Published 04 March 2016
Version 2; 13 May 2016

3.1* Barents Sea Ecoregion – Ecosystem overview

Ecoregion description

The Barents Sea is one of the shelf seas surrounding the Polar basin. It connects with the deeper Norwegian Sea to the west, the Arctic Ocean to the north, and the Kara Sea to the east, and borders the Norwegian and Russian coasts to the south. The 500 m depth contour is used to delineate the continental slope to the west and the north. To the east the Novaya Zemlya archipelago separates the Barents Sea and the Kara Sea. The Barents Sea covers an area of approximately 1.6 million km^2, has an average depth of ca. 230 m, and a maximum depth of about 500 m at the western end of Bear Island Trough (Figure 3.1.1). Its topography is characterized by troughs and basins, separated by shallow bank areas. The three largest banks are Central Bank, Great Bank, and Spitsbergen Bank. Several troughs over 300 m deep run from the central Barents Sea to the northern (e.g. Franz Victoria Trough) and western (e.g. Bear Island Trough) continental shelf break. These western troughs allow influx of Atlantic waters to the central Barents Sea. Atlantic waters enter the Arctic Basin through the Barents Sea and the Fram Strait. Large-scale atmospheric pressure systems influence the volume flux, temperature, and salinity of Atlantic waters, in turn affecting oceanographic conditions both in the Barents Sea and in the Arctic Ocean.

The Barents Sea is divided into the Russian Exclusive Economic Zone (EEZ) and the Norwegian EEZ (agreed since 2010). An EEZ around Svalbard was claimed by Norway in 1977 and is disputed by Russia.

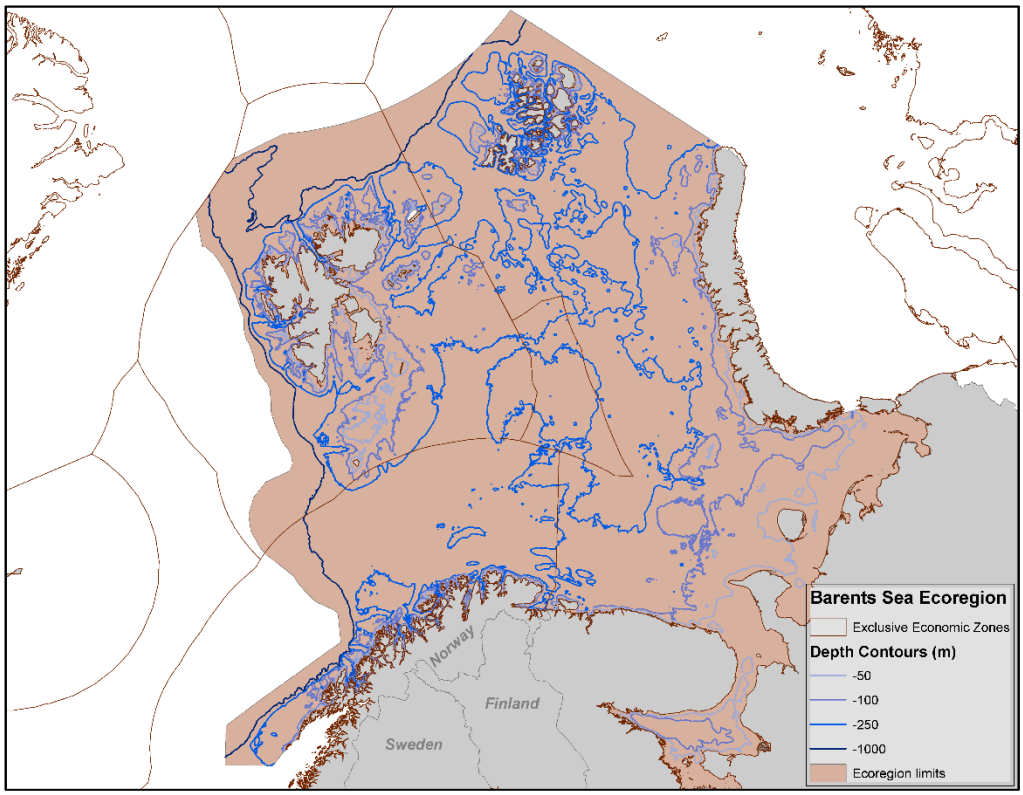

Figure 3.1.1† The Barents Sea ecoregion with EEZ delineations.

