

<b>ECOREGION</b>	<b>General advice</b>
<b>SUBJECT</b>	<b>OSPAR/NEAFC special request on review of the results of the Joint OSPAR/NEAFC/CBD Workshop on Ecologically and Biologically Significant Areas (EBSAs)</b>

#### **Advice summary**

ICES reviewed the ecological evidence supporting the ten proposed ecologically and biologically significant areas (EBSAs) from the OSPAR/NEAFC/CBD Workshop of September 2011, as presented in the annexes to that report. The review applied standard ICES practices and used primarily the references cited in the relevant annexes, but augmented those references with other publications and data sources. In nine of the ten proposed EBSAs, ICES came to different conclusions than were contained in the OSPAR/NEAFC/CBD Workshop report, with regard to the rankings of the Convention on Biological Diversity (CBD) EBSA criteria.

Of the ten proposed EBSAs, ICES supports the conclusion of the OSPAR/NEAFC/CBD workshop that the Arctic Ice area (Area 10) meets one or more EBSA criteria and this area could go forward at this time, possibly with minor suggested changes to the rationale.

In four proposed EBSAs (Reykjanes Ridge south of Iceland EEZ (Area 1); Charlie-Gibbs Fracture Zone and Subpolar Frontal Zone of the Mid-Atlantic Ridge (Area 2); Mid-Atlantic Ridge north of the Azores (Area 3); the Hatton and Rockall banks and Hatton–Rockall Basin (Area 4)), ICES considers that much of the area within the proposed EBSAs do not meet any of the EBSA criteria and for this reason the boundaries of these proposals need to be revised. More restricted parts of the proposed EBSAs meet several of the EBSA criteria and could go forward after boundary revision. ICES notes great similarities in the pro forma describing Areas 1 and 3 and part of Area 2 (OSPAR/NEAFC/CBD, 2011). A boundary revision to encompass the relevant parts of these areas as a single extended Mid-Atlantic Ridge proposed EBSA could be considered a step forwards. ICES recommends changes also to the pro forma rankings for all of these proposed EBSAs.

Only a small part of the proposed EBSA for the Arctic Front – Greenland/Norwegian seas (Area 9) possibly meets some of the EBSA criteria. However, another part of the general area might meet some of the EBSA criteria. ICES recommends that further data analyses followed by an evaluation of the new results against the EBSA criteria be undertaken before any further decision is taken.

The rationales for four proposed EBSAs (around the Pedro Nunes and Hugo de Lacerda seamounts (Area 5); Northeast Azores–Biscay Rise (Area 6); Evlanov Seamount region (Area 7); and Northwest of Azores EEZ (Area 8)) are not well supported by the information presented in the relevant annexes. There is a need for further data and analyses in these areas, particularly in relation to seabirds, and another evaluation of the areas against the EBSA criteria.

ICES found no clear evidence of additional EBSAs in areas beyond national jurisdiction (ABNJ) of the Northeast Atlantic meeting the CBD scientific criteria.

#### **Request**

*a) Review the description of areas meeting one or more of the CBD EBSA scientific criteria developed as an outcome of the Joint OSPAR/NEAFC/CBD Scientific Workshop, in particular:*

*1. Review each of the ten area delineations and descriptions in line with the CBD EBSA Scientific criteria and the most up-to-date scientific data and information, specifying any additional scientific data and information that is available;*

*2. Provide, if appropriate, revised EBSA proposals in the format of proformas adopted by the CBD*

*b) If there is clear evidence for additional areas in ABNJ of the North-East Atlantic meeting the CBD EBSA scientific criteria, present a description with supporting scientific data and information for such areas, including CBD EBSA proformas for each.*

## ICES advice

ICES made the following conclusions and proposals.

Area 1. Reykjanes Ridge south of Iceland EEZ: Much of the area in the proposed EBSA does not meet any of the EBSA criteria. A more restricted area down the spine of the Mid-Atlantic Ridge and defined by depth ranges of deep-water coral and sponge concentrations does meet several EBSA criteria and the boundary delineation, ranking, and full rationale could be developed based on this new boundary.

Area 2. Charlie-Gibbs Fracture Zone and Subpolar Frontal Zone of the Mid-Atlantic Ridge: Some areas in the proposed EBSA do not meet any of the EBSA criteria. A complex combination of the area down the spine of the Mid-Atlantic Ridge, the benthic area aligned with and close to the main fractures, and the water column in which the Subpolar Front is found throughout the year, does meet several EBSA criteria and the boundary delineation, ranking and full rationale could be developed at based on this new boundary.

Area 3. Mid-Atlantic Ridge north of the Azores: Much of the area in the proposed EBSA does not meet any of the EBSA criteria. A more restricted area down the spine of the Mid-Atlantic Ridge and defined by depth ranges of deep-water coral and sponge concentrations does meet several EBSA criteria and the boundary delineation, ranking, and full rationale could be developed based on this new boundary.

Area 4. The Hatton and Rockall banks and Hatton–Rockall Basin: Much of the area in the proposed EBSA does not meet any of the EBSA criteria. A more restricted area down to approximately 1500–1800 m depth, but excluding the abyssal plain does meet several EBSA criteria and the boundary delineation, ranking, and full rationale could be developed based on this new boundary.

Area 5. Around the Pedro Nunes and Hugo de Lacerda seamounts: The proposed EBSA is not supported well by the information presented in the pro forma. There is a need for further analyses of those data already considered, as well as any additional relevant data on seabird foraging and other information. When these analyses are done, including for the additional data, another evaluation of the area against the CBD EBSA criteria would make it possible to advise which areas, if any, meet EBSA criteria.

Area 6. Northeast Azores–Biscay Rise: The proposed EBSA is not supported well by the information presented in the pro forma. There is a need for further analyses of those data already considered as well as any additional relevant data on seabird foraging and other information. When these analyses are done, including for the additional data, another evaluation of the area against the CBD EBSA criteria would make it possible to advise which areas, if any, meet EBSA criteria.

Area 7. Evlanov Seamount region: The proposed EBSA is not supported well by the information presented in the pro forma. There is a need for further analyses of those data already considered as well as any additional relevant data on seabird foraging and other information. When these analyses are done, including for the additional data, another evaluation of the area against the CBD EBSA criteria would make it possible to advise which areas, if any, meet EBSA criteria.

Area 8. Northwest of Azores EEZ: The proposed EBSA is not supported well by the information presented in the pro forma. There is a need for further analyses of those data already considered as well as any additional relevant data on seabird foraging and other information. When these analyses are done, including for the additional data, another evaluation of the area against the CBD EBSA criteria would make it possible to advise which areas, if any, meet EBSA criteria.

Area 9. The Arctic Front – Greenland/Norwegian seas: Only a small part of the area proposed by the OSPAR/NEAFC/CBD Workshop as an EBSA was considered to possibly meet some of the criteria. However, another part of the general area might meet some EBSA criteria. There is a need for more analyses of productivity and diversity data for the more southerly part of the main area, and then a re-evaluation of the new results against the EBSA criteria, before any areas might be considered as possibly meeting EBSA criteria.

Area 10. The Arctic Ice: The rationale for concluding that this area meets one or more EBSA criteria can be improved, but the review by ICES generally supports the conclusions of the OSPAR/NEAFC/CBD workshop. A suggested revised proforma is attached as Annex 1.5.6.5.1 to this advice.

With regard to new proposed areas that meet EBSA criteria, ICES has no additional information. However, ICES suggests a potential alternative configuration to the areas in proposed EBSAs 1, 2, and 3 that would comprise two areas meeting EBSA criteria, one covering the specified depths of the entire Mid-Atlantic Ridge, and one for the Charlie-Gibbs Fracture Zone and pelagic area of the Subpolar Front. Each of the two areas would have coherent, but different ecological rationales.

ICES has provided its rankings for the revised proposed EBSAs and the rationale for those rankings. ICES has not revised the narrative or the references in the existing pro forma of proposed EBSAs other than for Arctic Ice habitat (Annex 1.5.6.5.1). Once OSPAR and NEAFC have made a decision on the configuration of the Mid-Atlantic Ridge proposed EBSAs, ICES could revise the pro forma for these EBSAs by the end of September 2013.

## **Background**

### *Method*

ICES conducted its review informed by the content of the CBD Decisions IX/20 and X/29 on Marine and Coastal Biodiversity (CBD, 2008, 2010), the reports from the 'Azores Workshop' (CBD, 2007) and the 'Ottawa Workshop' (CBD, 2009), and the UNGA Resolution 58/240 (United Nations, 2004). ICES considers that the application of the criteria was intended to be a *comparative* or *relative* process, such that areas should be evaluated against other generally comparable areas (e.g. of comparable depth and latitude). In addition, even though the application of EBSA criteria is not guided directly by management considerations, potential benefits of spatial management measures are a relevant consideration in the evaluation. However, the appropriate baseline is not the absence of all management, but the presence of measures sufficient to ensure human uses are sustainable in areas typical of the zone of evaluation.

ICES is responding to a request about EBSAs, and ICES stresses that this advice does not imply that any areas reviewed should or should not be considered as VMEs (but ICES notes that there is an overlap with advice provided recently on vulnerable marine ecosystems (VMEs; ICES, 2013a)). ICES notes that all areas found to meet criteria for VMEs would be expected to meet one or more criteria for EBSAs as well. However, the reverse is not necessarily true and EBSAs do not necessarily contain VMEs. There is neither a policy nor an ecological rationale for automatically excluding bottom fishing (or any other activity) from areas proposed as EBSAs. The expected initial response of regulatory authorities is to conduct risk or threat assessments of the activities they regulate relative to the properties considered ecologically or biologically significant, and to subsequently undertake management appropriate to the outcome of these assessments.

ICES advice is based on applying several standards during its review, including:

- Assigned rankings on a criterion should apply to at least most of the area included in a proposed EBSA, and not just to a small subset of the total area.
- Higher assigned rankings required the proposed area to differ from adjacent areas and other areas of similar depth and latitude on the property represented by the criterion.
- Some evidence must be available to justify awarding a higher ranking, noting that comprehensive data for the high seas cannot be expected.
- Rankings should not be based on the presence or history of threats to the features represented by the criteria, but on the biological, ecological, and geomorphological features of the area.
- Although EBSAs are not defined by or linked to any particular management actions by any authorities, it is appropriate to consider whether or not spatial management tools might benefit the conservation or sustainable use of the relevant features.

For each of the ten areas in the OSPAR/NEAFC/CBD report proposed to meet EBSA criteria, ICES assigned one of three categories:

- Proceed with boundaries proposed by the OSPAR/NEAFC/CBD Workshop, with a rationale revised by ICES.
- Proceed with developing a proposed EBSA with different boundaries than those proposed by the OSPAR/NEAFC/CBD Workshop, and with a rationale provided by ICES.
- Do not proceed with proposing an EBSA at this time, but rather undertake further collation and analysis of information and reconsider when the additional work is completed.

Although ICES review included an evaluation and commentary on all pro forma contents of the OSPAR/NEAFC/CBD 2011 Workshop report, this advice presents only ICES conclusions as to whether the areas meet the EBSA criteria. This advice takes the form of biological properties that ICES concludes would define the boundaries, rankings, and rationales of those areas against the EBSA criteria.

### **Proposed EBSAs that need minor revisions to the rationale**

#### ***Area 10. The Arctic Ice***

A suggested revised pro forma is attached to this advice as Annex 1.5.6.5.1.

### **Proposed EBSAs that should have redefined boundaries before proceeding**

#### ***Area 1. Reykjanes Ridge south of Iceland EEZ***

ICES advises that an area along the Reykjanes Ridge can be justified as meeting one or more EBSA criteria. This would be a much smaller area than the one proposed in the OSPAR/NEAFC/CBD Workshop report. Appropriate boundaries for such a proposed area that meets EBSA criteria would be a depth contour that runs in the deeper of two properties:

1. Including a large portion (arbitrarily, perhaps 90%) of all hard volcanic substrates; habitats are reported to host the larger known coral formations and their associated communities
2. Including a large portion (arbitrarily, 90%) of the records of large sponge communities in the overall northern Mid-Atlantic Ridge.

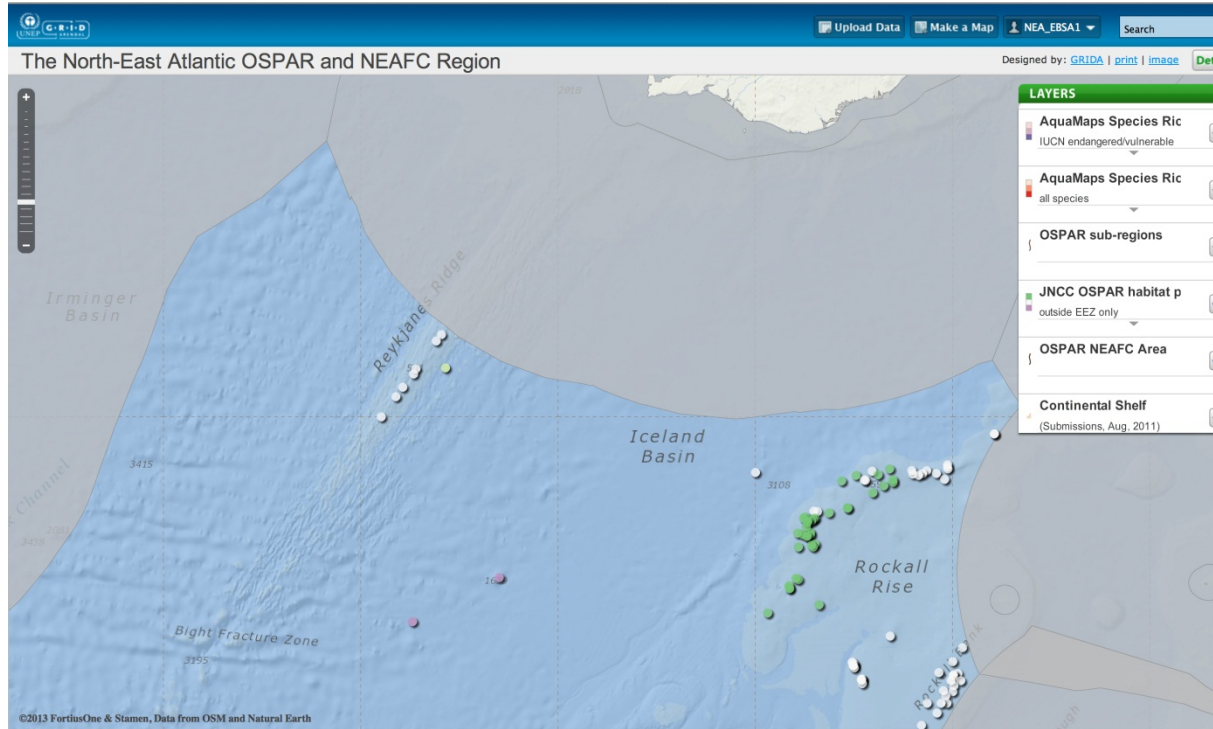
In addition, the proposed area will include the only known hydrothermal vent in the area (Olafsson *et al.*, 1991; German *et al.*, 1994; German and Parsons, 1998; Mironov and Gebruk, 2007), whatever depth contour is used. Information on water masses should also be consulted, allowing proper identification of benthic and fish fauna to be included in a revised narrative to a pro forma for this area.

In the time available ICES did not have the geological data to delineate the depth contour that would meet the first criterion, but such information should be readily available in marine geology databases. Nor did ICES have access to all of the records of where the large sponge deposits were taken. However, references to sources for those data are in the OSPAR/NEAFC/CBD Workshop pro forma and should be tracked back to find the appropriate depth contour for the second criterion in the tables below.

