics and fisheries management.

The key lessons are:

1. Determine criteria for regions across a range of categories/disciplines. Ensure that criteria for defining ecoregions consider both the ecological and the social (political) processes, and that they remain flexible in addressing regional concerns as small boundary changes are unlikely to undermine the broad socioecological justification for the regions.
2. Engage early and iteratively with management authorities. Scope widely, and determine your stakeholders before the scoping.
3. Do not assume that nations have agreed EEZ boundaries, or management boundaries.
4. Naming ecoregions can be a challenge. The naming process is as important as the delineation of boundaries, as regional names will have cultural, disciplinary, or political connotations.
5. Research disciplines may feel ownership of their existing systems for regionalization (e.g. oceanographers) and may not accept the notion of merging or splitting region for other priorities (e.g. socio-political rationale).
6. Ecoregions should be adopted with commitment and transparency of rationale, and assumed to be relatively static over time.
7. Do not expect definitive regions as the end product. Occasional likely changes will be needed also after an agreement has been reached. Ensure long-term management of the regionalization system.
8. Be aware that boundaries from other regionalization systems or EEZ boundaries are also subject to change over time. So although boundaries have been aligned with these, this may not be the case in the future. Expect to occasionally change some of the boundaries, names, or rationale through the process.
9. Link to a GIS system and data management system, and document and archive each decision, as they may be challenged later.

Further details can be provided through contacting [advice@ices.dk](mailto:advice@ices.dk).

**Table 1** Criteria for evaluating ecoregions and the expected qualities of ecoregions that would be appropriate for the implementation of an ecosystem approach in European waters (ICES, 2004).

Category/Criterion	Expectation in appropriate ecoregion
<b>1. Oceanography/biogeography/ecology</b>	
a. Do the boundaries of existing or proposed ecoregions appropriately demarcate areas with identifiable oceanographic characteristics?	Clear oceanographic justification for demarcation.
b. Do the boundaries of existing or proposed ecoregions appropriately demarcate the distribution of a range of species or communities that inhabit many different depths?	Boundaries should demarcate distribution of both pelagic and benthic species and communities.
c. Will oceanographically/biogeographically defined boundaries of the existing or proposed ecoregions continue to apply over the time-scales used for management (decades or more)?	Boundaries would apply for decades or more.
d. Would there be significant spatial variation in the response of existing or proposed ecoregions physical characteristics, species, and communities to climate variability and climate change?	Spatial variation should be low so that the rate of management adaptation to climate change can be similar throughout the ecoregion.
e. Is the level of exchange of materials between existing or proposed ecoregions as low as can be reasonably expected?	Low exchange; the ecoregion should be a relatively self-sustaining system.
f. Is the oceanographic and biological variability among sites within the existing or proposed ecoregion smaller than variability among ecoregions?	Variability within ecoregions should be smaller than variability among regions.
g. If there are subregions within the ecoregion (oceanographically/biogeographically identifiable regions that do not meet the criteria for ecoregions), do they nest within ecoregions without gaps or inefficiencies?	The ecoregion should divide clearly and completely into a small number (typically $\leq 3$ ) of subregions.
<b>2. Human impacts and their management</b>	
a. Would management action in one existing or proposed ecoregion negatively affect management in another ecoregion?	Responses to management action in one ecoregion should have minimal and/or positive impacts on management actions in other ecoregions.
b. Are the existing or proposed ecoregions compatible with the distributions and management of commercially exploited fish populations?	Fish populations should ideally be distributed and managed within the same ecoregion.
c. Are the boundaries of existing or proposed ecoregions consistent with those of existing or proposed management regions (e.g. WFD, GFCM, MAP, RACs, ICES, OSPAR)?	Consistency should be high.
d. Are the boundaries of existing or proposed management and/or ecoregions consistent with terrestrial management regions?	Boundaries should be consistent to support integration of marine and terrestrial assessment and management.