The fisheries in the Barents Sea ecoregion are managed by coastal states, with some fisheries managed by the North East Atlantic Fisheries Commission (NEAFC). Responsibility for salmon management rests with the North Atlantic Salmon Conservation Organization (NASCO) and for large pelagic fish with the International Commission for the Conservation of

* Version 2; Section number corrected
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Atlantic Tunas (ICCAT). Fisheries advice is provided by the International Council for the Exploration of the Sea (ICES). Environmental policy is managed by national agencies and OSPAR, with advice being provided by national agencies, OSPAR, and ICES. International shipping is managed under the International Maritime Organization (IMO).

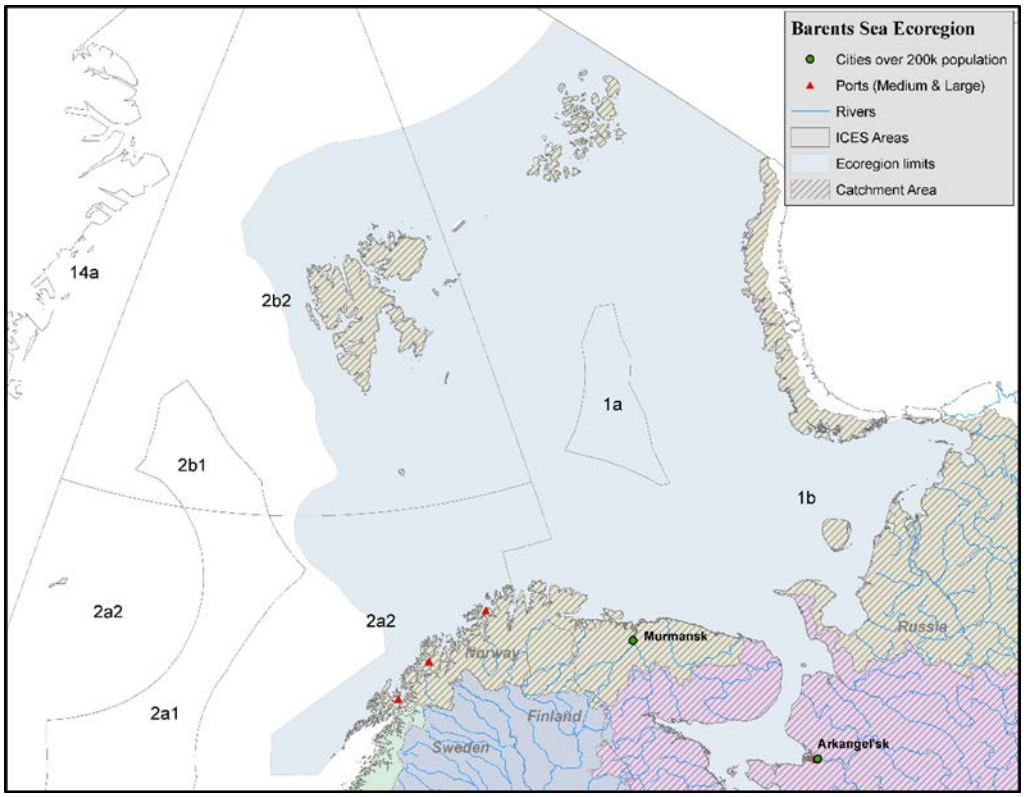

Figure 3.1.2[‡] Catchment area for the Barents Sea ecoregion showing major cities, ports, and ICES areas.