#### ***Evaluation of the revised area against the EBSA criteria***

<b>CBD EBSA Criterion</b>	<b>Description</b>	<b>Ranking of criterion relevance</b> (please mark one column with an X)			
		<b>Don't Know</b>	<b>Low</b>	<b>Some</b>	<b>High</b>
<b>Uniqueness or rarity</b>	The area contains either (i) unique ("the only one of its kind"), rare (occurs only in few locations), or endemic species, populations, or communities, and/or (ii) unique, rare, or distinct habitats or ecosystems, and/or (iii) unique or unusual geomorphological or oceanographic features.			<b>X</b>	<b>(X)</b>

CBD Criterion	EBSA	Description	Ranking of criterion relevance (please mark one column with an X)			
			Don't Know	Low	Some	High
<i>Explanation for ranking</i>						
<p>The bracketed “High” ranking is for a very restricted area covering the only known hydrothermal vent on the Reykjanes Ridge. Though this is a unique feature it occupies only a small part of the area proposed here as meeting this EBSA criterion (Olafsson <i>et al.</i>, 1991; German <i>et al.</i>, 1994; German and Parsons, 1998; Mironov and Gebruk, 2006).</p> <p>The MarEco sampling of corals and sponges reported a few species new to science and these may be restricted to the proposed area, although a firm conclusion on this cannot be drawn until more extensive sampling is undertaken.</p>						
<b>Special importance for life-history stages of species</b>		Areas that are required for a population to survive and thrive.		X		
<i>Explanation for ranking</i>						
<p>Although many populations undoubtedly complete their life cycles within the large area proposed in the OSPAR/NEAFC/CBD Workshop Report as an EBSA, this would be true of any marine area of comparable size. There is no evidence that the life history of any species is strongly dependent on any specific features of the area proposed as an EBSA.</p> <p>There is evidence from other areas of the Northeast Atlantic that areas of high coral density may be important as egg-case and nursery areas of deep-water sharks and rays. The area proposed here is targeted on the depths and substrates associated with higher coral and sponge densities, and if sharks and rays also concentrate spawning and early development in these habitats, then the score would be “Some” or “High” on this criterion as well.</p>						
<b>Importance for threatened, endangered, or declining species and/or habitats</b>		Areas containing habitats for the survival and recovery of endangered, threatened, or declining species, or areas with significant assemblages of such species.			X	
<i>Explanation for ranking</i>						
<p>Large formations of corals and sponges are found in the area proposed by ICES as meeting this criterion. Habitats containing these species are listed by OSPAR and also feature as VME indicator species; the majority of these would be included in the proposed EBSA. Additional explanation regarding corals and sponges is included in the rationale for the criterion on Vulnerability.</p> <p>The possible role of the area proposed by ICES in the life histories of sharks and rays is discussed in the criterion on Vulnerability and Sensitivity.</p>						
<b>Vulnerability, fragility, sensitivity, or slow recovery</b>		Areas that contain a relatively high proportion of sensitive habitats, biotopes, or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery.				X

CBD Criterion	EBSA	Description	Ranking of criterion relevance (please mark one column with an X)			
			Don't Know	Low	Some	High
<i>Explanation for ranking</i>						
<p>With regard to corals and sponges, Mortensen <i>et al.</i> (2008) found cold-water corals “<i>at every sample station ... observed at depths between 800 and 2400 m, however were commonly found shallower than 1400 m ..., with species richness being very high. ... no major reef structures were recorded, with the maximum colony size approximately 0.5 m in diameter. The number of coral taxa was strongly correlated with the percentage cover of hard bottom substrate ....</i>” The area proposed here is targeted at the seamount peaks and slopes where hard substrates dominate. For sponges, no actual large expanses of sponge reef were reported in the OSPAR/NEAFC/CBD Workshop report. However, the pro forma in that report (OSPAR/NEAFC/CBD, 2011) notes that overall sampling of the area is patchy and cites three studies that found local patches with high densities of sponges, although in no cases were the sizes of the patches documented.</p> <p>These observations of widespread occurrences of corals and sponges are supported by the records in the GRID–Arendal data, which show both taxa to be presented in nearly every appropriate sample taken along the cruise tracks in the database.</p> 						
Biological productivity		Areas containing species, populations, or communities with comparatively higher natural biological productivity.		X		
<i>Explanation for ranking</i>						
<p>Although benthic productivity of the proposed smaller EBSA may be higher than benthic productivity on the abyssal plain, productivity integrated over the entire water column and seafloor seems typical of systems of comparable depth and latitude globally.</p>						
Biological diversity		Areas containing a comparatively higher diversity of ecosystems, habitats, communities, or species, or with higher genetic diversity.			X	

CBD Criterion	EBSA	Description	Ranking of criterion relevance (please mark one column with an X)			
			Don't Know	Low	Some	High
<i>Explanation for ranking</i>						
The possible, but incompletely documented presence of large coral and sponge stands, and the documented high diversity of benthic and associated fish when corals or sponges are present in moderate or high density imply that some areas may have high diversity. Aside from these benthic communities of somewhat restricted distribution, the biodiversity otherwise appears typical of biotic communities at similar depths and latitude.						

## ***Area 2. Charlie-Gibbs Fracture Zone and Subpolar Frontal Zone of the Mid-Atlantic Ridge***

ICES advises that an area with the following boundaries, capturing three distinct features, would meet one or more EBSA criteria. The area would include the following features:

- i. *Subpolar Frontal Zone* (coinciding with the Charlie-Gibbs Fracture Zone): The northern and southern boundaries for this feature should be set according to the known northernmost and southernmost meandering of the frontal system at 53°N and 48°N, respectively (Søiland *et al.*, 2008). The eastern and western boundaries for this feature should be set according to the eastern and westernmost extension of the Charlie-Gibbs Fracture Zone (topography; approx. at 27°W and 42°W, respectively).
- ii. *Charlie-Gibbs Fracture Zone*: The eastern and western boundaries for this feature should be set according to the east–west extension of the Fracture Zone (approx. at 27°W and 42°W, respectively). The northern and southern boundaries for this feature should be set with a view to encompass the characteristic bathymetry, topography, and substrates of the Fracture Zone.
- iii. *Sections of the Mid-Atlantic Ridge*: The northernmost and southernmost boundaries would coincide respectively with the southern boundary of proposed Area 1 (Reykjanes Ridge south of Iceland EEZ) and the northern boundary of proposed Area 3 (Mid-Atlantic Ridge north of the Azores). Boundaries to the east and to the west would be a depth contour running in the deeper of two properties:
  - including a large portion (arbitrarily, perhaps 90%) of all hard volcanic substrates; habitats reported to host the larger known coral deposits and their associated communities;
  - including a large portion (arbitrarily, 90%) of the larger known deep-sea sponge aggregations.

Where the Charlie-Gibbs Fracture Zone crosses the Mid-Atlantic Ridge, the benthic boundaries of the Fracture Zone in feature ii) may extend to the east and west beyond the area defined by feature iii) for the Mid-Atlantic Ridge. In those cases the benthic area of the Fracture Zone is proposed for inclusion in the EBSA proposed here. However, any part of the seafloor and associated benthos that lies *below* the pelagic feature i) (the total area occupied by the Subpolar Front during its annual movement) but does *not* meet either feature ii) or feature iii) is *not* included in the area proposed as meeting EBSA criteria. Only those parts of the water column where the Subpolar Front is prominent at some time during the year are proposed as meeting one or more of the EBSA criteria. Moreover, in the entire *pelagic* area described by i), at any given time only those parts of the total area where the Subpolar Front is located would be expected to meet some of the criteria. Although maps will show the full pelagic area is proposed as part of this complex EBSA, any conservation measures for ecological properties of the water column would need to take into account the position of the Subpolar Front to be fully effective. For each of the above-mentioned features a set of geographic coordinates delineating their respective boundaries needs to be determined.

*Evaluation of the revised area against the EBSA criteria*

CBD EBSA Criterion	Description	Ranking of criterion relevance (please mark one column with an X)			
		Don't Know	Low	Some	High
<b>Uniqueness or rarity</b>	The area contains either (i) unique ("the only one of its kind"), rare (occurs only in few locations), or endemic species, populations, or communities, and/or (ii) unique, rare, or distinct habitats or ecosystems, and/or (iii) unique or unusual geomorphological or oceanographic features.			<b>X</b>	<b>(X)</b>
<p><i>Explanation for ranking</i></p> <p>The portion of the proposed area encompassing both the Charlie-Gibbs Fracture Zone and Subpolar Front Zone are unique. Both represent unique or unusual geomorphological or oceanographic features in the Northeast Atlantic. Other portions of the proposed EBSA are part of the Mid-Atlantic Ridge and, as discussed for Area 1 (Reykjanes Ridge south of Iceland EEZ), may host some unique benthic species based on Mar-Eco sampling.</p>					
<b>Special importance for life-history stages of species</b>	Areas that are required for a population to survive and thrive.		<b>X</b>		
<p><i>Explanation for ranking</i></p> <p>There is no evidence available suggesting a significant importance of the area for life-history stages of widespread species in comparison to other marine areas of similar size and depth range.</p>					
<b>Importance for threatened, endangered, or declining species and/or habitats</b>	Areas containing habitats for the survival and recovery of endangered, threatened, or declining species, or areas with significant assemblages of such species.				<b>X</b>
<p><i>Explanation for ranking</i></p> <p>There is good evidence that the area contains a significant assemblage of species and habitats that are assessed to be threatened, endangered, or declining, including the following: orange roughy (<i>Hoplostethus atlanticus</i>), leafscale gulper shark (<i>Centrophorus squamosus</i>), gulper shark (<i>Centrophorus granulosus</i>), Portuguese dogfish (<i>Centroscymnus coelepis</i>), Sei whale (<i>Balaenoptera borealis</i>), sperm whale (<i>Physeter macrocephalus</i>), leatherback turtle (<i>Dermochelys coriacea</i>), <i>Lophelia pertusa</i> reefs, and deep-sea sponge aggregations. Depending on the species, the special features of the Fracture Zone, the Subpolar Frontal Zone, or in a few cases the Mid-Atlantic Ridge, all provide important biological functions to the species which aggregate along each one.</p>					
<b>Vulnerability, fragility, sensitivity, or slow recovery</b>	Areas that contain a relatively high proportion of sensitive habitats, biotopes, or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery.			<b>X</b>	



CBD Criterion	EBSA Description	Ranking of criterion relevance (please mark one column with an X)			
		Don't Know	Low	Some	High
<i>Explanation for ranking</i>					
The Charlie-Gibbs Fracture Zone and sections of the Mid-Atlantic Ridge through its associated substrate, current, and feeding conditions, provide habitats to a number of sensitive/vulnerable species and communities both on soft and hard substrate and in the water column. In particular biogenic habitats such as those formed by cold-water corals and sponges are considered vulnerable, often fragile, and slow (if at all) to recover from damage. Some fish species associated with the Fracture Zone and Mid-Atlantic Ridge also show slow growth, late maturity, irregular reproduction, and long generation time, as well as community characteristics of high diversity at low biomass. However, there is no evidence available suggesting that the area contains a significantly higher proportion of species that are functionally fragile or with slow recovery than other areas of comparable structure and depth range along the Mid-Atlantic Ridge.					
Biological productivity	Areas containing species, populations, or communities with comparatively higher natural biological productivity.		X		(X)
<i>Explanation for ranking</i>					
There is good evidence that, due to the Subpolar Front, the pelagic area where the front is located at any particular time is characterized by an elevated abundance and diversity of many taxa, including an elevated standing stock of phytoplankton. This justifies a ranking of “High” for the pelagic area around the Subpolar Front, as it moves seasonally. However, there is no evidence of relatively elevated productivity in the benthic communities of the Fracture Zone and Mid-Atlantic Ridge.					
Biological diversity	Areas containing a comparatively higher diversity of ecosystems, habitats, communities, or species, or with higher genetic diversity.			X	(X)
<i>Explanation for ranking</i>					
The area of the Fracture Zone is characterized by a very high structural complexity, offering a diverse range of habitats. The area of the Subpolar Front is a feature where species are documented to assemble seasonally, and the sections of the Mid-Atlantic Ridge north and south of the Fracture Zone represent different biogeographic settings and their respective characteristic communities. Consequently, each of the three features characterizing this area contribute to a relatively higher diversity of ecosystems, habitats, communities, and species in comparison to other areas of similar size along the Mid-Atlantic Ridge.					

### ***Area 3. Mid-Atlantic Ridge north of the Azores***

ICES considers that one or more EBSA criteria would be met by an area with boundaries including all the following properties:

- Including a large portion (arbitrarily, perhaps 90%) of all hard volcanic substrates on the Mid-Atlantic Ridge south of the summer location of the Subpolar Front.
- Including the Moytirra Hydrothermal Vent Field.
- Including the area in the Mid-Atlantic Ridge included in the 50% density Kernel for foraging Cory's shearwater.

*Evaluation of the proposed area against the EBSA criteria*

CBD Criterion	EBSA Description	Ranking of criterion relevance (please mark one column with an X)			
		Don't Know	Low	Some	High
<b>Uniqueness or rarity</b>	The area contains either (i) unique (“the only one of its kind”), rare (occurs only in few locations), or endemic species, populations, or communities, and/or (ii) unique, rare, or distinct habitats or ecosystems, and/or (iii) unique or unusual geomorphological or oceanographic features.		<b>X</b>		<b>(X)</b>
<p><i>Explanation for ranking</i></p> <p>There is support for qualification under this criterion only from the hydrothermal vent field in the area which is considered to be rare, and its associated communities which may be unique. This habitat is known from a single discrete location (thus the brackets) and so it cannot be considered to offer justification for the entire extent of the proposed area. ICES does not consider that any of the other evidence presented here supports qualification under this criterion.</p>					
<b>Special importance for life-history stages of species</b>	Areas that are required for a population to survive and thrive.			<b>X</b>	
<p><i>Explanation for ranking</i></p> <p>There is some support for qualification under this criterion from the occurrence of an important long-range foraging area for Cory’s shearwaters during their breeding season. However, the core area encompassing 50% of locations at sea is relatively small and does not justify the entire extent of the proposed area.</p> <p>If research finds that deep-sea sharks and rays use the denser coral deposits as important spawning and nursery grounds, as has been reported in the Hatton–Rockall Bank area proposed by ICES, then there would be additional justification for a score of “Some” on this criterion.</p>					
<b>Importance for threatened, endangered, or declining species and/or habitats</b>	Areas containing habitats for the survival and recovery of endangered, threatened, or declining species, or areas with significant assemblages of such species.			<b>X</b>	
<p><i>Explanation for ranking</i></p> <p>The only recognised threatened and/or declining species identified in the report as occurring in the area are the deep-water sharks <i>Centrophorus squamosus</i> and <i>Centroscymnus coelolepis</i>, both of which are included on the OSPAR list of threatened and/or declining species and habitats. Since this area is not considered to have special importance for their survival (compared with other areas of similar depth and latitude elsewhere) they would not qualify under this criterion.</p> <p>However, in addition to the threatened and declining species mentioned in the proposal, the OSPAR listed habitats ‘seamount communities’ and ‘coral gardens’ are likely to exist in this area. If these were taken into account together with the sharks, this might be regarded as a significant assemblage of threatened and declining species and habitats and the ranking would be “Some”.</p>					
<b>Vulnerability, fragility, sensitivity, or slow recovery</b>	Areas that contain a relatively high proportion of sensitive habitats, biotopes, or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery.			<b>X</b>	

CBD Criterion	EBSA	Description	Ranking of criterion relevance (please mark one column with an X)			
			Don't Know	Low	Some	High
<i>Explanation for ranking</i>						
The proposed area focuses on areas with high abundance of seamounts, stony corals, and coral gardens. Recently a new hydrothermal vent was discovered on the ridge at 45°N. Seamounts, ocean ridges with hydrothermal vents, coral reefs, and coral gardens are all considered priority habitats in need of protection by the OSPAR convention for the protection and conservation of the Northeast Atlantic.						
There is good support for qualification under this criterion from the occurrence of vulnerable marine ecosystems, including seamounts, stony corals, coral gardens, and hydrothermal vents.						
Biological productivity		Areas containing species, populations, or communities with comparatively higher natural biological productivity.			X	
<i>Explanation for ranking</i>						
There is no evidence that the productivity in the revised area is any different from the expected productivity of marine systems of similar depth and latitude.						
Biological diversity		Areas containing a comparatively higher diversity of ecosystems, habitats, communities, or species, or with higher genetic diversity.			X	
<i>Explanation for ranking</i>						
The presence of a hydrothermal vent field does not in itself indicate high diversity, but it does provide some evidence of habitat heterogeneity from which species diversity may be inferred. In addition, there is a mingling of benthic faunas characteristic of both warmer southern and cooler northern ocean environments, giving the area as a whole somewhat higher net biological diversity, although the diversity in any individual site is not markedly enhanced.						