e. Can research, assessment, and monitoring of terrestrial and marine impacts be effectively linked at the scale of the existing or proposed ecoregion?	It should be possible to link research, assessment, and monitoring of terrestrial and marine impacts to effectively support integrated management.
f. Are the existing or proposed ecoregion boundaries compatible with patterns of land-use type and change and the distribution of human populations?	There should be compatibilities between ecoregion boundaries and land-use type and change and the distribution of human populations since these are key drivers of impacts on the marine environment.
g. If there are subregions within the ecoregion (management regions that do not meet the criteria for ecoregions), do they nest within ecoregions without gaps or inefficiencies?	The ecoregion should divide clearly and completely into a small number (typically $\leq 3$ ) of subregions.
h. Do contiguous shelf areas and the slope to a depth of at least 1000 m fall within the same ecoregion?	The shelf and slope to a depth of at least 1000 m should fall within the same ecoregion as human activities such as fishing have increasingly spread from shelf to slope regions.
<b>3. Management/policy</b>	
a. Do the existing or proposed ecoregions apply, to the fullest possible extent, to the marine environment including the coastal areas, internal waters, the territorial sea, the exclusive fishery zones, and other sea areas under the sovereignty and jurisdiction of the Member States of the European Union and neighbouring countries?	Ecoregions should apply to the fullest possible extent to the marine environment.
b. Are the boundaries of the existing or proposed ecoregion compatible with the provisions of UNCLOS and other relevant international conventions?	Ecoregion boundaries should be compatible with the provisions of UNCLOS and other relevant international conventions.
c. In relation to the jurisdiction areas of regional conventions, are there any gaps within the existing or proposed ecoregions?	There should be no gaps in jurisdiction.
d. If a number of conventions apply in different parts of the existing or proposed ecoregions, then will the management response to any human impact be inconsistent in different parts of the ecoregion?	Management responses should be consistent throughout the ecoregion.
e. Do the boundaries of existing or proposed ecoregions create any known impediments to effective management (in relation to the management of, for example, aggregate extraction and mining, aquaculture, dredging, engineering and construction, fisheries, land-based impacts, military activities, oil and gas, reclamation, recreation, renewable energy, or shipping)?	Boundaries should not create impediments to effective management.
f. Do the existing or proposed ecoregions facilitate partnerships with neighbouring countries in the Atlantic, Baltic, Mediterranean, and Black seas?	The ecoregions should facilitate partnerships.
g. Can the existing or proposed ecoregions be subdivided into political or management regions with as few gaps and inefficiencies as possible?	The ecoregion should divide clearly and completely into political and management regions.

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**Annex 1 Original request from the European Commission for information and advice about ecoregions for the ecosystem approach in European waters (August 2004)**

EUROPEAN COMMISSION  
DIRECTORATE-GENERAL  
ENVIRONMENT

The Director-General

Date	13.09
File	G-16

Brussels, 27-08-2004  
ENV.D2/OH/sh D (2004) 522381

Dr. D. de Griffith  
Director General ICES  
Palægade 2-4  
DK-1261 Copenhagen K.

Dear Dr. de Griffith,

**Subject: Request for scientific information and advice about appropriate eco-regions for the implementation of an ecosystem approach in European waters.**

As you are no doubt aware, the forthcoming EU Marine strategy will be implemented at many levels, ranging from local to pan-European. This requires us to identify individual regional areas for which ecological objectives are to be defined. Ecosystem boundaries are typically based on biological and physical processes. The boundaries of these eco-regions should therefore be based on bio geographic and oceanographic features, taking account of existing political, social, economic and management divisions. By doing so, eco-regions should be characterised by greater similarity in bio geographic and oceanographic characteristics among sites within the same eco-regions, then between regions. It is envisaged that the eco-regions could be subdivided into sub-regions as appropriate.

In our view appropriate bio geographic characteristics may be the composition of faunal communities and patterns of primary production. Appropriate physical oceanographic characteristics may be depths, basin morphology, tidal and ocean currents, temperature or degree of seasonal stratification. Identification of eco-regions should also take account of the links between the marine and terrestrial environment, including patterns of land use and distribution and density of human populations.