Key signals within the environment and the ecosystem

- The last decade was the warmest on record, with the highest temperatures in 2007 and 2012. Spatial distribution of zooplankton and several fish species has extended northwards in the ice-free period over the last decade. Although there has been a decrease in mesozooplankton biomass (2012 to 2014) and a declining trend in the proportion of large mesozooplankton, the biomass/productivity of plankton has remained relatively stable in recent years compared to the 1980s and 1990s. Capelin *Mallotus villosus* is the major grazer of zooplankton in the Barents Sea and its high biomass (> 3 million tonnes) over the last seven years has contributed to a high predation pressure on plankton. There is evidence of reduced growth in capelin.
- The decrease of mesozooplankton in Arctic waters of the Barents Sea has influenced the distribution and abundance of Arctic species such as the planktonic hyperiid *Themisto libellula* and polar cod *Boreogadus saida*, with a decrease in the biomass of *T. libellula* and a strong decline and recruitment failure of polar cod. Copepods and *T. libellula* are the most important prey of polar cod and decrease in their consumption by polar cod has been observed since 2010.
- The North Atlantic Oscillation (NAO) and its variation affects the Barents Sea fundamentally. Part of this influence is through ice coverage. For example in 2014, north-westerly winds resulted in an increase in ice cover during summer (the widest summer ice cover for 20 years) as a result of the winter NAO index moving to a positive value and north-westerly winds prevailing over the Barents Sea. In contrast, ice cover in 2012 was the lowest ever recorded.
- Fisheries landings have decreased since the peak of 1500 thousand tonnes in 2011. In 2014, catches of about 1300 thousand tonnes were reported from the stocks of capelin, cod *Gadus morhua*, haddock *Melanogrammus aeglefinus*, redfish *Sebastes*

[‡] Version 2; figure number corrected

spp., Greenland halibut *Reinhardtius hippoglossoides*, and deep-water (northern) shrimp *Pandalus borealis*. A fisheries management plan set the upper limits for landings in the region.

- The cod stock has extended towards the north further impacting the foodweb, e.g. through predation on polar cod. Between 1980 and 1999, the ratio of pelagic to demersal fish fluctuated greatly; currently the ratio is more stable. The change in trend is caused by the increased biomass of haddock and cod. Currently the biomass of the main demersal stocks is about equal to the biomass of pelagic stocks. As the cod stock has increased, the condition (blubber thickness) of the two other main fish predators in the Barents Sea (minke whales *Balaenoptera acutorostrata* and harp seals *Pagophilus groenlandicus*) has declined.
- Snow crabs *Chionoecetes opilio*, an invasive species, are increasing in abundance and expanding westwards. Red king crabs *Paralithodes camtchaticus*, another invasive species, are also established in the ecoregion.

Pressures

The Barents Sea ecosystem has been strongly influenced by fishing and the hunting of marine mammals. More recently, human activities include transportation of goods, oil and gas, tourism, and aquaculture. In recent years interest has focused on the likely response of the Barents Sea ecosystem to future climate change and ocean acidification. Retreating ice edges are opening new grounds for trawling and for transport routes. Activities in some of these newly-opened grounds may affect benthic communities that were previously protected by ice cover. The main pressures described below are defined in the ICES glossary of human pressures (ICES, 2015a).