#### ***Area 4. The Hatton and Rockall banks and the Hatton–Rockall Basin***

The Hatton and Rockall banks, and associated slopes, represent unique offshore bathyal habitats (200 to 3000 m) and constitute a prominent feature of the Northeast Atlantic continental margin south of the Greenland to Scotland ridges. The banks and slopes have high habitat heterogeneity and support a wide range of benthic and pelagic faunas. They are also subject to significant fishing impact, including bottom trawling, longlining, and midwater fisheries. The banks encompass a large depth range and consequently the seabed communities encounter strong environmental gradients (e.g. temperature, pressure, and food availability). These factors cause large-scale changes in species composition with depth and give rise to a high diversity of species and habitats. The area is influenced by a number of different water masses and there is considerable interaction between the topography and physical oceanographic processes, in some areas focusing internal wave and tidal energy which results in strong currents and greater mixing and resuspension.

ICES recommend that additional work is needed primarily to refine the boundaries set out for this proposed EBSA. In particular the evidence base to use the 3000 m contour as the southern and western limits of this proposed EBSA is questionable since no evidence was provided that ecosystems meeting EBSA criteria are present at these depths. The features contributing to the uniqueness and rarity, threatened and declining species, vulnerability/fragility/sensitivity, and importance for life-history criteria stages all occur exclusively at relatively shallow depths (< 1500 m) with most being < 1200 m, and the only additional benefit gained by extending the boundary to 3000 m is an increase in the overall depth range covered and hence additional biological diversity. It is unclear whether the additional diversity conferred by the inclusion of the 1500 to 3000 m depth zone is any different from that present in any other area at comparable depth and latitude.

ICES therefore recommends that proposed EBSA should go forward with a revised boundary approximating to the 1500 m depth contour. If further work can establish significant additional value in the inclusion of greater depths, the boundary could be adjusted accordingly in the future.

*Evaluation of the proposed area against the EBSA criteria*

CBD EBSA Criterion	Description	Ranking of criterion relevance (please mark one column with an X)			
		Don't Know	Low	Some	High
<b>Uniqueness or rarity</b>	The area contains either (i) unique (“the only one of its kind”), rare (occurs only in few locations), or endemic species, populations, or communities, and/or (ii) unique, rare, or distinct habitats or ecosystems, and/or (iii) unique or unusual geomorphological or oceanographic features.			X	(X)
<p><i>Explanation for ranking</i></p> <p>The area has considerable environmental heterogeneity, and therefore biological diversity, as a result of its large depth range and strong environmental gradients. Habitat-forming sessile benthic communities, such as those of giant protozoans and sponges, are common. Although distinctive these features are not rare <i>per se</i>.</p> <p>Large areas of cold-water corals and sponges have been reported in the area. Some of these have been impacted by bottom trawl and longline fishing and past periods of bottom gillnet fishing, but some areas of large coral frameworks still exist, including areas such as the Logachev coral carbonate mound province which spans both national EEZ (Ireland) and international waters. Many of these coral frameworks are now protected as VMEs.</p> <p>An area of polygonal faults may be a unique seabed feature. It is currently poorly investigated but may host important biological communities (e.g. cold-seeps).</p> <p>The polygonal faults do not themselves appear to support unique biological communities or species but may be indicative of possible presence of active hydrocarbon seeps. One such active seep has recently been discovered in this area, supporting a rare chemosynthetic community that hosts species that have not been recorded elsewhere (hence the bracketed “High” score).</p> <p>There is support for qualification under this criterion from the occurrence of polygonal faults and an active cold hydrocarbon seep. These features exist within a very restricted area of the site and, as described, the uniqueness and rarity criterion would only apply where these habitats occur. If further information is provided on the occurrence of large areas of cold-water coral reef, this may provide further support for this criterion over a wider geographical area.</p>					
<b>Special importance for life-history stages of species</b>	Areas that are required for a population to survive and thrive.			X	
<p><i>Explanation for ranking</i></p> <p>Cold-water corals and areas of natural coral rubble provide highly diverse habitats. Recent observations show that <i>Lophelia pertusa</i> reefs provide nursery grounds for deep-water sharks, and egg cases of deep-water rays were recorded with small patches of <i>Solenosmilia variabilis</i> framework on the Hebrides Terrace Seamount during the RRS <i>James Cook</i> 073 Changing Oceans Expedition in June 2012. New evidence from RRS <i>James Cook</i> cruises 073 and 060 shows that small patch reefs of <i>L. pertusa</i> on Rockall Bank are used as refuge by gravid <i>Sebastes viviparus</i>.</p> <p>Parts of the Hatton–Rockall area are important as spawning areas for blue whiting, and the area is used as a corridor for a range of migrating species, including turtles.</p> <p>Blue whiting has a widespread spawning area from the Faroe–Shetland Channel in the north to the Porcupine Bank in the south. Three areas of blue ling spawning aggregations are known on the shallow parts of Hatton and Lousy banks. These are significant since they represent three of the six known or suspected spawning locations for the southern stock of blue ling.</p>					

CBD EBSA Criterion	Description	Ranking of criterion relevance (please mark one column with an X)			
		Don't Know	Low	Some	High
<b>Importance for threatened, endangered, or declining species and/or habitats</b>	Areas containing habitats for the survival and recovery of endangered, threatened, or declining species, or areas with significant assemblages of such species.				<b>X</b>
<p><i>Explanation for ranking</i></p> <p>The OSPAR threatened and declining habitats and species “carbonate mounds” and <i>Lophelia pertusa</i> are confirmed to be present in the area, and indicator species for “deep-sea sponge aggregations” and “coral gardens” have been recorded. The presence of these habitats has been confirmed in some areas that are now protected as VMEs.</p> <p>The cold-water corals and natural rubble contain very large numbers of invertebrate species, including giant protozoans (xenophyophores), vase-shaped white sponges, actinarians, antipatharian corals, hydroids, bryozoans, asteroids, ophiuroids, echinoids, holothurians, and crustaceans.</p> <p>The distribution of cold-water coral has been severely reduced in the area over the last 30 years.</p> <p>The deep-water sharks <i>C. coelolepis</i> and <i>C. squamosus</i> are also listed in the OSPAR list. Both occur in the area, but there is no information to indicate that this area is important for either species in the sense of having a significant proportion of the population or higher density than other areas of similar depth in the region.</p> <p>Both Zino’s petrel (endangered) and Fea’s petrel (near threatened) are listed on the IUCN Red List. A further five species of seabirds listed in Annex I of the European Union Bird’s Directive are found within the area. However, tracking for the two petrel species (data in Figure 2 of the proposal; OSPAR/NEAFC/CBD, 2011) appears to show that the area is of relatively low importance (5 to 10% of tracked birds) during a very short period (one month).</p> <p>Knowledge of cetaceans in the area is poor, but the critically endangered northern right whale (<i>Eubalaena glacialis</i>) has been observed in this area. However, this single observation is insufficient to demonstrate importance for this species.</p>					
<b>Vulnerability, fragility, sensitivity, or slow recovery</b>	Areas that contain a relatively high proportion of sensitive habitats, biotopes, or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery.				<b>X</b>

CBD Criterion	EBSA Description	Ranking of criterion relevance (please mark one column with an X)			
		Don't Know	Low	Some	High
<i>Explanation for ranking</i>					
<p>It is uncertain how “a relatively high proportion” is defined in this context, but there is good evidence for vulnerable habitats and benthic species in the area (records of cold-water coral reefs and carbonate mounds, and indicator species for coral gardens, deep-water sponge aggregations). Distribution is not uniform across the area and many of the areas where they occur are now protected as VMEs.</p> <p>There is a high diversity of corals, including bamboo coral (Isididae), black coral (Antipatharia), as well as the reef-forming stony corals (Scleractinia), though some of these may now be reduced in distribution and occurring in patches. Cold-water coral habitats are easily impacted and recover very slowly. Some species of cold-water corals can live for more than 4000 years.</p> <p>Many of the demersal fish have life histories of deep-water fish fauna with very slow recovery times as a result of their slow reproductive rate compared to pelagic fish. These fish may be more exposed to fishing pressure because trawlable habitat is more common in this area than is typical at these depths. Stocks have already been diminished in some areas.</p> <p>There is good support for qualification under this criterion from the occurrence of vulnerable marine ecosystems, including stony corals, carbonate mounds, possible coral gardens and deep-sea sponge aggregations, and an active cold seep. Although comparative studies have not been done, it is probable that occurrence of corals in the Rockall–Hatton area is higher than in other areas of comparable depth and latitude. This would therefore constitute a “relatively high proportion”.</p> <p>The species or habitats discussed in this rationale are generally found in depths above 1500 m and thus this proposed EBSA should be limited to this depth contour.</p>					
<b>Biological productivity</b>	Areas containing species, populations, or communities with comparatively higher natural biological productivity.		<b>X</b>		
<i>Explanation for ranking</i>					
<p>It is likely that pelagic production may be enhanced relative to surrounding areas due to upwelling, but benthic secondary production in deep-water environments is generally considered to be low compared to other environments.</p>					
<b>Biological diversity</b>	Areas containing a comparatively higher diversity of ecosystems, habitats, communities, or species, or with higher genetic diversity.				<b>X</b>
<i>Explanation for ranking</i>					
<p>The area comprises a patchwork of habitats with species changing consistently with both habitat type and increasing depth. Some habitats are threatened by direct impacts (e.g. bottom fishing), others may suffer indirectly (e.g. through the creation of sediment plumes by impacts of fishing gear in sensitive areas). Seabed communities include cold-water corals, rocky reefs, carbonate mounds, polygonal fault systems, sponge aggregations, and steep and gentle sedimented slopes. Cold-water corals provide diverse habitats for other invertebrates and fish.</p> <p>This area spans more than one biogeography province; consequently, overall diversity is likely to be higher than in other areas with comparable depth and habitat range. Rare habitats such as cold seeps and highly diverse habitats such as cold-water coral reef and rubble further contribute to the overall diversity.</p>					

**Proposal for a different configuration of EBSAs than those presented in the OSPAR/NEAFC/CBD Workshop report**

Proposed EBSAs 1, 2, and 3 (Reykjanes Ridge south of Iceland EEZ, Charlie-Gibbs Fracture Zone and Subpolar Frontal Zone of the Mid-Atlantic Ridge, and Mid-Atlantic Ridge north of the Azores) all encompass the hard substrates running roughly north–south in the higher elevations of the Mid-Atlantic Ridge, and for proposed

EBSAs 1 to 3 the southern boundary of each aligns with the northern boundary of the next. The boundaries between them were defined primarily by the extreme limits of the position of the east–west-oriented Subpolar Front, a major pelagic oceanographic feature in proposed EBSA 2 that moves seasonally northward (spring and summer) and southward (autumn and winter).

The Subpolar Front has affinities with the Charlie-Gibbs Fracture Zone, but not with the Mid-Atlantic Ridge. If the Charlie-Gibbs Fracture Zone, running roughly east to west, and associated Subpolar Frontal Zone were treated separately from the Mid-Atlantic Ridge, then all the areas delineated by the features of the Mid-Atlantic Ridge specified for the proposed EBSAs 1, 2, and 3 would share a consistent geomorphological feature (the emergent hard substrates primarily of volcanic origin) with associated benthic fauna present from the northern boundary of proposed EBSA 1 to the southern boundary of proposed EBSA 3, with the Charlie-Gibbs Fracture Zone itself simply serving as an interruption in this feature.

The entire Mid-Atlantic Ridge feature would score “Some” or “High” on several criteria, and for generally the same biological rationales for the entire ridge. The species composition of the benthic biota does change from north to south, but aside from the structural interruption caused by the transverse fractures, there is no strong evidence that discontinuities in benthic community composition exist along the ridge. Thus, an alternative area to proposed EBSAs 1, 2, and 3 can be justified along the entire Mid-Atlantic Ridge in the OSPAR/NEAFC area, defined by the features specified in the description of proposed EBSA 1, and ranked as “Some” or “High” on several EBSA criteria with a common justification for that entire area.

A second alternative EBSA could then be proposed, consisting of the Charlie-Gibbs Fracture Zone and Subpolar Frontal Zone, taken together. This area would have its own set of ecological properties and associated rankings on the EBSA criteria. It would be ranked “Some” or “High” on several criteria for justifications specific to the Fracture Zone and Subpolar Front, but in several cases for justifications very different from that of the Mid-Atlantic Ridge.

These two potential proposed EBSAs would replace proposed EBSAs 1, 2, and 3 from the OSPAR/NEAFC/CBD Workshop report. It would also require a separate consideration of seabird foraging in the southern third of the area, jointly with the additional analyses already recommended for the OSPAR/NEAFC/CBD Workshop proposed EBSAs 5–8.

#### *Alternative proposed EBSA for the Mid-Atlantic Ridge*

The Mid-Atlantic Ridge runs from the southern boundary of the Icelandic EEZ to the northern boundary of the Portuguese EEZ in the Azores and includes all area above a depth contour that runs in the deeper of two properties:

1. Including a large portion (arbitrarily, perhaps 90%) of all hard volcanic substrates; habitats are reported to host the larger known coral deposits and their associated communities.
2. Included a large portion (arbitrarily, 90%) of the records of large sponge communities in the overall Mid-Atlantic Ridge.

In addition the proposed area should include all known hydrothermal vents along the ridge, if any of these are deeper than the contours meeting the properties above.

#### *Evaluation of the proposed area against the EBSA criteria*

CBD EBSA Criterion	Description	Ranking of criterion relevance (please mark one column with an X)			
		Don't Know	Low	Some	High
<b>Uniqueness or rarity</b>	The area contains either (i) unique (“the only one of its kind”), rare (occurs only in few locations), or endemic species, populations, or communities, and/or (ii) unique, rare, or distinct habitats or ecosystems, and/or (iii) unique or unusual geomorphological or oceanographic features.			X	(X)

CBD EBSA Criterion	Description	Ranking of criterion relevance (please mark one column with an X)			
		Don't Know	Low	Some	High
<i>Explanation for ranking</i> The qualified “High” ranking is for restricted areas of the few known hydrothermal vents along the ridge. These are globally rare features; only a small part of the area proposed here meets this EBSA criterion.  The MarEco sampling of corals and sponges reported several species new to science as it sampled the Mid-Atlantic Ridge. However, it is not possible to draw a firm conclusion on the presence of unique species along the ridge until more extensive sampling is undertaken.					
Special importance for life-history stages of species	Areas that are required for a population to survive and thrive.		X		
<i>Explanation for ranking</i>  Although many populations undoubtedly complete their life cycles within the harder-substrate areas of the Mid-Atlantic Ridge, this would be true of any marine area of comparable size. There is no evidence that the life history of any species is strongly dependent on any specific features of the area proposed as an alternative EBSA.  There is evidence from other areas of the Northeast Atlantic that areas of high coral density may be important as egg-case and nursery areas of deep-water sharks and rays. The area proposed here is targeted on the depths and substrates associated with higher coral and sponge densities, and if sharks and rays also concentrate spawning and early development in these habitats, then the score would be “Some” or “High” on this criterion as well. However, it has not yet been documented that skates and rays do preferentially use the coral and sponge formations for these life history functions in the Mid-Atlantic Ridge.  For the more southern portions of the Mid-Atlantic Ridge in particular, there are reports of areas being important for foraging by seabirds, including Cory’s shearwater. The evidence available is not considered strong, however, and this aspect of the ecological functionality of the central ridge area should be considered as part of the reanalysis of EBSAs 5–8 proposed in the OSPAR/NEAFC/CBD Workshop report.					
Importance for threatened, endangered, or declining species and/or habitats	Areas containing habitats for the survival and recovery of endangered, threatened, or declining species, or areas with significant assemblages of such species.				X
<i>Explanation for ranking</i>  There are large deposits of corals and sponges found in the alternative area proposed by ICES as meeting this criterion. Habitats containing these species are listed by OSPAR and are also VME indicator species, and the majority of these would be included in the alternative proposed EBSA. Additional explanation regarding corals and sponges is included in the rationale for the criterion on Vulnerability.  The possible role of the alternative proposed Mid-Atlantic Ridge area in the life histories of sharks and rays is discussed in the criterion on Vulnerability and Sensitivity. If a dependency between the breeding or early life history of threatened or endangered skates or rays were documented, there would be additional justification for a “High” ranking of this criterion.					
Vulnerability, fragility, sensitivity, or slow recovery	Areas that contain a relatively high proportion of sensitive habitats, biotopes, or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery.			X	



CBD Criterion	EBSA Description	Ranking of criterion relevance (please mark one column with an X)			
		Don't Know	Low	Some	High
<i>Explanation for ranking</i>					
With regard to corals and sponges, Mortensen <i>et al.</i> (2008) found cold-water corals “ <i>at every sample station ... observed at depths between 800 and 2400 m, however were commonly found shallower than 1400 m ..., with species richness being very high. ... no major reef structures were recorded, with the maximum colony size approximately 0.5 m in diameter. The number of coral taxa was strongly correlated with the percentage cover of hard bottom substrate ....</i> ” The area proposed here is targeted at the seamount peaks and slopes where hard substrates dominate. For sponges, no actual large expanses of sponge reef were reported in the OSPAR/NEAFC/CBD Workshop report. However, the pro forma in that report notes that overall sampling of the area is patchy and cites three studies that found local patches with high densities of sponges, although in no cases were the sizes of the patches documented.					
If research finds that deep-sea sharks and rays use the denser coral deposits as important spawning and nursery grounds, as has been reported in the Hatton–Rockall Bank area proposed by ICES, then there would be additional justification for a score of “Some” on this criterion.					
Biological productivity	Areas containing species, populations, or communities with comparatively higher natural biological productivity.		X		
<i>Explanation for ranking</i>					
Although benthic productivity of the alternative proposed Mid-Atlantic Ridge EBSA may be higher than benthic productivity on the abyssal plain, productivity integrated over the entire water column and seafloor seems typical of systems of comparable depth and latitude globally.					
Biological diversity	Areas containing comparatively higher diversity of ecosystems, habitats, communities, or species, or with higher genetic diversity.			X	
<i>Explanation for ranking</i>					
The presence of comparatively large coral and sponge formations, and the documented high diversity of benthic and associated fish when corals or sponges are present in moderate or high density imply that some areas along the ridge may have high diversity. From north to south there is a mingling of benthic and demersal fish faunas characteristic of both cooler northern and warmer southern ocean environments, giving the area as a whole a somewhat higher net biological diversity, even if the diversity in any individual site is not markedly enhanced. Aside from the benthic communities of somewhat restricted distribution associated with the biogenic habitats, the biodiversity otherwise appears typical of biotic communities at similar depths and latitude.					