Boundaries between eco-regions should be defined unambiguously to guide research, objective-setting, assessment, monitoring and enforcement and should take account of the jurisdiction of existing management authorities and areas for sectoral activities, and utilise existing boundaries where they meet the wider criteria for boundary selection.

There are several existing divisions of marine areas into regions, such as those to be found in the Common Fisheries Policy, Marine Conventions, Large Marine Ecosystem, Bio-geographical regions used by EEA, the EU Water Framework Directive etc.

In the light of the above, we would like to request ICES, within the framework of the existing Memorandum of Understanding between the Community and ICES, to undertake

Commission européenne, B-1049 Bruxelles / Europese Commissie, B-1049 Brussel - Belgium. Telephone: (32-2) 299 11 11. Office: BU9-3-170. Telephone: direct line (32-2) 2992116. Fax: (32-2) 2968825.

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a scientific review and evaluation of all relevant information concerning the above mentioned classification of regions. The work should focus on how the above criteria have been applied and which classification offers the best starting point for the identification of eco-regions. In the event that the analysis suggests that a new system is needed, ICES is requested to provide recommendations on a new system or on how this could be achieved.

Due to the timeframe for the development of the Marine Strategy, the Commission would like to have the report preferably before the Stakeholder Conference on 10-12 November but in any case not later than the end of 2004.

In the event that your organisation is willing to provide the requested scientific information and advice, I would appreciate to receive a proposal from your side setting out the methodology and timetable together with an estimate of the budget requirements.

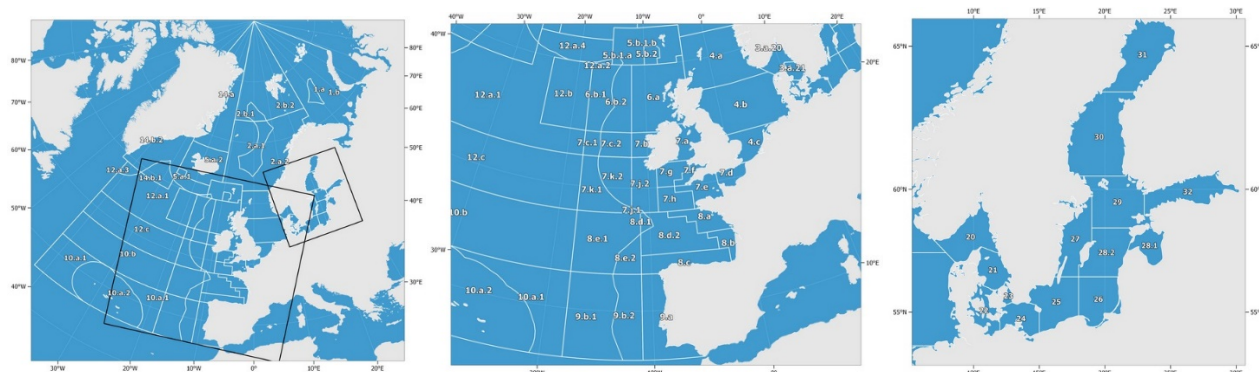
Yours sincerely,

A handwritten signature in black ink, appearing to read 'Catherine Day', with a stylized flourish at the end.