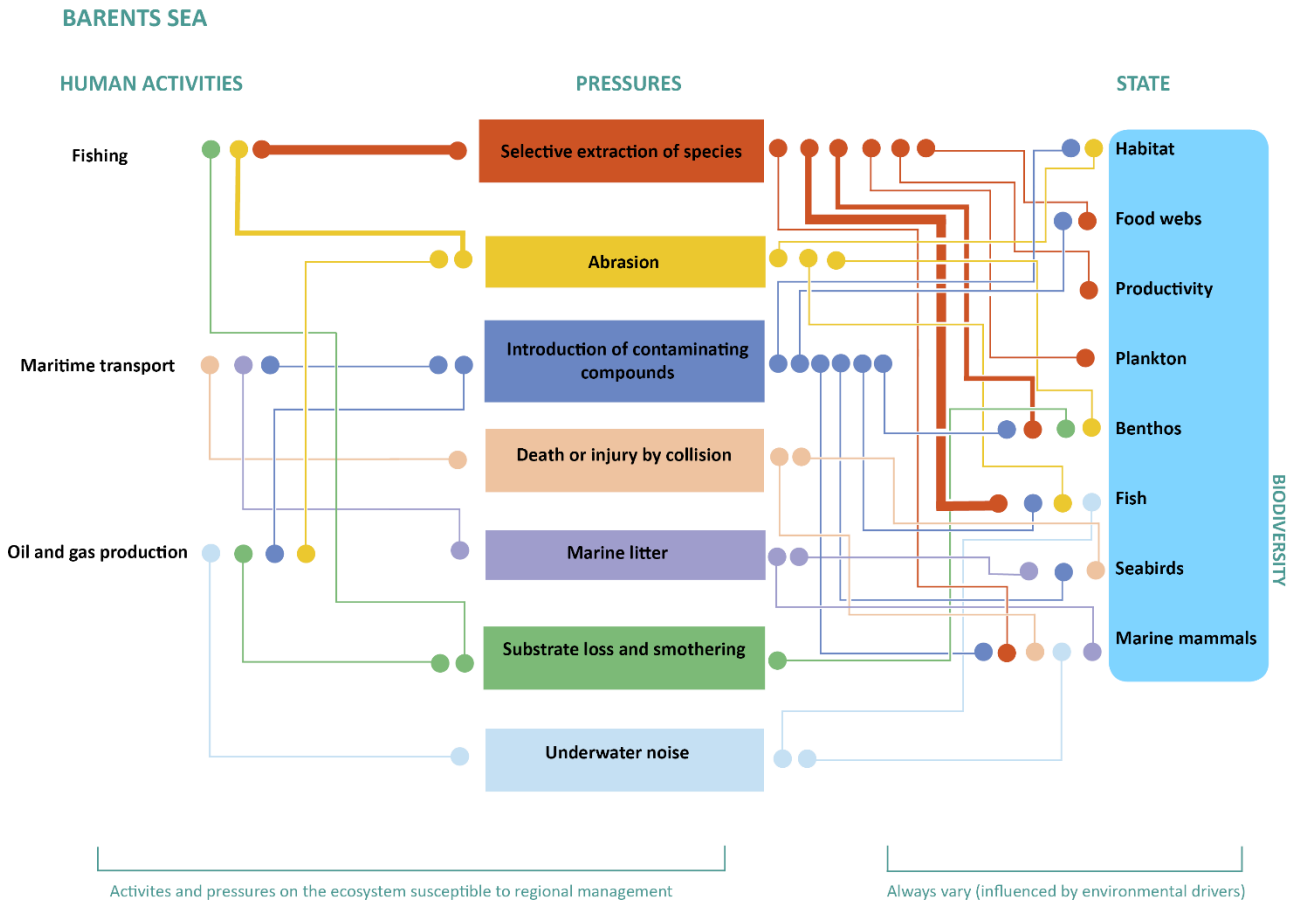

Figure 3.1.3[§] Barents Sea ecoregion overview with the major regional pressures, human activities, and state of the ecosystem components. The width of lines indicates the relative importance of individual links.

[§] Version 2; figure number corrected

Selective extraction of species

Commercial fisheries have the largest human impact on the fish stocks in the Barents Sea, and thereby on the functioning of the whole ecosystem. It is the human activity with the largest spatial extent, as fishing takes place in most of the Barents Sea except farthest north (Figure 3.1.4). There is a multinational fishery operating in the Barents Sea using different fishing gears and targeting several species (Figure 3.1.5). The largest commercially exploited fish stocks (capelin, cod, and haddock) are now harvested at fishing mortalities close to those in the management plan and have full reproductive capacity. Some of the smaller stocks (golden redfish *Sebastes marinus* and coastal cod in Norway) are overfished. Other species subject to targeted fisheries include Greenland halibut, halibut *Hippoglossus hippoglossus*, beaked redfish *Sebastes mentella*, deep-water shrimps, red king crabs, and snow crabs.

Abrasion

Vessel monitoring system (VMS)-based maps show that the most widespread gears used in the central Barents Sea are bottom trawl and lines (Figures 3.1.4–3.1.6). Bottom trawling produces abrasion on the seafloor.