***Alternative proposed EBSA – The Charlie-Gibbs Fracture Zone and Subpolar Frontal Zone***

The area would include:

- i. *Subpolar Frontal Zone* (coinciding with the Charlie-Gibbs Fracture Zone): The northern and southern boundaries for this feature should be set according to the known northernmost and southernmost locations of the frontal system (at approximately 53°N and 48°N). The eastern and western boundaries for this feature should be set according to the eastern and westernmost extension of the Charlie-Gibbs Fracture Zone (at approximately 27°W and 42°W).
- ii. *Charlie-Gibbs Fracture Zone*: The eastern and western boundaries for this feature should be set according to the east–west extension of the Fracture Zone (at approximately 27°W and 42°W). The northern and southern seabed boundaries for this feature should be set with a view to encompass the characteristic topography and substrates of the Fracture Zone.

Any area of the seafloor and associated benthos that lies *below* the pelagic feature i) (the total area occupied by the Subpolar Front during its annual movement) but does *not* meet feature ii) is *not* included in the area proposed as meeting EBSA criteria. Only those parts of the water column where the Subpolar Front is prominent at some time during the year are proposed as meeting one or more of the EBSA criteria. Moreover, in the entire *pelagic* area described by i), at any given time only that part of the total area where the Subpolar Front

is located would be expected to meet some of the criteria. Although maps will show that the full pelagic area is proposed as part of this complex EBSA, any conservation measures for ecological properties of the water column would need to take into account the position of the Subpolar Front to be fully effective.

*Evaluation of the proposed area against the EBSA criteria*

CBD EBSA Criterion	Description	Ranking of criterion relevance (please mark one column with an X)			
		Don't Know	Low	Some	High
<b>Uniqueness or rarity</b>	The area contains either (i) unique ("the only one of its kind"), rare (occurs only in few locations), or endemic species, populations, or communities, and/or (ii) unique, rare, or distinct habitats or ecosystems, and/or (iii) unique or unusual geomorphological or oceanographic features.				<b>X</b>
<p><i>Explanation for ranking</i></p> <p>The Charlie-Gibbs Fracture Zone is a set of geomorphological features unique to the entire North Atlantic, and the Subpolar Front is an oceanographic feature also unique to the Northeast Atlantic. Together these features justify a "High" score for this criterion.</p>					
<b>Special importance for life-history stages of species</b>	Areas that are required for a population to survive and thrive.		<b>X</b>		
<p><i>Explanation for ranking</i></p> <p>No evidence is available suggesting a significant importance of the area for life-history stages of widespread species in comparison with other marine areas of similar size and depth range. It is possible that there are species with special affinities for the unique geophysical features of the deep faults, but clear documentation of species with such affinities was not found in the references provided by the OSPAR/NEAFC/CBD Workshop report, and was not otherwise known to ICES.</p>					
<b>Importance for threatened, endangered or declining species and/or habitats</b>	Areas containing habitats for the survival and recovery of endangered, threatened, or declining species, or areas with significant assemblages of such species.				<b>X</b>
<p><i>Explanation for ranking</i></p> <p>There is good evidence that the area contains a significant assemblage of species and habitats that are assessed to be threatened, endangered, or declining, including leafscale gulper shark (<i>Centrophorus squamosus</i>), gulper shark (<i>Centrophorus granulosus</i>), Portuguese dogfish (<i>Centroscymnus coelepis</i>), Sei whale (<i>Balaenoptera borealis</i>), sperm whale (<i>Physeter macrocephalus</i>), leatherback turtle (<i>Dermochelys coriacea</i>), as well as cold-water coral reefs and deep-sea sponge aggregations. Depending on the species, the special features of the Fracture Zone and the Subpolar Front are inferred to provide important biological functions to the species which aggregate along each one.</p>					
<b>Vulnerability, fragility, sensitivity, or slow recovery</b>	Areas that contain a relatively high proportion of sensitive habitats, biotopes, or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery.			<b>X</b>	

CBD Criterion	EBSA Description	Ranking of criterion relevance (please mark one column with an X)			
		Don't Know	Low	Some	High
Explanation for ranking					
The Charlie-Gibbs Fracture Zone geophysical structure provides habitats for a number of sensitive/vulnerable species and communities both on soft and hard substrate and in the associated water column. In particular biogenic habitats such as those formed by cold-water corals and sponges are considered vulnerable, are often fragile, and slow (if at all) to recover from damage. Some fish species associated with the Fracture Zone and the Subpolar Front also show slow growth, late maturity, irregular reproduction, and long generation time, as well as community characteristics of high diversity at low biomass. However, the documentation that the species with vulnerable life histories are especially closely affiliated with the Fracture Zone and frontal habitats is weak, and it is clear that these vulnerable species and biogenic habitats are not consistently present throughout the entire Fracture Zone and Subpolar Front.					
Biological productivity	Areas containing species, populations, or communities with comparatively higher natural biological productivity.			X	(X)
Explanation for ranking					
There is good evidence that, because of the Subpolar Front, the pelagic area where the front is located at any particular time is characterized by an elevated abundance and diversity of many taxa, including an elevated standing stock of phytoplankton. This justifies a ranking of “High” for the pelagic area around the Subpolar Front, as it moves seasonally. However, there is no evidence of relatively elevated productivity in the benthic communities of the Fracture Zone.					
Biological diversity	Areas containing a comparatively higher diversity of ecosystems, habitats, communities, or species, or with higher genetic diversity.				X
Explanation for ranking					
The area of the Fracture Zone is characterized by a very high structural complexity, offering a diverse range of habitats. The area of the Subpolar Front is a feature where species are documented to assemble seasonally. Consequently, both features characterizing this area contribute to a relatively higher diversity of ecosystems, habitats, communities, and species in comparison to other areas of the Northeast Atlantic.					

### **Proposed EBSAs for which there is insufficient scientific justification**

For five of the ten areas proposed as meeting one or more EBSA criteria in the OSPAR/NEAFC/CBD Workshop report, ICES concluded that there is insufficient scientific justification at this time to propose their delineated area, or any subset of it, as meeting EBSA criteria. In all cases ICES recommends that additional information needs to be collated and analysed, and a new evaluation be conducted when those results are available. ICES provides reasoning for its advice and recommendations for further work in each of these areas below.

#### ***Area 5. Around the Pedro Nunes and Hugo de Lacerda seamounts and***

#### ***Area 6. Northeast Azores–Biscay Rise***

The OSPAR/NEAFC/CBD Workshop concluded that both areas ranked as “High” on criterion Special Importance to Life History of Species, and “Some” on criteria Uniqueness and Rarity; Importance to Threatened, Endangered, or Declining Species; and Vulnerability, Sensitivity, etc., the latter primarily for seabirds. ICES questions the basis for these conclusions, noting that the data used to assess all the criteria specified were incomplete and often incorrectly interpreted, with the proposed boundaries not matching the information in the cited sources.

ICES recommends that all available data on foraging activity of the Zino’s petrel, Cory’s shearwater, and other relevant species be examined. This should include published and any other available data. Occurrence data may be used as well, provided the rationale details how occurrence and foraging data are used to derive EBSA boundaries.

### ***Area 7. Evlanov Seamount region***

The OSPAR/NEAFC/CBD Workshop concluded that the area they delineated ranked as “High” on criterion Importance to Threatened, Endangered, or Declining Species, and “Some” on criteria Uniqueness and Rarity; Special Importance to Life History of Species; and Vulnerability, Sensitivity, etc., the latter primarily for seabirds. ICES questions the basis for these conclusions, noting that the data used to assess all the criteria specified were incomplete and often incorrectly interpreted, with the proposed boundaries not matching the information in the cited sources. In particular the sample sizes for Fea’s petrel were very small, and the information for sooty shearwater did not seem to differentiate the proposed EBSA area from most of surrounding area.

ICES advises not to proceed with proposing any portion of this area as an EBSA at this time, but rather undertake further collation and analysis of information and reconsider when the additional work is completed.

### ***Area 8. Northwest of Azores EEZ***

The OSPAR/NEAFC/CBD Workshop concluded that the area they delineated ranked as “High” on criteria Special Importance for Life History of Stages of Species and Importance for Threatened, Endangered or Declining Species, and “Some” on criteria Uniqueness and Rarity; Vulnerability, Sensitivity, etc.; and Biological Diversity, the latter primarily for seabirds. ICES questions the basis for these conclusions, noting that the data used to assess all the criteria specified were incomplete and often incorrectly interpreted, with very small sample sizes for some of the species’ (e.g. Zino’s petrel) foraging areas, and questionable interpretation of the foraging areas of Cory’s shearwater.

ICES does not support this area going forward as presented in the OSPAR/NEAFC/CBD EBSA Workshop report. ICES advises that improvements are needed to the supporting evidence in the narrative for criteria related to Special Importance for Life History Stages of Species and Importance for Threatened, Endangered or Declining Species and/or Habitats. It is necessary to augment information on how the area is being used (feeding, conditioning, migration) for the survival and recovery of the species and to put some scale on its importance to the species (some of which have very restricted breeding sites in the larger area). It is also necessary to document the proportion of species that are highly susceptible to degradation or depletion by human activity, in this case bycatch in longline fisheries.

### ***Area 9. The Arctic Front – Greenland/Norwegian seas***

The OSPAR/NEAFC/CBD Workshop concluded that the area they delineated ranked as “High” on criteria Special Importance to Life History of Species; Importance to Threatened, Endangered, or Declining Species; Biological Productivity; and Biological Diversity. ICES questions the basis for these conclusions, noting that (1) for several features the area proposed as meeting criteria were not noticeably different from the surrounding areas; (2) some of the rankings regarding importance appeared to be inferred from a belief that the area is high in productivity, but the rankings were not demonstrated otherwise; and (3) publications with contrasting conclusions were found for some of the key references cited in the OSPAR/NEAFC/CBD Workshop report.

ICES recommends not to proceed with the proposed Arctic Front EBSA. There is no evidence of enhanced productivity at the Arctic Front which is the main rationale used to justify the proposed EBSA. However, there seems to be circumstantial evidence for an enhanced production that may attract feeding animals in the areas around and south of Jan Mayen, including the Jan Mayen Front. If parts of this area are located in the high seas, further analyses should be undertaken to determine if this area meets the EBSA criteria.

### **Sources**

- CBD. 2007. Expert Workshop on Ecological Criteria and Biogeographic Classification Systems for Marine Areas in Need of Protection. 2–4 October 2007, Azores, Portugal. (<http://www.cbd.int/doc/meetings/mar/ewsebm-01/official/ewsebm-01-02-en.pdf>).
- CBD. 2008. CBD Decision IX/20 on Marine and Coastal Biodiversity. (<http://www.cbd.int/doc/decisions/cop-09/cop-09-dec-20-en.pdf>).
- CBD. 2009. Expert Workshop on Scientific and Technical Guidance on the Use of Biogeographic Classification Systems and Identification of Marine Areas beyond National Jurisdiction in Need of Protection. 29

- September–2 October 2009, Ottawa, Canada. (<https://www.cbd.int/doc/meetings/sbstta/sbstta-14/information/sbstta-14-inf-04-en.pdf>).
- CBD. 2010. CBD Decision X/29 on Marine and Coastal Biodiversity. (<https://www.cbd.int/decision/cop/default.shtml?id=12295>).
- German, C. R., and Parsons, L. M. 1998. Distributions of hydrothermal activity along the Mid-Atlantic Ridge: interplay of magmatic and tectonic controls. *Earth and Planetary Science Letters*, 160: 327–341.
- German, C. R., Briem, J., Chin, C., Danielsen, M., Holland, S., James, R., Jónsdóttir, A., Ludford, E., Moser, C., Ólafsson, J., Palmer, M. R., and Rudnicki, M. D. 1994. Hydrothermal activity on the Reykjanes Ridge: the Steinahóll vent-field at 63°06'N. *Earth and Planetary Science Letters*, 121: 647–654.
- ICES. 2013a. Vulnerable deep-water habitats in the NEAFC Regulatory Area. *In* Report of ICES Advisory Committee, 2013, Section 1.5.5.1. ICES Advice, 2013, Book 1.
- ICES. 2013b. Report of the Workshop to Review and Advise on EBSA Proposed Areas (WKEBSA), 27–31 May 2013, Copenhagen, Denmark. In draft.
- Mironov, A., and Gebruk, A. 2007. Deep-sea benthos of the Reykjanes Ridge: biogeographic analysis of the fauna living below 1000 m. Report on preliminary phase of the project patterns and processes of the ecosystems of the northern Mid-Atlantic (Mar-Eco). ([http://www.mareco.no/sci/component\\_projects/epibenthos/deep-sea\\_benthos\\_of\\_the\\_reykjanes\\_ridge](http://www.mareco.no/sci/component_projects/epibenthos/deep-sea_benthos_of_the_reykjanes_ridge)).
- Mortensen, P. B., Buhl-Mortensen, L., Gebruk, A. V., and Krylova, E. M. 2008. Occurrence of deep-water corals on the Mid-Atlantic Ridge based on Mar-Eco data. *Deep-Sea Research*, 55: 142–152.
- Ólafsson, J., *et al.* 1991. A sudden cruise off Iceland. *RIDGE Events Newsletter*, 2(2): 35–38.
- OSPAR/NEAFC/CBD. 2011. Report of the Joint OSPAR/NEAFC/CBD Scientific Workshop on the Identification of Ecologically or Biologically Significant Marine Areas (EBSAs) in the North-East Atlantic. 8–9 September 2011, Hyères, France. Annex 11.
- Søiland, H., Budgell, W. P., and Knutsen, Ø. 2008. The physical oceanographic conditions along the Mid-Atlantic Ridge north of the Azores in June–July 2004. *Deep-Sea Research II*, 55: 29–44.
- United Nations. 2004. UNGA Resolution 58/240. (<http://daccess-dds-ny.un.org/doc/UNDOC/GEN/N03/508/92/PDF/N0350892.pdf?OpenElement>).