Catherine Day

## Annex 2 ICES fishing areas

ICES fishing areas are developed from historical links between an area and the collection of fisheries statistics. The initial ICES fishing areas were established in 1904 (for the fisheries statistics for 1903), with originally 20 areas. As various international treaties were drawn up, the geographic expanse of these areas changed with their management. The western Atlantic was taken out of the ICES system in 1950 when the International Commission for the Northwest Atlantic Fisheries (ICNAF) was established by Canada and the USA. In 1979, with the extension of the Exclusive Economic Zones (EEZs), ICNAF was replaced by the Northwest Atlantic Fisheries Organization (NAFO), leading to the current system in the Northwest Atlantic. In the remaining North Atlantic, the Permanent Commission, formed in 1946, developed into the North-East Atlantic Fisheries Commission (NEAFC) in 1959, which was then reformed in 1980 with the extensions of the national fishing limits to 200 nautical miles of the EEZ. With the growth of the EU, increasingly more fishing areas were included in the EU Common Fisheries Policy (CFP). Although the boundaries can be adjusted when new information becomes available, ICES fishing areas, originally determined by socio-economic criteria, rarely have the flexibility to fit the biology and distribution of fish stocks, and certainly not the ecosystem approach to management. Changes to ICES fishing areas are documented and recorded in the FAO Coordinating Working Party on Fishery Statistics (CWP) reports (FAO, 2020a):



**Figure A1** ICES fishing areas, in (left) FAO area 27, (middle) the wider North Atlantic, and (right) the eastern Atlantic shelf and Baltic Sea (FAO, 2020b).

### Annex 3 Detailed rationale for the boundary changes, ecoregion definitions

Overall the extent of the ICES ecoregions is defined by FAO Major Fishing Area 27 (FAO, 2020b).

Within the EU (Baltic Sea, Greater North Sea, Celtic Seas, Bay of Biscay and the Iberian Coast, Azores, Mediterranean Sea, and Black Sea), the ICES ecoregions in FAO Area 27 are identical to the drafted MSFD marine regions and subregions (European Environment Agency, 2018), with a few exceptions. Note that the MSFD regions and subregions have not been finally agreed and may have changed when in their final form.

- The division between the Mediterranean Sea and the Northeast Atlantic Ocean is defined by a meridian line at 5°36'W. In MSFD this division follows the Barcelona Convention (Anon., 1995), corresponding to a meridian line of 5°55'W.
- In ICES ecoregions, the waters around Madeira and the Canary Islands are not included. In MSFD (EU, 2008) the subregion “Macaronesian biogeographic region” comprises the waters around Azores, Madeira, and the Canary Islands.
- The waters south of 36°N around the Azores have not been included in ICES ecoregions.

For the ICES ecoregions outside of EU (Oceanic Northeast Atlantic Ocean, Faroes, Icelandic Waters, Greenland Sea, Norwegian Sea, Barents Sea, and Arctic Ocean), the delineations are based on large marine ecosystems (LMEs; GRID-Arendal, 2017), Norwegian administrative sea areas (Forvaltningsplanområder for havområdene; Norwegian Environment Agency, 2011), and the Icelandic EEZ.

#### Arctic Ocean

The Arctic Ocean ecoregion follows the definition of “Central Arctic and Canadian High Arctic–North Greenland” in the LME definition. The westward and eastward extent is defined by FAO Major Fishing Area 27.

#### Greenland Sea

Greenland Sea follows the EEZ definition.

#### Barents Sea

The delineation of the Barents Sea ecoregion follows the definition of LME, with some exceptions. The eastern boundary is extended to 68°30'E to reach the boundary of FAO Major Fishing Area 27. The boundary towards the Norwegian Sea ecoregion is defined by Norwegian administrative sea areas from the coast of Norway and until a point at 77°0'10.8 N and 9°58'37.2 E, where it intersects with the LME definition. Note that division between the Barents and the Norwegian seas, as defined by the Norwegian administrative areas, has been continued through the Lofoten area. This has been done to include the coastal areas in the ICES ecoregions (see Figure A2); the Norwegian administrative areas do not include the coastal waters.

#### Norwegian Sea

The boundary between the Greenland Sea and Norwegian Sea ecoregions follows the Norwegian administrative sea areas\* definition. The boundary towards the Icelandic Waters and Faroes ecoregions is aligned with ICES statistical areas. The boundary towards the Barents Sea ecoregion is defined by Norwegian administrative sea areas from the coast of Norway and until a point at 77°0'10.8 N and 9°58'37.2 E, where it intersects with the LME definition. Note that division between the Barents and the Norwegian seas, as defined by the Norwegian administrative areas, has been continued

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\* Version 2: Text corrected, ‘Norwegian administrative sea areas’ inserted.

through the Lofoten area. This has been done to include the coastal areas in the ICES ecoregions (see Figure A2); the Norwegian administrative areas do not include the coastal waters.