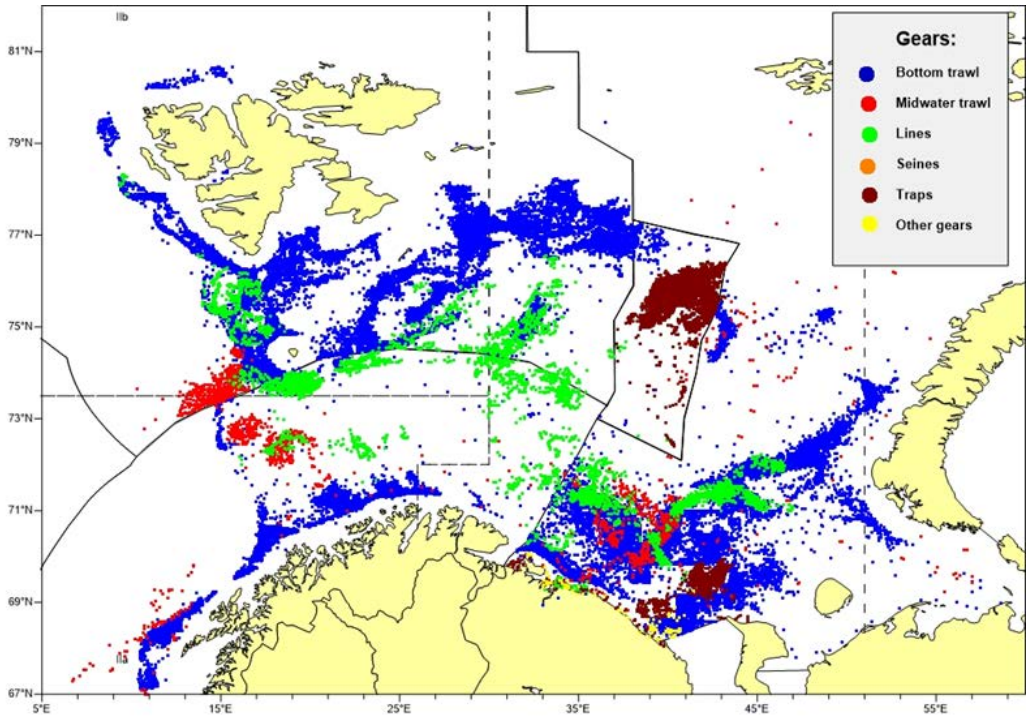

Figure 3.1.4[**] Location of Russian fishing activity in all waters, and of non-Russian fishing activity within the Russian EEZ in 2014 as reported (VMS) to Russian authorities.

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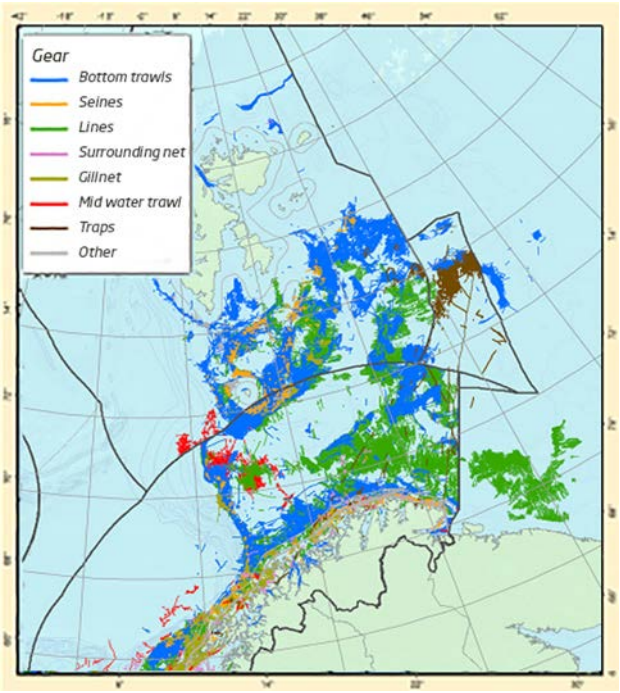

Figure 3.1.5[††] Location of Norwegian fishing activity in all waters, and non-Norwegian fishing activity within the Norwegian EEZ as reported (VMS) to Norwegian authorities.