Joint OSPAR/NEAFC/CBD Scientific Workshop on the Identification of Ecologically or Biologically Significant Marine Areas (EBSAs) in the North-East Atlantic

Hyères (Port Cros), France: 8 – 9 September 2011

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## EBSA identification proforma for the North-East Atlantic - 10

**Title/Name of the area** - The Arctic Ice habitat - multiyear ice, seasonal ice and marginal ice zone

**Presented by** WWF and reviewed by Participants at the Joint OSPAR/NEAFC/CBD Scientific Workshop on the Identification of Ecologically or Biologically Significant Marine Areas in the North-East Atlantic

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### **Abstract**

The permanently ice covered waters of the high Arctic provide a range of globally unique habitats associated with the variety of ice conditions. Multi-year sea ice only exists in the Arctic and although the projections of changing ice conditions due to climate change project a considerable loss of sea ice, in particular multiyear ice, the Eurasian Central Arctic high seas are likely to at least keep the ice longer than many other regions in the Arctic basin. Ice is a crucial habitat and source of particular foodweb dynamics, the loss of which will affect also a number of mammalian and avian predatory species. The particularly pronounced physical changes of Arctic ice conditions as already observed and expected for the coming decades, will require careful ecological monitoring and eventually measures to maintain or restore the resilience of the Arctic populations to quickly changing environmental conditions.

### **Introduction**

Up until today most of the Eurasian part of the Arctic Basin, and in particular the high seas area in the Arctic Ocean (the waters beyond the 200 nm zones of coastal states, i.e. Norway, Russia, USA, Canada and Greenland/Denmark) is permanently ice covered. However, in recent years, much of the original multiyear pack ice has been replaced by seasonal (1 year) ice which made it possible for research and other vessels to reach the pole. In addition, the former fast pack-ice is now increasingly broken up by leads. This structural change in the Arctic ice quality will result in a substantial increase in light penetrating the thin ice and water column, in conjunction with the overall warming of surface waters and increased temperature and salinity stratification due to the melting of ice.

In the near future, up to the end of the century, the permanent ice cover is expected to disappear completely in some models (Anisimov *et al.*, 2007). This will result in significant changes in the structure and dynamics of the high Arctic ecosystems (CAFF, 2010; Gradinger, 1995; Piepenburg,

2005; Renaud *et al.*, 2008; Wassmann, 2008, 2011) which should be closely monitored (Bluhm *et al.*, 2011) as already envisaged by the Arctic Council (Gill *et al.*, 2011; Mauritzen *et al.*, 2011).

Therefore, the area proposed here as EBSA is of particular scientific interest and may in the longterm, become relevant for the commercial exploitation of resources.

## Location

The Ecologically or Biologically Significant Marine Area (EBSA) proposed focusses on the presently permanently ice-covered waters in the OSPAR/NEAFC maritime areas, including the high seas section in the Central Arctic Basin north of the 200 nm zones of coastal states (see Fig. 1 attached). Therefore, the boundaries proposed extend from the North Pole (northernmost point of OSPAR/NEAFC maritime areas) to the southern limit of the summer sea ice extent and marginal ice zone, including on the shelf of East Greenland.

The proposal currently only relates to features of the water column. Two legal states have to be distinguished: the Central Arctic high seas waters north of the 200 nm zones of adjacent coastal states, generally north of 84° N, and the waters within the Exclusive Economic Zones of Greenland, Russia and the fisheries protection zone of Norway around Svalbard. Figure 1 distinguishes between the high seas beyond national jurisdiction for which the „Joint OSPAR/NEAFC/CBD Scientific Workshop on the Identification of Ecologically or Biologically Significant Marine Areas (EBSAs) in the North-East Atlantic“ has a mandate<sup>1</sup>, and national/nationally administered waters within the 200 nm zone, within which the OSPAR Contracting Parties have the responsibility to report candidate EBSAs to the Convention on Biodiversity EBSA repository (OSPAR Commission, 2011).

The seafloor of the respective region will likely fall on the extended continental shelves of several coastal states. It belongs to the „Arctic Basin“ region of (Gill *et al.*, 2011).

The coordinates of the overall area, as well as the high seas section are provided in Annex 1 (in decimals, shape files provided):

c.f. **Figure 1:** Location of the Arctic Ice „Ecologically or Biologically Significant Area“ (EBSA) proposed by WWF in September 2011. The position of the Arctic and polar fronts was redrawn after (Rey, 2004, Fig. 5.7).

## Feature description

The Ecologically or Biologically Significant Marine Area (EBSA) proposed focusses on the presently permanently ice-covered waters in the OSPAR/NEAFC maritime areas, including the high seas section in the Central Arctic Basin north of the 200 nm zones of coastal states, and the marginal ice zone (where the ice breaks up, also called seasonal ice zone) along its southern margins (see Fig. 1 attached). Due to the inflow of Atlantic water along the shelf of Svalbard, and the concurrent outflow of polar water and ice on the Greenland side of Fram Strait, the southern limit of the summer sea ice extent is much further south in the western compared to the eastern Framstrait, and in former times extended all along the Greenland coast.

The high seas section of the OSPAR maritime area in the Central Arctic ocean is generally north of 84° N and is until today fully ice-covered also in summer, although the quantity of multiyear ice has already substantially decreased and the 1-year ice leaves increasingly large leads and open water spaces. The ice overlays a very deep water body of up to 5000 m depth far away from the surrounding continental shelves and slopes of Greenland and the Svalbard archipelago. The Nansen-Gakkel Ridge, a prolongation of the Mid-Atlantic Ridge north of the Fram Strait is structuring

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<sup>1</sup> Participant Briefing for a Joint OSPAR/NEAFC/CBD Scientific Workshop on the Identification of Ecologically or Biologically Significant Marine Areas (EBSAs) in the North-East Atlantic. Invitation Annex 2, 2011

the deep Arctic basin in this section, separating the Central Nansen Basin to the south from the Amundsen Basin to the north. Abundant hydrothermal vent sites have been discovered on this ridge at about 85° 38 N (Edmonds *et al.*, 2003).

North of Spitsbergen, the Atlantic water of the West Spitsbergen Current enters the Arctic basin as a surface current. At around 83° N, a deep-reaching frontal zone separates the incoming Atlantic and shelf waters from those of the Central Nansen Basin (Anderson *et al.*, 1989), as reflected in ice properties, nutrient concentrations, zooplankton communities, and benthic assemblages (Hirche and Mumm, 1992, and literature quoted). This water subsequently submerges under the less dense (less salinity, lower temperature) polar water and circulates, in opposite direction to the surface waters and ice, counterclockwise along the continental rises until turning south along the Lomonosov Ridge and through Fram Strait as East Greenland Current south to Danmark Strait (Aagaard, 1989; Aagaard *et al.*, 1985). Connecting the more fertile shelves with the deep central basin, these modified Atlantic waters supply the waters north of the Nansen-Gakkel Ridge, in the Amundsen basin, with advected organic material and nutrients which supplement the autochthonous production (Mumm *et al.*, 1998). Due to the import of organic biomass from the Greenland Sea and the Arctic continental shelves, part of which may not be kept in the food web due to the polar conditions, the Arctic Ocean may also represent an enormous carbon sink (Hirche and Mumm, 1992).

In the Fram Strait, the region between Svalbard to the east and Greenland to the west, the East Greenland Current is the main outflow of polar water and ice from the Arctic Basin (Maykut, 1985) (Aagaard and Coachman, 1968). The polar front (0° C isotherm and 34.5 isohaline at 50 m depth) extends approximately along the continental shelf of Greenland, separating the polar surface water from the Arctic (Intermediate) water and the marginal ice zone to the east (e.g. Aagaard and Coachman, 1968; Paquette *et al.*, 1985). The ice cover is densest in polar water, its extent to the east depends on the wind conditions (compare also Angelen *et al.*, 2011; Wadhams, 1981).

The seasonal latitudinal progression of increasing and diminishing light levels, respectively, is the determining factor for the timing of the phytoplankton-related pelagic production. Therefore, the springbloom and ice break up progress from south to north in spring, reaching the Arctic area by about June/July. Because the currents in Fram Strait move in opposite direction, the polar East Greenland Current to the south, and the Atlantic West Spitsbergen Current to the north, there is a delay of about a month between biological spring and summer between the polar and the Atlantic side (Hirche *et al.*, 1991). Therefore sea ice and the effect of melting ice are important determinants of the ecosystem processes all along the East Greenland polar front from the Greenland Sea through Fram Strait to the Arctic Basin (Legendre *et al.*, 1992; Wassmann, 2011).

### **Ice situation**

The Arctic Ocean develops towards a one-year instead of a multi-year sea-ice system with consequences for the entire ecosystem, including ecosystem shifts, biodiversity loss, for water mass modifications and for its role in the global overturning circulation. At its maximum, sea-ice covers 4.47 million km<sup>2</sup> in the Arctic Basin (Gill *et al.*, 2011): According to data from ice satellite observations in 1973-76 (NASA, 1987, in (Gill *et al.*, 2011)), permanent ice occupied 70-80% of the Arctic Basin area, and the interannual variability of this area did not exceed 2%. Seasonal ice occupied 6-17% (before the melting period of the mid-1970s). Only in the first decade of the 21st century, the permanent-ice area decreased to 6% in February 2008, concurrent with a rapid increase in seasonal- ice. Whereas multiyear ice used to cover 50-60% of the Arctic, it covered less than 30% in 2008, after a minimum of 10% in 2007. The average age of the remaining multiyear ice is also decreasing from over 20 % being at least six years in the mid- to late 1980s, to just 6% of ice six years old or older in 2008.

c.f. **Figure 2:** Modelled ice age distribution in 1985-2000 (left) compared to February 2008 (right) (CAFF, 2010).



This trend is likely to amplify in the coming years, as the net ocean-atmosphere heat output due to the current anomalously low sea ice coverage has approximately tripled compared to previous years, suggesting that the present sea ice losses have already initiated a positive feedback loop with increasing surface air temperatures in the Arctic (Kurtz *et al.*, 2011).

About 10% of the sea ice in the Arctic basin is exported each year through Fram Strait into the Greenland Sea (Maykut, 1985) which is therefore major sink for Arctic sea ice (Kwok, 2009). From 2001 to 2005, the summer ice cover was so low on the East Greenland shelf, that it was more of a marginal ice zone (Smith Jr and Barber, 2007), however the subsequent record lows in overall Arctic ice cover brought about an increase in ice cover off Greenland, which minimised the extent of the North East Water Polynia on the East Greenland shelf<sup>2</sup>, a previously seasonally ice-free stretch of water (Wadhams, 1981).

### ***Ice related biota***

Allover the Arctic, an inventory of ice-associated biota presently counts over 1000 protists, and more than 50 metazoan species (Bluhm *et al.*, 2011). The regionally very variable ice fauna (depends i.e. on ice age, thickness, origin) consists of sympagic biota living within the caverns and brine channels of the ice, and associated pelagic fauna. The most abundant and diverse sympagic groups of the ice mesofauna in the Arctic seas are amphipods and copepods. Polar cod (*Boreogadus saida*) and partly Arctic cod (*Arctogadus glacialis*) are dependent on the sympagic macro- and mesofauna for food, themselves being important food sources for Arctic seals (such as ringed seal *Phoca hispida*) and birds, for example black guillemots *Cephus grylle* (Bradstreet and Cross, 1982; Gradinger and Bluhm, 2004 and literature reviewed; Horner *et al.*, 1992; Sűfke *et al.*, 1998).

The higher the light level in the ice, the higher is the biomass of benthic algae as well as meiofauna and microorganisms within the ice (Gradinger *et al.*, 1991). Decreasing snow cover induces a feedback loop with enhanced algal biomass increasing the heat absorption of the ice which leads to changes in the ice structure, and ultimately the release of algae from the bottom layer (Apollonio, 1961 in Gradinger *et al.*, 1991). Because of the distance to land and shelves, and the thickness and internal structure of the multiyear pack ice over deeper water, this type of ice has a fauna of its own (Carey, 1985; Gradinger *et al.*, 1991). Arctic multiyear ice floes can have very high algal biomasses in the brine channels and in the bottom centimeters which serves as food for a variety of proto- and metazoans, usually smaller than 1 mm, over deep water (Gradinger *et al.*, 1999). In the central Arctic, ice algal productivity can contribute up to 50 % of the total primary productivity, with lower contributions in the sea ice covered margins (Bluhm *et al.*, 2011).

In the boundary layer between ice floes and the water column, another specific community exists which forms the link between the ice based primary production and the pelagic fauna (Gradinger, 1995): large visible bands of diatoms hang down from the ice, exploited by amphipods such as *Gammarus wilkitzki*, and occasionally by water column copepods such as *Calanus glacialis*, which are important prey of for example polar cod *Boreogadus saida*. The caverns, wedges and irregularities of the ice provide important shelter from predators for larger ice associated species and provide an essential habitat for these species (Gradinger and Bluhm, 2004).

During melt, the entire sympagic ice biota are released into the water column where they may initiate the spring algal plankton bloom (Smith and Sakshaug, 1990) or they may sink to the sea floor and serve as an episodic and first food pulse for benthic organisms before pelagic production begins (Arndt and Pavlova, 2005). In particular the shallow shelves and the shelf slope benthos has been shown to profit of this biomass input, reflected in very rich benthic communities (Klitgaard and Tendal, 2004; Piepenburg, 2005).

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<sup>2</sup> <http://www.issibern.ch/teams/Polynya/>

### ***The role of the polar front and marginal ice zone for the production system***

Primary production in the Arctic Ocean is primarily determined by light availability, which is a function of ice thickness, ice cover, snow cover, light attenuation), the abundance of both ice algae and phytoplankton, nutrient availability and surface water stratification. Generally, the spring bloom occurs later further north and in regions with a thick ice and snow cover. The current production period in the Arctic Ocean may extend to 120 days per year, with a total annual primary production in the central Arctic Ocean of probably up to 10 g C m<sup>-2</sup> (Wheeler *et al.*, 1996).

Ice algae start primary production already at relatively low light levels when melting reduces the thickness of the ice and snow cover. Only after the ice breaks up, when melting releases the ice biota into the water column and meltwater leads to surface stratification, a major phytoplankton bloom of a few weeks develops, fuelling the higher trophic foodweb of the Arctic (Gradinger *et al.*, 1999, and literature quoted).

The marginal ice zones, i.e. where the ice gets broken up in warmer Atlantic or Arctic water, therefore play an important role in the overall production patterns of the Arctic Ocean. Due to the strong water column stratification and increased light levels involved with the melting of the ice, the location and recession of the ice edge in spring and summer determines the timing and magnitude of the spring phytoplankton bloom, which is generally earlier than in the open water (Gradinger and Baumann, 1991; Smith Jr *et al.*, 1987). Wind- or eddy-induced upwelling in the marginal ice zone, as well as biological regeneration processes replenish the surface nutrient pool and therefore prolong the algal growth period (Gradinger and Baumann, 1991; Smith, 1987). The hydrographic variability explains the patchy patterns of primary and secondary production observed, as well as consequently the patchy occurrence of predators.

The polar front separates to some degree the pelagic faunas of the polar and Arctic waters in the Greenland Sea and Fram Strait, each characterised by a few dominant copepod species with different life history strategies (Hirche *et al.*, 1991; see also review in Melle *et al.*, 2005): In polar waters, *Calanus glacialis* uses under ice plankton production and lipid reserves for initiating its spring reproduction phase, however depending on the phytoplankton bloom for raising its offspring (e.g. Leu *et al.*, 2011). Somewhat later, on the warm side of the polar front in Arctic water, the Atlantic species *Calanus finmarchicus* uses the ice edge-related phytoplankton bloom for secondary production. *Calanus hyperboreus*, the third and largest of the charismatic copepod species has its core area of distribution in the Arctic waters of the Greenland Sea (Hirche, 1997; Hirche *et al.*, 2006).

### ***Zooplankton of the Arctic Basin***

Overall zooplankton biomass decreases towards the central Arctic basin, reaching a minimum in the most northerly waters, i.e. the region with permanent ice cover (Mumm *et al.*, 1998). However, investigations in recent years demonstrated increased biomasses compared to studies several decades earlier - possibly a consequence of the decrease in ice thickness and cover which only enabled the investigations to take place from ship board.