### **Iceland Sea – renamed “Icelandic Waters” in April 2017**

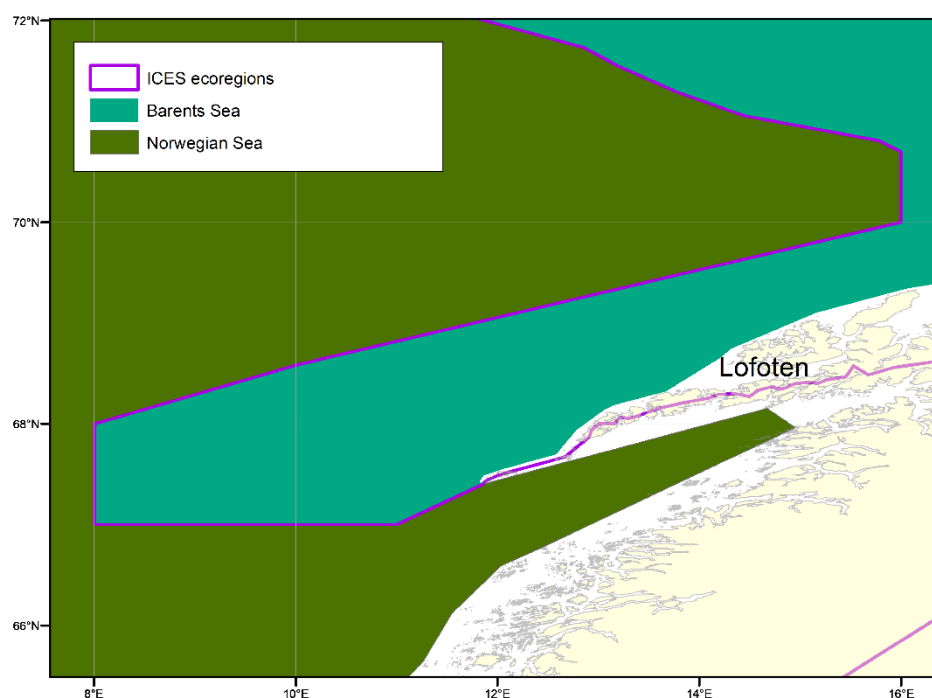
Following the analysis by Marine Research Institute Iceland in December 2014, the Iceland Sea ecoregion echoed the EEZ. As the EEZ provides the outer boundaries of the MSFD, it is suggested that the same basis is used as the outer boundaries of the Faroes, Icelandic Waters, and East Greenland ecoregions. This is also in conformity with the main objective of the adjusted ecoregion definitions, i.e. to define areas which will be useful “to provide regional advice”. For ecosystem and integrated approaches it will be further useful to apply bathymetric, oceanographic, and biological productivity criteria for definition of subregions.

### **Faroes**

The boundary between the Faroes and Celtic Seas ecoregions follows the MSFD marine regions and subregions. The remaining part of the Faroes follows the EEZ.

### **Oceanic Northeast Atlantic**

The boundary between the Oceanic Northeast Atlantic and Greenland Sea ecoregions follows the LME definition. Towards the Icelandic Waters and Faroes ecoregions the delineation follows their EEZs. The boundaries towards the Celtic Seas, Bay of Biscay and the Iberian Coast, and Azores ecoregions follows MSFD marine regions and subregions. The extent of the Oceanic Northeast Atlantic ecoregion towards south and west is defined by FAO Major Fishing Area 27.



**Figure A2** ICES ecoregions and the Norwegian administrative sea areas for the Norwegian and Barents seas.