Using VMS and logbook data it has been estimated that mobile bottom trawling techniques used by commercial fisheries in the 12 m+ vessel category have been deployed over approximately 35 000 km^2 of the Barents Sea in 2013, corresponding to ca. 1.6% of the ecoregion's spatial extent (Figure 3.1.6). This figure excludes Russian fishing effort. The proportion of swept seafloor increased by ca. 1% from 2009 until 2013. The pressure is mainly concentrated close to the coastline and in the central Barents Sea.

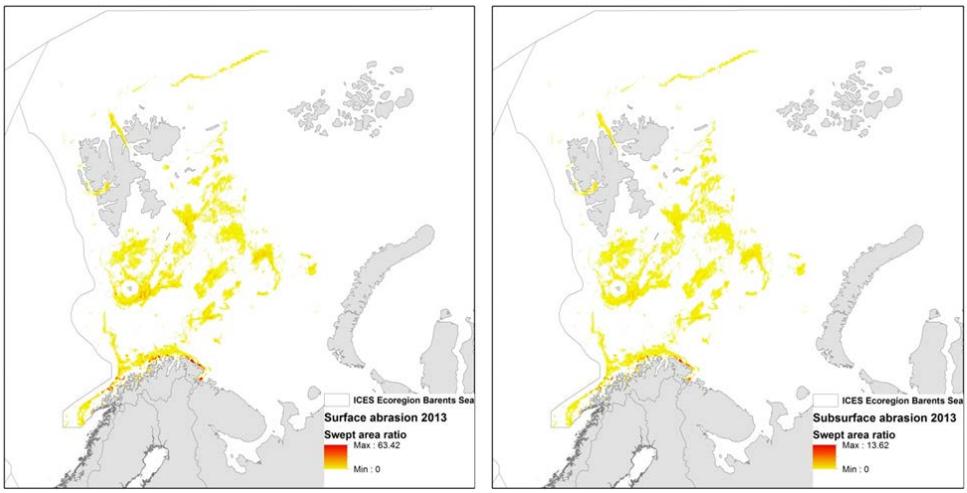

Figure 3.1.6[‡‡] Surface and subsurface abrasion pressure expressed as the swept-area ratio from VMS data from 2013 in the Barents Sea ICES ecoregion. Russian fishing effort is not included (ICES, 2015b).

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Introduction of contaminating compounds

The Barents Sea remains relatively clean with low pollution levels compared to marine areas in many industrialized parts of the world. The main sources of contaminants in the Barents Sea are outside the region (introduced through long-range transport), accidental releases from local activities, and ship fuel emissions.

Transport of oil and other petroleum products from ports and terminals in northwestern Russia have been increasing over the last decade. In the next decade, the total available capacity from Russian Arctic oil export terminals will increase greatly. The risk of oil tanker accidents will therefore increase in the years to come, unless concomitant measures are taken to reduce such risk.

Potential pressures arising from increased anthropogenic activity

There are plans to develop oil and gas production, aquaculture, and shipping in the Barents Sea. All of these can lead to increases in pressures, including substrate loss, nutrient and organic enrichment, and introduction of non-indigenous species.

Aquaculture is increasing along the coasts and in the fjords of northern Norway and Russia, with several commercial fish farms producing salmonids (salmon *Salmo salar*, trout *Oncorhynchus mykiss*) and shellfish. Red king crabs were released in the past to provide a resource for fishing, but these releases are now regarded as the introduction of an invasive species and the long-term effects on the ecosystem are unknown.

The environmental risks of known future developments have been evaluated several times and most pressures can be managed.