There is a south-north decrease in zooplankton biomass, with a sharp decline north of 83°N (Hirche and Mumm, 1992), coinciding with differences in the species composition of the biomass-forming zooplankton species. Whereas the southern Nansen basin plankton is dominated by the Atlantic species *Calanus finmarchicus*, entering the Arctic Basin with the West Spitsbergen Current, the northernmost branch of the North Atlantic current, the Arctic and polar species *Calanus hyperboreus* and *C. glacialis* dominate the biomass in the high-Arctic Amundsen and Makarov Basins (Auel and Hagen, 2002; Mumm *et al.*, 1998). The zooplankton species communities generally can be differentiated according to their occurrence in Polar Surface Water (0-50 m, temperature below – 1.7°C, salinity less than 33.0), Atlantic Layer (200–900 m; temperature 0.5–1.5°C; salinity 34.5–34.8)

and Arctic Deep Water (deeper than 1000 m, temperature -0,5--1° C, salinity > 34.9) (Auel and Hagen, 2002; Grainger, 1989; Kosobokova, 1982). The polar surface community in the upper 50 m of the water column consists of original polar species as well as species emerging from deeper Atlantic waters, altogether leading to a high abundance and biomass peak in summer. Diversity and biomass are minimal in the impoverished Arctic basin deepwater community (Kosobokova 1982). Apart from a limited exchange with the Atlantic Ocean via the Fram Strait, the central Arctic deep-sea basins are isolated from the rest of the world ocean deepsea fauna. Therefore, the bathypelagic fauna consists of a few endemic Arctic species and some species of Atlantic origin. Due to the separation of the Eurasian and Canadian Basins by the Lomonosov Ridge, significant differences in hydrographic parameters (Anderson *et al.* 1994) and in the zooplankton composition occur between both basins (Auel and Hagen, 2002).

### **Fish**

Polar cod, *Boreogadus saida*, is a keystone species in the ice-related foodwebs of the Arctic. Due to schooling behavior and high energy content polar cod efficiently transfer the energy from lower to higher trophic levels, such as seabirds, seals and some whales (Crawford and Jorgenson, 1993).

### **Seabirds**

Ice cover is a physical feature of major importance to marine birds in high latitude oceans, providing access to resources, refuge from aquatic predators (Hunt, 1990). As seabirds are dependant on leads between ice floes or otherwise open water to access food, they search for the most productive waters in polynias (places within the ice which are permanently ice free) and marginal ice zones (Hunt, 1990). Here they forage both on the pelagic and sympagic ice-related fauna, especially the early stages of polar cod and the copepods *Calanus hyperboreus* and *C. glacialis*. Likely, they benefit of the structural complexity and good visibility of their prey near the ice (Hunt, 1990).

In the Greenland Sea and Fram Strait, major breeding colonies exist on Svalbard, Greenland and on Jan Mayen, all of these within reach of the seasonally moving marginal ice zone or a polynia (North East Water Polynia on the East Greenland shelf). Breeding seabirds like Little auks (*Alle alle*), from colonies in the northern Svalbard archipelago feed their offspring with prey caught in the vicinity of the nests, however intermittently travel at least 100 km to the marginal ice zone at 80° N to replenish their body reserves (Jakubas *et al.*, Online 03 June 2011). Therefore, the distance of the marginal ice zone to the colony site is a critical factor determining the breeding success (e.g. Joiris and Falck, 2011). Opportunistically, the birds also use other zooplankton aggregations such as a in a cold core eddy in the Greenland Sea, closer to the nesting site (Joiris and Falck, 2011).

A synopsis of seabird data for the period 1974–1993 (Joiris, 2000) showed that the little auk is one of the most abundant species, together with the fulmar *Fulmarus glacialis*, kittiwake *Rissa tridactyla* and Brünnich's guillemot *Uria lomvia* in the European Arctic seas (mainly the Norwegian and Greenland Seas). In the Greenland Sea and the Fram Strait, little auks represented the main species in polar waters, at the ice edge and in closed pack ice, reaching more than 50% of all bird species (Joiris and Falck, 2011). In spring and autumn, millions of seabirds pass through the area when migrating between their breeding sites on Svalbard or the Russian Arctic and their wintering areas in Canada (Gill *et al.*, 2011).

There are several seabird species in the European Arctic which are only met in ice-covered areas, for example the Ivory gull *Pagophila eburnea* and the Thick-billed guillemot *Uria lomvia* (see e.g. CAFF, 2010): Both species spend the entire year in the Arctic, and breed in close vicinity to sea ice although Thick-billed guillemots were observed to fly up to 100 km from their colonies over open water to forage at the ice edge (Bradstreet 1979). The relatively rare Ivory gulls are closely associated with pack-ice, favouring areas with 70 – 90% ice cover near the ice edge, where they feed on small fish,

including juvenile Arctic cod, squid, invertebrates, macro-zooplankton, carrion, offal and animal faeces (e.g. OSPAR Commission, 2009b). Ivory gulls have a low reproductive rate and breeding only takes place if there is sufficient food, which makes the population highly vulnerable to the effects of climate warming (e.g. OSPAR Commission, 2009b). Thick-billed guillemots are relatively long lived and slow to reproduce and has a low resistance to threats including oil pollution, by-catch in and competition with commercial fisheries operations, population declines due to hunting – particularly in Greenland (OSPAR Commission, 2009c).

Ivory gull and Thick-billed guillemots are both listed by OSPAR as being under threat and/or decline, (OSPAR Commission, 2008) and in 2011 recommendations for conservation action were agreed (OSPAR Commission, 2011) which will be implemented in conjunction with the circumpolar conservation actions of CAFF (CAFF, 1996; Gilchrist *et al.*, 2008).

### **Marine mammals**

Several marine mammal species permanently associate with sea ice in the European Arctic. These include polar bear, walrus, and several seal species: bearded, *Erignathus barbatus*; ringed, *Pusa hispida*; hooded, *Cystophora cristata*; and harp seal *Pagophilus groenlandicus*. Three whale species also occupy Arctic waters year-round – narwhal, *Monodon monoceros*; beluga whale, *Delphinapterus leucas*; and bowhead whale, *Balaena mysticetus*.

**Polar bears** *Ursus maritimus* are highly specialized for and dependent on the sea ice habitat and are therefore particularly vulnerable to changes in sea ice extent, duration and thickness. They have a circumpolar distribution limited by the southern extent of sea ice. Three subpopulations of polar bears occur in the European high Arctic: the East Greenland, Barents Sea and Arctic Basin sub-populations, all with an unknown population status (CAFF, 2010). Following the young-of-the-year ringed seal distribution, polar bears are most common close to land and over the shelves, however some also occur in the permanent multi-year pack ice of the central Arctic basin (Durner *et al.*, 2009). Due to low reproductive rates and long lifetime, it is expected that the polar bears will not be able to adapt to the current fast warming of the Arctic and become extirpated from most of their range within the next 100 years (Schliebe *et al.*, 2008).

**Walruses**, *Odobenus rosmarus*, inhabit the Arctic ice year-round. They are conservative benthic feeders, diving to 80-100 m depth for scaping off the rich mollusc fauna of the continental shelves, and need ice floes as resting and nursing platform close to their foraging grounds. Walruses have been subject to severe hunting pressure from the end of the 18th century to the mid 20th century, and are still hunted today in Greenland (NAMMCO). By 1934, the estimated 70000-80000 individuals of the Atlantic population were reduced to 1200-1300, with none left on Svalbard (Weslawski *et al.*, 2000). Today's relatively small sub-populations on the East Greenland and Svalbard-Franz Josef Land coasts have recently shown a slightly increasing trend, in the latter case reflecting the full protection of the species since the 1950's (CAFF, 2010; NAMMCO). Apart from their sensitivity to direct human disturbance and pollution, it is expected that walruses will suffer from the changing ice conditions (location, thickness for being used as haul-out site) as well as changes in ice-related productivity.

The Atlantic subspecies of the **bearded seal**, *Erignathus barbatus* occurs south of 85° N from the central Canadian Arctic east to the central Eurasian Arctic, but no population estimates exist (Kovacs, 2008b). Because of their primarily benthic feeding habits they live in ice covered waters overlying the continental shelf. They are typically found in regions of broken free-floating pack ice; in these areas bearded seals prefer to use small and medium sized floes, where they haul out no more than a body length from water and they use leads within shore-fast ice only if suitable pack ice is not available (Kovacs, 2008b, and literature quoted).

The **Arctic ringed seal** *Pusa (Phoca) hispida hispida* has a very large population size and broad distribution, however, there are concerns that future changes of Arctic sea ice will have a negative impact on the population, some of which have already been documented in some parts of the subspecies range (Kovacs *et al.*, 2008). As the other seals, the ringed seal uses sea ice exclusively as their breeding, moulting and resting (haulout) habitat, and feed on small schooling fish and invertebrates. In a co-evolution with one of their main predators, the polar bear, they developed the ability to create and maintain breathing holes in relatively thick ice, which makes them well adapted to living in fully ice covered waters all over the year.

The West Ice (or Is Odden) to the west of Jan Mayen, at approx. 72-73° N, in early spring a stretch of more or less fast drift ice, is of crucial importance as a whelping and moulting area for harp seals and hooded seals (summarised e.g. by ICES, 2008). Discovered in the early 18th century, up to 350000 seals (1920s) were killed per year, decimating the populations from an estimated one million individuals in the 1950s (Ronald *et al.*, 1982) to today's 70000 and 243000 of hooded and harp seals, respectively (Kovacs, 2008a, c).

**Hooded seal**, *Cystophora cristata*, is a pack ice species, which is dependent on ice as a substrate for pupping, moulting, and resting and as such is vulnerable to reduction in extent or timing of pack ice formation and retreat, as well as ice edge related changes in productivity (Kovacs, 2008a, and literature quoted). Hooded Seals feed on a wide variety of fish and invertebrates, including species that occur throughout the water column. After breeding and moulting on the West Ice they follow the retreating pack ice to the north, but also spend significant periods of time pelagically, without hauling out (Folkow and Blix 1999) in (Kovacs, 2008a). The northeast Atlantic breeding stock has declined by 85-90 % over the last 40-60 years. The cause of the decline is unknown, but very recent data suggests that it is on-going (30% within 8 years), despite the protective measures that have been taken in the last few years. The species is therefore considered to be vulnerable (Kovacs, 2008a).

**Harp seals** *Pagophilus (Phoca) groenlandicus* are the most numerous seal species in the Arctic seas. Their reproduction takes place in huge colonies, for example on the pack ice of the "West Ice" north of Jan Mayen, and after the breeding season they follow the retreating pack ice edge northwards up to 85° N, feeding mainly on polar cod under the ice (Kovacs, 2008c).

**Narwhals** *Monodon monoceros* primarily inhabit the ice-covered waters of the European Arctic, including the ice sheet off East Greenland (Jefferson *et al.*, 2008b). For two months in summer, they visit the shallow fjords of East Greenland, spending all the rest of the year offshore, in deep ice-covered waters along the continental slope in the Greenland Sea and Arctic Basin (Heide-Jørgensen and Dietz, 1995). Narwhals are deep diving benthic feeders and forage on fish, squid, and shrimp, especially Arctic fish species, such as Greenland halibut, Arctic cod, and polar cod at up to 1500 m depth and mostly in winter. A recent assessment of the sensitivity of all Arctic marine mammals to climate change ranked the narwhal as one of the three most sensitive species, primarily due to its narrow geographic distribution, specialized feeding and habitat choice, and high site fidelity (Laidre *et al.* 2008 in (Jefferson *et al.*, 2008b)).

**Bowhead whales** *Balaena mysticetus* are found only in Arctic and subarctic regions and a Svalbard-Barents population occurs from the coast of Greenland across the Greenland Sea to the Russian Arctic. They spend all of their lives in and near openings in the pack ice feeding on small to medium-sized zooplankton. They migrate to the high Arctic in summer, and retreat southward in winter with the advancing ice edge (Moore and Reeves 1993 in (Reilly *et al.*, 2008)). Whaling has decimated the original bowhead whale populations to be rare nowadays, listed by OSPAR as being under threat and/or decline (OSPAR Commission, 2008). The species is considered to be very sensitive to changes in the ice-related ecosystem as well as sound disturbance, possible consequences of a progressive reduction of ice cover (OSPAR Commission, 2009a).

**Belugas** *Delphinapterus leucas* prefer coastal and continental shelf waters with a broken-up ice cover. They have never been surveyed around Svalbard. Pods numbering into the thousands are sighted irregularly around the archipelago, and pods ranging from a few to a few hundred individuals are seen regularly (Gjertz and Wiig 1994; Kovacs and Lydersen 2006 in (Jefferson *et al.*, 2008a)).

Little is known about the populations of the larger fauna in the Central Arctic Basin over the deepsea basins and ridges. But it is not likely that it is currently an area of great abundance - too far from the coastal nesting sites of marine birds, and over too deep water to allow feeding on benthos, as most of the larger mammals would need, and currently of too low plankton production to feed the large whales. All of these groups have their distribution center along the continental shelves presently - however, following the receding ice edge out to the central Arctic basin may be one of the options for the future.

### **Feature condition, and future outlook**

This high Arctic region is particularly vulnerable to the the loss of ice cover and other effects of the anticipated global warming, including elevated UV radiation levels (Agustí, 2008). (Wassmann *et al.*, 2010) summarise what changes may be expected within the subarctic/Arctic region:

- northward displacement (range shifts) of subarctic and temperate species, and cross-Arctic transport of organisms;
- increased abundance and reproductive output of subarctic species, decline and reduced reproductive success of some Arctic species associated with the ice and species now preyed upon by predators whose preferred prey have declined;
- increased growth of some subarctic species and primary producers, and reduced growth and condition of animals that are bound to, associated with, or born on the ice;
- anomalous behaviour of ice-bound, ice-associated, or ice-born animals with earlier spring events and delayed fall events;
- changes in community structure due to range shifts of predators resulting in changes in the predator–prey linkages in the trophic network.

(Wassmann, 2008) expects radical changes in the productivity, functional relationships and biodiversity of the Arctic Ocean. He suggests that a warmer climate with less ice cover will result in greater primary production, a reduction of the stratified water masses to the south, changes in the relationship between biological processes in the water column and the sediments, a reduction in niches for higher trophic levels and a displacement of Arctic by boreal species. On the shelves, increased sediment discharges are expected to lower the primary production due to higher turbidity, and enhance the organic input to the deep ocean. A more extensive review of expected or suspected consequences of climate change for the marine system of the Arctic is given in (Loeng *et al.*, 2005).

**Figure 3**, extracted from (Gill *et al.*, 2011), presents the conceptual ideas about possible Arctic ecosystem changes mediated by human impact:

The normal situation shown in the upper left panel consists of ice-dependent species and species that tolerate a broader range of temperatures and are found in waters with little or no sea ice. Primary production occurs in phytoplankton (small dots in the figure) in ice-free waters and in ice-attached algae and phytoplankton in ice-covered waters. Phytoplankton (small t-shaped symbols in the figure) and ice algae are the main food sources for zooplankton and benthic animals. The fish community consists of both pelagic and demersal species. Several mammals are ice-associated, including polar bears and several species of seals. A number of sea bird species are also primarily associated with ice-covered waters.

At moderate temperature increases (upper right) populations of ice-dependent species are expected to decline as sea ice declines, and sub-Arctic species are expected to move northwards. Arctic benthic species are expected to decline, especially if their distributions are pushed close to or beyond the continental slope.

The expected effects from fisheries relate to the continental shelves. Two major effects are reductions in populations of benthic organisms due to disturbance from bottom trawling and removal of large individuals in targeted fish stocks. In addition, the size of targeted stocks, both demersal and pelagic, may be reduced.

In addition, the effects of ocean acidification are considered (lower right). Ocean acidification will result in depletion of carbonate phases such as aragonite and calcite. This will alter the structure and function of calcareous organisms, particularly at lower trophic levels. Changes in pH can also alter metabolic processes in a range of organisms. It is not known how these changes will propagate to higher trophic levels, but the effects could be substantial.

**c.f. Figure 3:** Conceptual models showing potential impacts on Arctic marine ecosystems under different scenarios (Gill *et al.*, 2011).

(Gill *et al.*, 2011) conclude that the central part of the Arctic Basin is not a region for fisheries or oil and gas exploration. However, this region has played and will continue to play a very important role in the redistribution of pollutants, due to ice drift and/or currents between coastal and shelf areas and the Arctic Basin peripheries, far from sources of pollution.

## Assessment against CBD EBSA Criteria

**Table 1.** relation of each of the CBD criteria to the proposed area relating to the best available science. Note that a candidate EBSA may qualify on the basis of one or more of the criteria, the boundaries of the EBSA need not be defined with exact precision.

CBD EBSA Criterion	Description	Ranking of criterion relevance (please mark one column with an X)			
		Don't Know	Low	Some	High
<b>Uniqueness or rarity</b>	The area contains either (i) unique ("the only one of its kind"), rare (occurs only in few locations) or endemic species, populations or communities, and/or (ii) unique, rare or distinct, habitats or ecosystems; and/or (iii) unique or unusual geomorphological or oceanographic features				x
<p>Explanation for ranking</p> <p>Arctic sea ice, in particular the multiyear ice of the Central Arctic is globally unique and hosts endemic species such as the Gammarid amphipod <i>Gammarus wilkitzki</i> and sea ice meiofauna which will disappear with the melting of the ice. Polar bears, walruses, bowhead whales, narwhales, belugas, several seal species and many bird species are endemic to the high Arctic ice.</p> <p>While sea ice species such as <i>G. wilkitzki</i> are not endemic to the proposed EBSA they are endemic to the Arctic and unique within the OSPAR area</p>					
<b>Special importance for life-history stages of species</b>	Areas that are required for a population to survive and thrive				x
<p>Explanation for ranking</p> <p>Sea ice is essential for its sympagic fauna, and to some extent also for the pelagic associated fauna which also depends on the right timing of biomass production (match/mismatch with bloom periods). The marginal ice zone and other openings in the ice are essential feeding grounds for a large number of ice-associated species which exploit the seasonally high production there.</p> <p>At present the area covered by the proposed EBSA is ice-covered throughout the summer but although there is no marginal ice zone there will be an ice zone community present, thus the sea ice is essential to maintain the sympagic biological community and associated ecosystem functions.</p>					



<b>Importance for threatened, endangered or declining species and/or habitats</b>	Area containing habitat for the survival and recovery of endangered, threatened, declining species or area with significant assemblages of such species			x	
<p>Explanation for ranking</p> <p>The high arctic ice hosts endemic species such as the Gammarid amphipod <i>Gammarus wilkitzki</i> and sea ice meiofauna which will disappear with the melting of the ice. Many of the obligatory ice-related species are listed as vulnerable by IUCN, and/or listed as under threat and/or decline by OSPAR, examples include the Ivory gull, thick-billed guillemot, bowhead whale, hooded seal and polar bear. With the overall trend of retreating sea ice extent, the proposed EBSA may become increasingly important for all ice-dependent species in the future.</p>					
<b>Vulnerability, fragility, sensitivity, or slow recovery</b>	Areas that contain a relatively high proportion of sensitive habitats, biotopes or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery				x
<p>Explanation for ranking</p> <p>The ice-related foodweb and ecosystem is highly sensitive to the ecological consequences of a warming climate. Beyond this the Arctic is at the forefront of the impacts of ocean acidification (Wicks &amp; Roberts 2012). The largest changes in ocean pH will occur in the Arctic Ocean, with complete undersaturation of the Arctic Ocean water column predicted before the end of this century (Steinacher <i>et al.</i> 2009). Many of the seabird and mammal populations are particularly sensitive to changes due to their already low population numbers, and low fertility. If the retreat of the ice to the north will lead to increased shipping and oil and gas exploitation in Arctic waters, the increased risk of spills would also pose a potential hazard for example for guillemots, which are extremely susceptible to mortality from oil pollution (CAFF, 2010). In addition, some species like Ivory gull are sensitive to an increased heavy metal load in their prey.</p>					
<b>Biological productivity</b>	Area containing species, populations or communities with comparatively higher natural biological productivity				
<p>Explanation for ranking</p> <p>This criterion was not evaluated in the <i>OSPAR/NEAFC/CBD Workshop</i>. ICES did not have enough information to evaluate this criterion.</p>					
<b>Biological diversity</b>	Area contains comparatively higher diversity of ecosystems, habitats, communities, or species, or has higher genetic diversity				

## Explanation for ranking

This criterion was not evaluated in the *OSPAR/NEAFC/CBD Workshop*. ICES did not have enough information to evaluate this criterion.

## References

- Aagaard, K., 1989. A synthesis of Arctic Ocean circulation. Rapport Proces et Verbeaux Réunion du Conseil international pour l'Exploration de la Mer 188, 11-22.
- Aagaard, K., Coachman, L.K., 1968. The East Greenland Current north of Denmark Strait: Part II. *Arctic* 21, 267-290.
- Aagaard, K., Swift, J.H., Carmack, E.C., 1985. Thermohaline circulation in the Arctic mediterranean seas. *Journal of Geophysical Research* 90, 4833-4846.
- Agustí, S., 2008. Impacts of increasing ultraviolet radiation on the polar oceans. In: *Impacts of global warming on polar ecosystems*. Duarte, C.M. (Ed.) Fundación BBVA pp. 25-46.
- Anderson, L.G., Jones, E.P., Koltermann, K.P., Schlosser, P., Swift, J.H., Wallace, D.W.R., 1989. The first oceanographic section across the Nansen Basin in the Arctic Ocean. *Deep Sea Research* 36, 475-482.
- Angelen, J.H.v., Broeke, M.R.v.d., Kwok, R., 2011. The Greenland Sea Jet: A mechanism for wind-driven sea ice export through Fram Strait. *Geophysical Research Letters* 38 (L12805).
- Anisimov, O.A., Vaughan, D.G., Callaghan, T.V., Furgal, C., Marchant, H., Prowse, T.D., Vilhjálmsson, H., Walsh, J.E., 2007. Polar regions (Arctic and Antarctic). In: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Parry, M.L., Canziani, O.F., Palutikof, J.P., Linden, P.J.v.d., Hanson, C.E. (Eds.) Cambridge University Press, Cambridge pp. 653-685.
- Arndt, C., E., Pavlova, O., 2005. Origin and fate of ice fauna in the Fram Strait and Svalbard area. *Marine Ecology Progress Series* 301, 55-66.
- Auel, H., Hagen, W., 2002. Mesozooplankton community structure, abundance and biomass in the central Arctic Ocean. *Marine Biology* 140, 1013-1021.
- Bluhm, B.A., Gebruk, A.V., Gradinger, R., Hopcroft, R.R., Huettmann, F., Kosobokova, K.N., Sirenko, B.I., Weslawski, J.M., 2011. Arctic marine biodiversity: An update of species richness and examples of biodiversity change. *Oceanography* 24 (3), 232-248.
- Bradstreet, M.S.M., Cross, W.E., 1982. Trophic relationships at high Arctic ice edges. *Arctic* 35 (1), 1-12.
- CAFF, 1996. International Murre conservation strategy and action plan. CAFF International Secretariat, CAFF Circumpolar Seabird Working Group, Akureyri, Iceland, pp. 1-16.
- CAFF, 2010. Arctic Biodiversity Trends 2010. Selected indicators of change. CAFF International Secretariat, Akureyri, Iceland.
- Carey, A.G.I., 1985. Marine Ice Fauna. In: *Arctic Sea Ice Biota*. A., H.R. (Ed.) CRC Press, Boca Raton. Florida pp. 17-190
- Crawford, R.E., Jorgenson, J.K., 1993. Schooling behaviour of arctic cod, *Boreogadus saida* in relation to drifting pack ice. *Environmental Biology of Fishes* 36 (4), 345-357.

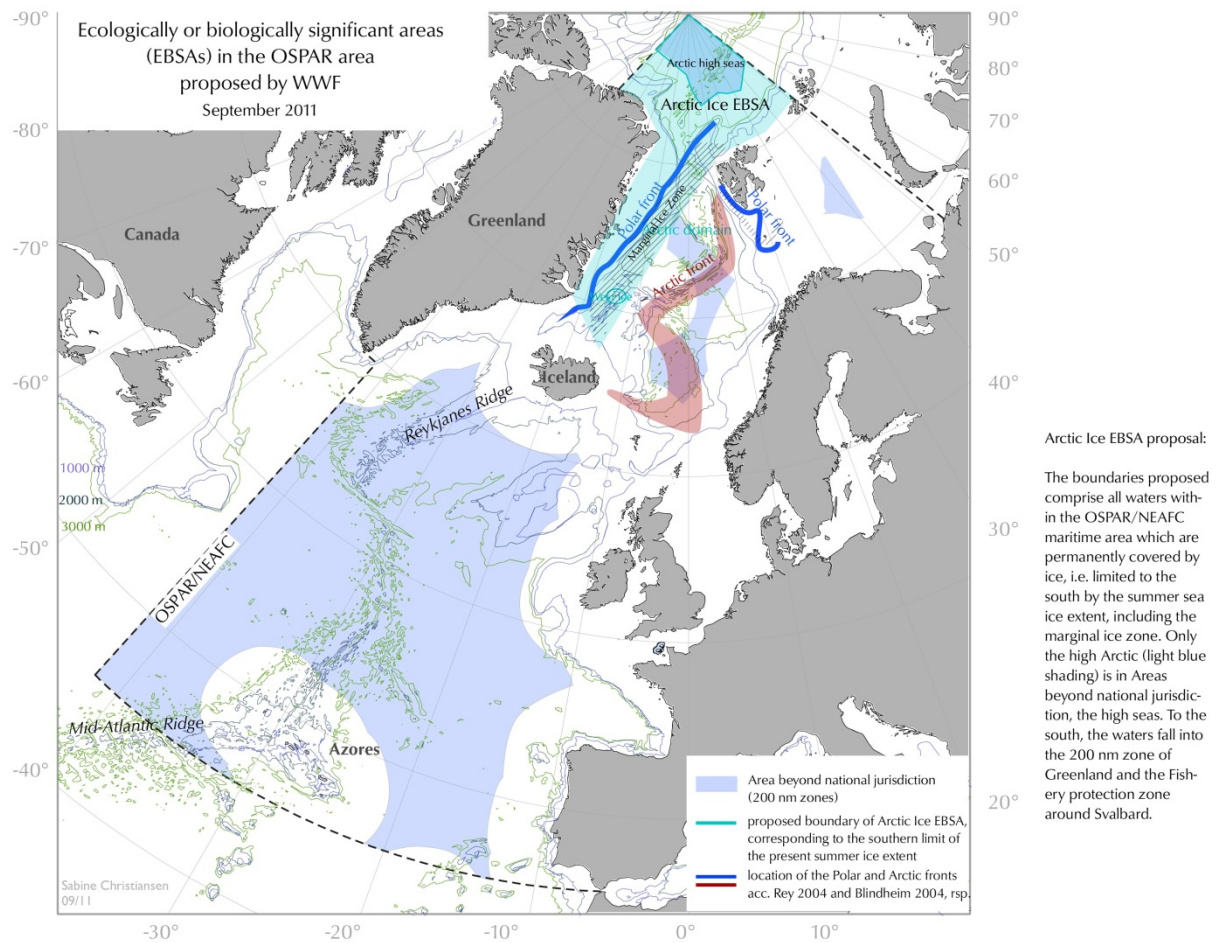
- Durner, G.M., Douglas, D.C., Nielson, R.M., Amstrup, S.C., McDonald, T.L., Stirling, I., Mauritzen, M., Born, E.W., Wiig, Ø., Deweaver, E., Serreze, M.C., Belikov, S.E., Holland, M.M., Maslanik, J., Aars, J., Bailey, D.A., Derocher, A.E., 2009. Predicting 21st-century polar bear habitat distribution from global climate models. *Ecological Monographs* 79 (1), 25-58.
- Edmonds, H.N., Michael, P.J., Baker, E.T., Connelly, D.P., Snow, J.E., Langmuir, C.H., Dick, H.J.B., Mühe, R., German, C.R., Graham, D.W., 2003. Discovery of abundant hydrothermal venting on the ultraslow-spreading Gakkel ridge in the Arctic Ocean. *Nature* 421, 252-256.
- Gilchrist, G., Strøm, H., Gavrilov, M.V., Mosbech, A., 2008. International Ivory Gull conservation strategy and action plan. CAFF International Secretariat, Circumpolar Seabird Group (CBird). CAFF Technical Report No. 18.
- Gill, M.J., Crane, K., Hindrum, R., Arneberg, P., Bysveen, I., Denisenko, N.V., Gofman, V., Grant-Friedman, A., Gudmundsson, G., Hopcroft, R.R., Iken, K., Labansen, A., Liubina, O.S., Melnikov, I.A., Moore, S.E., Reist, J.D., Sirenko, B.I., Stow, J., Ugarte, F., Vongraven, D., Watkins, J., 2011. Arctic Marine Biodiversity Monitoring Plan (CBMP-MARINE PLAN), CAFF Monitoring Series Report No.3, April 2011. CAFF International Secretariat, Akureyri, Iceland.
- Gradinger, R., 1995. Climate change and biological oceanography of the Arctic Ocean. *Phil. Trans. R. Soc. A* 352, 277-286.
- Gradinger, R., Bluhm, B.A., 2004. In situ observations on the distribution and behavior of amphipods and Arctic cod (*Boreogadus saida*) under the sea ice of the high Arctic Canadian Basin. *Polar Biology* 27, 595-603.
- Gradinger, R., Friedrich, C., Spindler, M., 1999. Abundance, biomass and composition of the sea ice biota of the Greenland Sea pack ice. *Deep Sea Research* 46, 1457-1472.
- Gradinger, R., Spindler, M., Henschel, D., 1991. Development of Arctic sea-ice organisms under graded snow cover. In: *Proceedings of the Pro Mare Symposium on Polar Marine Ecology*. Sakshaug, E., E., H.C.C., Øritsland, N.A. (Eds.), *Polar Research* 10 (1), Trondheim pp. 295-307.
- Gradinger, R.R., Baumann, M.E.M., 1991. Distribution of phytoplankton communities in relation to the large-scale hydrographical regime in the Fram Strait. *Mar. Biol.* 111, 311-321.
- Grainger, E.H., 1989. Vertical distribution of zooplankton in the central Arctic Ocean. In: *Proc 6th Conf Comite Arctique Int 1985*. Rey, L., Alexander, V. (Eds.) Brill Leiden pp. 48-60.
- Heide-Jørgensen, M.P., Dietz, R., 1995. Some characteristics of narwhal, *Monodon monoceros*, diving behaviour in Baffin Bay. *Canadian Journal of Zoology* 73, 2106-2119.
- Hirche, H.J., 1997. Life cycle of the copepod *Calanus hyperboreus* in the Greenland Sea. *Marine Biology* 128 (4), 607-618.
- Hirche, H.J., Baumann, M.E.M., Kattner, G., Gradinger, R., 1991. Plankton distribution and the impact of copepod grazing on primary production in Fram Strait, Greenland Sea. *Journal of Marine Systems* 2 (3-4), 477-494.
- Hirche, H.J., Mumm, N., 1992. Distribution of dominant copepods in the Nansen Basin, Arctic Ocean, in summer. *Deep Sea Research Part A. Oceanographic Research Papers* 39 (2, Part 1), S485-S505.
- Hirche, H.J., Muyakshin, S., Klages, M., Auel, H., 2006. Aggregation of the Arctic copepod *Calanus hyperboreus* over the ocean floor of the Greenland Sea. *Deep Sea Research Part I: Oceanographic Research Papers* 53 (2), 310-320.
- Horner, R., Ackley, S.F., Dieckmann, G.S., Gulliksen, B., Hoshiai, T., Legendre, L., Melnikov, I.A., Reeburgh, W.S., Spindler, M., Sullivan, C.W., 1992. Ecology of sea ice biota. Habitat, terminology, and methodology. *Polar Biology* 12 (3), 417-427.