State of the ecosystem

Habitat – benthic and pelagic

A baseline survey (2011) of epibenthos using bottom-trawl surveys found that the Barents Sea has at least 354 benthic taxa. Depth, temperature, salinity, and number of ice days determine four main megafaunal regions. The southwestern region is dominated by filter-feeders (sponges) in the inflow area of warm Atlantic water while the deeper trenches have detritivorous fauna (echinoderms). On the banks/slopes in the southeast and west regions, predators (sea stars, anemones. and snow crabs) prevail together with filtrating species (sea cucumber and bivalves) within a mosaic of banks and slopes. Plankton-feeding brittle stars are common in the northwestern and northeastern regions, with an increasing snow crab population in the northeast.

Increasing snow and red king crab populations and potentially expanding trawling activity (e.g. for scallops and demersal fish) are the main impacts to the benthic community. Species including *Geodia* sponges in the southwestern, basket stars *Gorgonocephalus* spp. in the northern areas, sea pen *Umbellula encrinus* on the shelf facing the Arctic Ocean, and sea cucumber *Cucumaria frondosa* in shallow southern areas are particularly vulnerable to being impacted by trawling activities.

Phytoplankton

A moderate increase in net primary production has occurred since 1997, most likely caused by a response to changes in climate that include increases in the area and duration of open water each year.

Zooplankton

There is large interannual variation in the mesozooplankton biomass (mostly copepods). The western Barents Sea has shown a declining trend since the mid-2000s. The mean biomass in the western Barents Sea in 2013 is now the lowest recorded since

the early 1990s. However, the average mesozooplankton biomass in the northeastern Barents Sea is relatively high. Overall there has been a decrease in the biomass of the Arctic hyperiid *Themisto libellula*.

Changes in the total abundance of krill (euphausiids) within regions show the strongest decline in the east.

In 2014, jellyfish, mostly the Lion's Mane jellyfish *Cyanea capillata*, were found across the Barents Sea. The calculated jellyfish biomass in 2014 was close to the record-high biomass of jellyfish (near 5 million tonnes observed in 2001).

Benthos and shellfish

The distribution of deep-water (northern) shrimp appears to have expanded towards the north-east since 2004.

Red king crabs are well established along the mainland Russian and Norwegian coast. The abundance and reproduction rates have declined in recent years, due to a decrease in recruitment rate and high fishing mortality.

The snow crab stock is increasing in the central and eastern Barents Sea, and the biomass is calculated to be ten times higher than the biomass of red king crabs and close to half the biomass of the deep-water shrimp. A commercial fishery has been launched for the species. A further expansion in range westwards towards Svalbard is expected.

Fish

The dominant commercial demersal species in this ecoregion is cod. The cod stock abundance is high and has expanded northward since 2004. The haddock spawning-stock biomass has been above a safe biological reference point since 1990 and is increasing. The saithe stock is stable. The total stock of polar cod is at its lowest abundance level since 1990. Halibut abundance has slightly increased along the western coast in the Barents Sea region.

Currently the herring *Clupea harengus* stock size is half of the average stock size that was present from 1999 to 2013. The amount of young herring entering the Barents Sea has been low in recent years. Capelin stock size has been stable.

The beaked redfish stock is recovering from the low level it was at some years ago. The golden redfish stock size is very low.

Seabirds

The Barents Sea supports at least 20 million seabirds, divided between 40 species and 1600 colonies, in summer. Numbers are lower in winter when most species move southwards. The commonest species are Brünnich's guillemot *Uria lomvia* and the black-legged kittiwake *Rissa tridactyla*. Numbers of little auk *Alle alle* may be of the same order, but colonies are very difficult to count. In Norway (and Svalbard) numbers of Brünnich's guillemots and black-legged kittiwakes have approximately halved in the past 25 years, with the same trend being seen in several other species.

Marine mammals

The Barents Sea is inhabited by 21 species of marine mammals and is an important feeding ground for a range of large whales, including fin whale *Balaenoptera physalus*, minke whale *Balaenoptera acutorostrata*, humpback whale *Megaptera novaeangliae*, and sperm whale *Physeter macrocephalus*. Among the smaller whales and dolphins, the Barents Sea is important for northern bottlenose whale *Hyperoodon ampullatus*, killer whale *Orcinus orca*, white-beaked dolphin *Lagenorhychus albirostris*, narwhal *Monodon monoceros*, and beluga whale *Delphinapterus leucas*. Among other marine mammals, grey seal *Halichoerus grypus*, harp seal *Pagophilus groenlandicus*, walrus *Odobenus rosmarus*, and polar bear *Ursus maritimus* are present in globally important numbers.