- Hunt, G.L.J., 1990. The pelagic distribution of marine birds in a heterogeneous environment. *Polar Research* 8, 43-54.
- ICES, 2008. Report of the ICES Advisory Committee In: ICES Advice, Book 3, The Barents and the Norwegian SEa.
- Jakubas, D., Iliszko, L., Wojczulanis-Jakubas, K., Stempniewicz, L., Online 03 June 2011. Foraging by little auks in the distant marginal sea ice zone during the chick-rearing period. *Polar Biology*, 1-9.
- Jefferson, T.A., Karczmarski, L., Laidre, K., O'Corry-Crowe, G., Reeves, R.R., Rojas-Bracho, L., Secchi, E.R., Slooten, E., Smith, B.D., Wang, J.Y., Zhou, K., 2008a. *Delphinapterus leucas* In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. [www.iucnredlist.org](http://www.iucnredlist.org) Downloaded on 31 August 2011.
- Jefferson, T.A., Karczmarski, L., Laidre, K., O'Corry-Crowe, G., Reeves, R.R., Rojas-Bracho, L., Secchi, E.R., Slooten, E., Smith, B.D., Wang, J.Y., Zhou, K., 2008b. *Monodon monoceros*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. . [www.iucnredlist.org](http://www.iucnredlist.org) Downloaded on 31 August 2011.
- Joiris, C., Falck, E., 2011. Summer at-sea distribution of little auks *Alle alle* and harp seals *Pagophilus (Phoca) groenlandica* in the Fram Strait and the Greenland Sea: impact of small-scale hydrological events. *Polar Biology* 34 (4), 541-548.
- Joiris, C.R., 2000. Summer at-sea distribution of seabirds and marine mammals in polar ecosystems: a comparison between the European Arctic seas and the Weddell Sea, Antarctica. *Journal of Marine Systems* 27, 267-276.
- Klitgaard, A.B., Tendal, O.S., 2004. Distribution and species composition of mass occurrences of large-sized sponges in the northeast Atlantic. *Progress in Oceanography* 61, 57-98.
- Kosobokova, K.N., 1982. Composition and distribution of the biomass of zooplankton in the central Arctic Basin. *Oceanology* 22, 744-750.
- Kovacs, K., 2008a. *Cystophora cristata*. IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. [www.iucnredlist.org](http://www.iucnredlist.org) Downloaded on 31 August 2011.
- Kovacs, K., 2008b. *Erignathus barbatus*. IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. [www.iucnredlist.org](http://www.iucnredlist.org) Downloaded on 31 August 2011.
- Kovacs, K., 2008c. *Pagophilus groenlandicus*. IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. [www.iucnredlist.org](http://www.iucnredlist.org) Downloaded on 31 August 2011.
- Kovacs, K., Lowry, L., Härkönen, T., 2008. *Pusa hispida*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. . [www.iucnredlist.org](http://www.iucnredlist.org) Downloaded on 31 August 2011.
- Kwok, R., 2009. Outflow of Arctic Ocean sea ice into the Greenland and Barents seas: 1979-2007. *Journal of Climate* 22, 2438-2456.
- Legendre, L., Ackley, S.F., Dieckmann, G.S., Gulliksen, B., Horner, R., Hoshiai, T., Melnikov, I.A., Reeburgh, W.S., Spindler, M., Sullivan, C.W., 1992. Ecology of sea ice biota. *Polar Biology* 12 (3), 429-444.
- Leu, E., Søreide, J.E., Hessen, D.O., Falk-Petersen, S., Berge, J., 2011. Consequences of changing sea ice cover for primary and secondary producers in the European Arctic shelf seas: timing, quantity, and quality. *Progress in Oceanography* 90, 18-32.
- Loeng, H., Brander, K., Carmack, E.C., Denisenko, S., Drinkwater, K., Hansen, B., Kovacs, K., Livingston, P., McLaughlin, F., Sakshaug, E., 2005. Marine systems. In: Arctic Climate Impact Assessment, ACIA. Symon, C., Arrisand, L., Heal, B. (Eds.), Cambridge University Press, Cambridge pp. 453-538.

- Mauritzen, C., Hansen, E., Andersson, M., Berx, B., Beszczynska-Möller, A., Burud, I., Christensen, K.H., Debernard, J., de Steur, L., Dodd, P., Gerland, S., Godøy, Ø., Hansen, B., Hudson, S., Høydalsvik, F., Ingvaldsen, R., Isachsen, P.E., Kasajima, Y., Koszalka, I., Kovacs, K.M., Køltzow, M., LaCasce, J., Lee, C.M., Lavergne, T., Lydersen, C., Nicolaus, M., Nilsen, F., Nøst, O.A., Orvik, K.A., Reigstad, M., Schyberg, H., Seuthe, L., Skagseth, Ø., Skarðhamar, J., Skogseth, R., Sperrevik, A., Svensen, C., Søiland, H., Teigen, S.H., Tverberg, V., Wexels Riser, C., 2011. Closing the loop - Approaches to monitoring the state of the Arctic Mediterranean during the International Polar Year 2007-2008. *Progress in Oceanography* 90 (1-4), 62-89.
- Maykut, G.A., 1985. The ice environment. In: Sea-ice biota. Horner, R. (Ed.) CRC Press, Boca Raton pp. 21-82.
- Melle, W., Ellertsen, B., Skjoldal, H.R., 2005. Zooplankton: The link to higher trophic levels. In: The Nordic Seas: An integrated perspective oceanography, climatology, biogeochemistry, and modelling. . Drange, H., Dokken, T., Furevik, T., Gerdes, R., Berger, W. (Eds.) Geophysical Monograph Series 158 pp. 137-202.
- Mumm, N., Auel, H., Hanssen, H., Hagen, W., Richter, C., Hirche, H.J., 1998. Breaking the ice: large-scale distribution of mesozooplankton after a decade of Arctic and transpolar cruises. *Polar Biology* 20 (3), 189-197.
- NAMMCO, The Atlantic Walrus. North Atlantic Marine Mammal Commission. Status of Marine Mammals in the North Atlantic, Tromsø, pp. 1-7.
- OSPAR Commission, 2008. OSPAR List of Threatened and/or Declining Species and Habitats. Reference number 2008-6. [http://www.ospar.org/documents/dbase/decrecs/agreements/08-06e\\_ospar%20list%20species%20and%20habitats.doc](http://www.ospar.org/documents/dbase/decrecs/agreements/08-06e_ospar%20list%20species%20and%20habitats.doc).
- OSPAR Commission, 2009a. Background Document for Bowhead whale *Balaena mysticetus*. OSPAR Commission, Biodiversity Series 494/2010, pp. 1-20.
- OSPAR Commission, 2009b. Background Document for Ivory gull *Pagophila eburnea*. OSPAR Commission, Biodiversity Series 410/2009, pp. 1-16.
- OSPAR Commission, 2009c. Background Document for Thick-billed murre *Uria lomvia*. OSPAR Commission, Biodiversity Series 416/2009, pp. 1-20.
- OSPAR Commission, 2011. Meeting of the OSPAR Commission (OSPAR) London: 20-24 June 2011. Summary Record OSPAR 11/20/1-E. OSPAR Commission, London.
- Paquette, R., Bourke, R., Newton, J., Perdue, W., 1985. The East Greenland Polar Front in autumn. *Journal of Geophysical Research* 90 (C3), 4866-4882.
- Piepenburg, D., 2005. Recent research on Arctic benthos: common notions need to be revised. *Polar Biology* 28 (10), 733-755.
- Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., , Brownell Jr., R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urbán, J., Zerbini, A.N., 2008. *Balaena mysticetus*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. . [www.iucnredlist.org](http://www.iucnredlist.org) Downloaded on 31 August 2011.
- Renaud, P.E., Carroll, M.L., Ambrose, W.G.J., 2008. Effects of global warming on Arctic seafloor communities and its consequences for higher trophic levels. In: Impacts of global warming on polar ecosystems. Duarte, C.M. (Ed.) Fundación BBVA pp. 141-177.
- Rey, F., 2004. Phytoplankton: the grass of the sea. In: The Norwegian Sea Ecosystem. Skjoldal, H.R. (Ed.) Tapir Academic Press, Trondheim, Norway pp. 97-136.

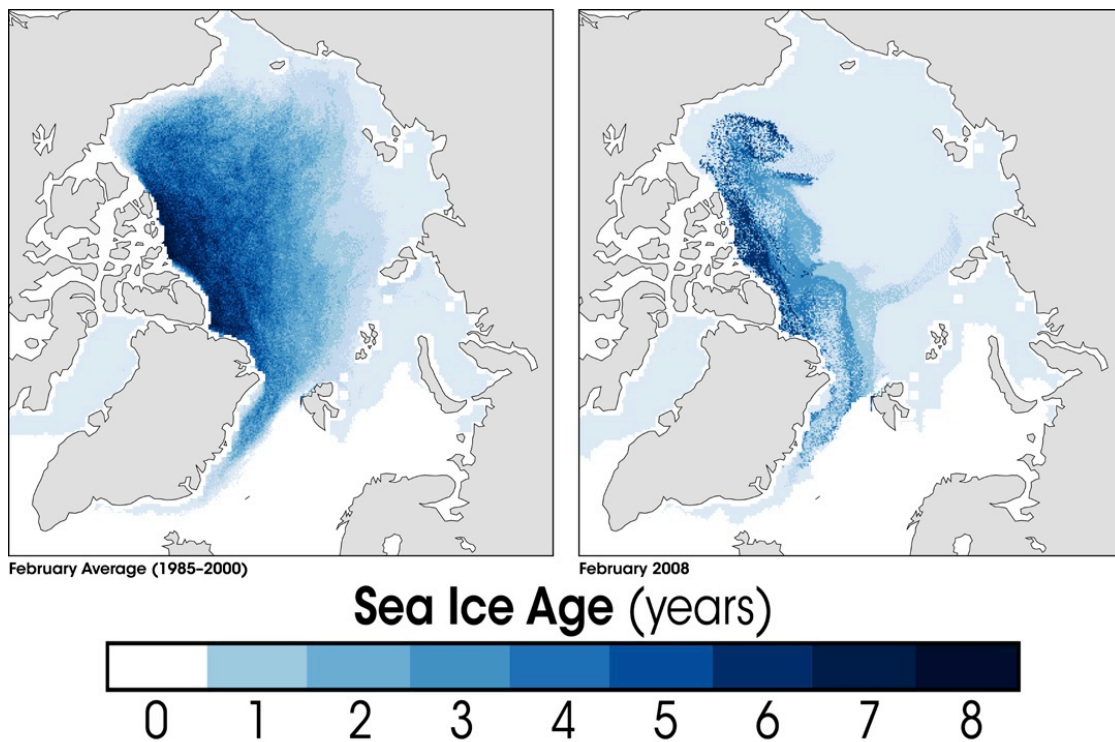
- Ronald, K., Healey, P.J., Fisher, H.D., 1982. The harp seal, *Pagophilus groenlandicus*. In: Small cetaceans, seals, sirenians and otters. FAO Fisheries Series No. 5, Vol. IV, Food and Agriculture Organisation of the United Nations. Working Party on Mammals.
- Schliebe, S., Wiig, Ø., Derocher, A.E., Lunn, N., 2008. *Ursus maritimus*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. [www.iucnredlist.org](http://www.iucnredlist.org) Downloaded on 31 August 2011.
- Smith Jr, W.O., Barber, D., 2007. Polynyas and climate change: a view to the future. In: Polynyas, windows to the world. Halpern, D. (Ed.), Elsevier Oceanography Serie 74, Elsevier, Amsterdam pp. 411-420.
- Smith Jr, W.O., Baumann, M.E.M., Wilson, D.L., Aletsee, L., 1987. Phytoplankton biomass and productivity in the Marginal Ice Zone of the Fram Strait during summer 1984. Journal of Geophysical Research 92 (C7), 6777-6786.
- Smith, W.O.J., 1987. Phytoplankton dynamics in the marginal ice zones. Oceanography and Marine Biology Annual Review 25, 11-38.
- Smith, W.O.J., Sakshaug, E., 1990. Polar phytoplankton. In: Polar oceanography. Part B. Chemistry, biology and geology. Smith Jr, W.O. (Ed.) Academic Press, San Diego pp. 477-525.
- Steinacher, M., Joos, F., Frölicher, T., Plattner, G. & Doney, S.c. 2009. Imminent ocean acidification in the Arctic projected with the NcAR global coupled carbon cycle-climate model. *Biogeosciences* 6, 515–533.
- Süfke, L., Piepenburg, D., Dorrien, C.C.v., 1998. Body size, sex ratio and diet composition of *Arctogadus glacialis* (Peters, 1874) (Pisces: Gadidae) in the Northeast Water Polynya (Greenland). Polar Biology 20, 357-363.
- Wadhams, P., 1981. The ice cover in the Greenland and Norwegian Seas. Rev. Geophys. Space Physics 19, 345-393.
- Wassmann, P., 2008. Impacts of global warming on Arctic pelagic ecosystems and processes. In: Impacts of global warming on polar ecosystems. Duarte, C.M. (Ed.) Fundación BBVA pp. 113-148.
- Wassmann, P., 2011. Arctic marine ecosystems in an era of rapid climate change. Progress in Oceanography 90, 1-17.
- Wassmann, P., Duarte, C.M., Agustí, S., Seijr, M., 2010. Footprints of climate change in the Arctic Marine Ecosystem. Biological Global Change.
- Weslawski, J.M., Hacquebord, L., Stempniewicz, L., Malinga, M., 2000. Greenland whales and walruses in the Svalbard food web before and after exploitation. Oceanologia 42 (1), 37-56.
- Wheeler, P.A., Gosselin, M., Sherr, E., Thibault, D., Kirchman, D.L., Benner, R., Whitledge, T.E., 1996. Active cycling of organic carbon in the central Arctic Ocean. Nature 380, 697-699.
- Wicks, L., Roberts, J.M. (2012) Benthic invertebrates in a high CO<sub>2</sub> world. Oceanography & Marine Biology: An Annual Review 50: 127 -188

## Maps and Figures

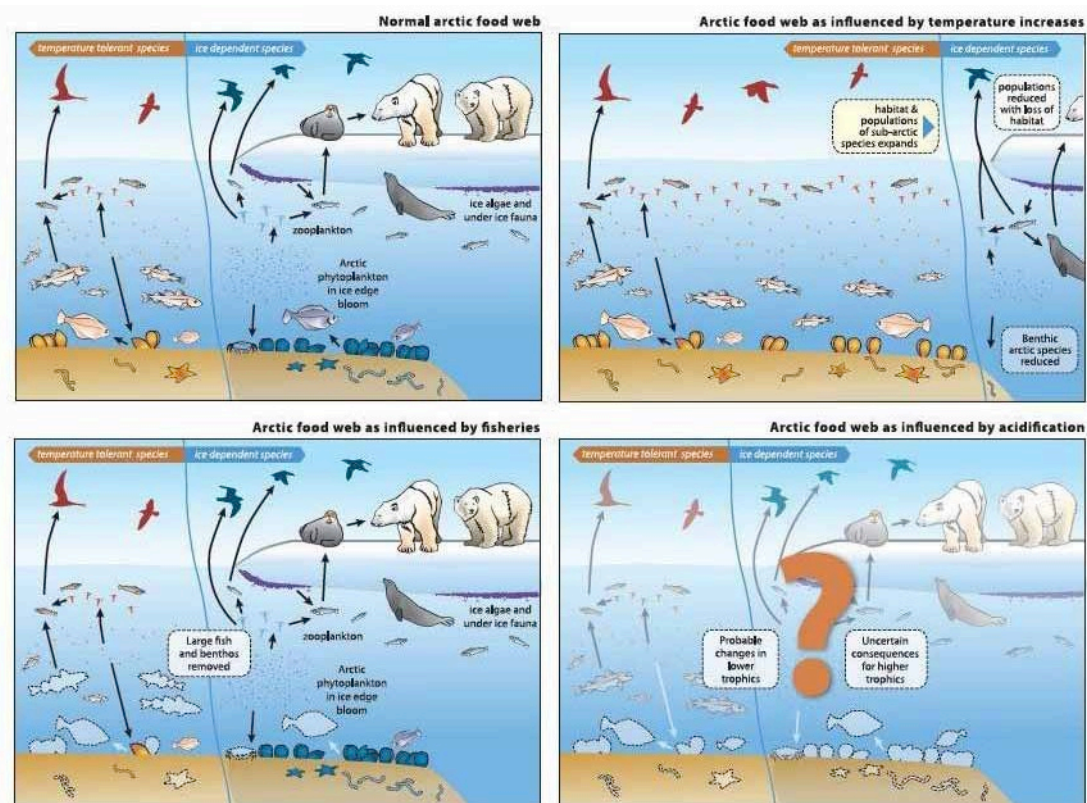


**Figure 1:** Location of the Ecologically or biologically significant areas (EBSA) proposed by WWF in September 2011. The position of the Arctic and polar fronts was redrawn after (Rey, 2004, Fig. 5.7).





**Figure 2:** Modelled ice age distribution in 1985-2000 (left) compared to February 2008 (right) (CAFF, 2010).



**Figure 3:** Conceptual models showing potential impacts on Arctic marine ecosystems under different scenarios (Gill *et al.*, 2011).