There is limited information on the trends in cetaceans, though humpbacks at least are believed to be recovering from past overexploitation. Numbers of both grey seals and walruses were reduced by past hunting; recent evidence shows that grey seal is recovering. Numbers of polar bears increased in the last quarter of the 20th century, but trends since 2000 are unclear.

Non-indigenous species

The red king crab and the snow crab are new benthic species which are now significant parts of the benthic community in coastal and eastern regions of the Barents Sea, respectively.

Threatened and declining species and habitats

The threatened and declining species in the Barents Sea according to OSPAR are shown in the table below.

SCIENTIFIC NAME	**COMMON NAME**
INVERTEBRATES	
Arctica islandica	Ocean quahog
Nucella lapillus	Dog whelk
SEABIRDS	
Larus fuscus fuscus	Lesser black-backed gull
Pagophila eburnea	Ivory gull
Polysticta stelleri	Steller's eider
Rissa tridactyla	Black-legged kittiwake
Uria lomvia	Thick-billed murre (or Brünnich's guillemot)
FISH	
Acipenser sturio	Sturgeon
Alosa alosa	Allis shad
Anguilla anguilla	European eel
Cetorhinus maximus	Basking shark
Coregonus lavaretus	Whitefish
Dipturus batis	Common skate
Lamna nasus	Porbeagle
Petromyzon marinus	Sea lamprey
Raja clavata	Thornback ray
Salmo salar	Salmon
Squalus acanthias	[Northeast Atlantic] spurdog
MARINE MAMMALS	
Balaena mysticetus	Bowhead whale
Balaenoptera musculus	Blue whale
Eubalaena glacialis	Northern right whale
Phocoena phocoena	Harbour porpoise

Threatened and declining habitats in the Barents Sea according to OSPAR

HABITATS
Coral gardens
Cymodocea meadows
Deep-sea sponge aggregations
Intertidal mudflats
Lophelia pertusa reefs
Modiolus modiolus beds
Ostrea edulis beds
Seamounts
Zostera beds

Sources and acknowledgments

The content for the ICES regional ecosystem overviews is based on information and knowledge generated by the following ICES processes: Workshop on Benchmarking Integrated Ecosystem Assessment (WKBEMIA) 2012, ACOM/SCICOM Workshop on Ecosystem Overviews (WKECOVER) 2013, Workshop to draft advice on Ecosystem Overviews (WKDECOVER) 2013, and Advice drafting group to finalize draft Ecosystem Overviews (ADGECO) 2015, which provided the theoretical framework and final layout of the documents. The ICES integrated ecosystem assessment working group Working Group on the Integrated Assessments of the Barents Sea (WGIBAR) contributed to the main sections of this overview.

The maps and GIS products were produced by the ICES Secretariat using data from:

1. Exclusive Economic Zones. *Marineregions.org (VLIZ).*
2. Offshore Wind-farms. *OSPAR Commission.*
3. Depth Contours. *General Bathymetric Chart of the Oceans (GEBCO).*
4. Natura 2000. *European Commission.*
5. Ecoregions. *International Council for the Exploration of the Sea (ICES).*
6. Ports. *Global Shipping Lanes and Harbors (ESRI).*
7. Cities. *World Cities (ESRI).*
8. Rivers. *WISE Large Rivers and large lakes. European Environment Agency (EEA).*
9. ICES Areas. *International Council for the Exploration of the Sea (ICES).*
10. Catchment Area. *European Environment Agency (EEA). European Topic Centre on Inland, Coastal and Marine waters (ETC/ICM).*
11. Substrate maps. EU EMODNET seabed habitats; www.emodnet-seabedhabitats.eu.
12. Non indigenous species. AquaNIS; http://www.corpi.ku.lt/databases/index.php/aquanis.

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