13.1 Oceanic Northeast Atlantic ecoregion – Ecosystem overview

Table of contents

Ecoregion description

The Oceanic Northeast Atlantic ecoregion consists of the portion of the ICES Area that is beyond national jurisdiction (ABNJ), i.e. outside the 200 mile limit of the exclusive economic zones (EEZs) of the EU Member States, the Faroe Islands, Iceland, and Greenland. The ecoregion is mostly deeper than 1000 m, with only a small fraction of the seabed (ca. 0.03%) shallower than 500 m. The area comprises mostly extensive abyssal plains, with the Mid-Atlantic Ridge (MAR), many seamounts, and the Rockall–Hatton Plateau rising above the abyssal plain (Figure 1). This ecoregion is entirely oceanic, and differs from all other ecoregions by being distant from land; as a consequence, it is much less influenced by coastal and terrestrial processes. A number of claims are made on the parts of the continental shelf that extend into the ecoregion from adjacent EEZs. Alongside the exploitation rights, such claims carry responsibility to protect the seabed and its habitats.

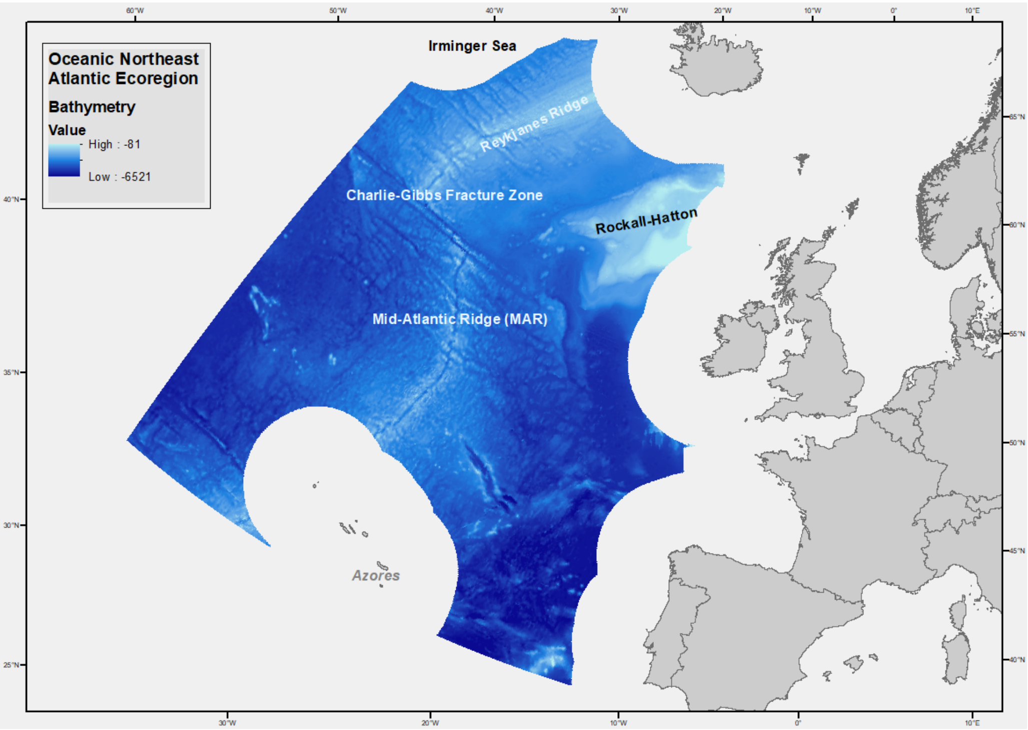

Figure 1 ICES Oceanic Northeast Atlantic ecoregion, corresponding to the area beyond national jurisdiction (ABNJ) in the eastern North Atlantic.

Management activities

Regulation of the fisheries

The Northeast Atlantic Fisheries Commission (NEAFC) is the regional fisheries management organization mandated to manage most fisheries in the Oceanic Northeast Atlantic ecoregion. These include fisheries for pelagic stocks of mackerel (*Scomber scombrus*), herring (*Clupea harengus*), blue whiting (*Micromesistius poutassou*), and redfish (*Sebastes mentella*), as well as demersal fisheries for haddock (*Melanogrammus aeglefinus*) and deep-sea species. These fisheries are conducted both inside EEZs and in the ABNJ, where they are regulated by a mixture of national, EU, and NEAFC measures. NEAFC has frozen the fishing footprint by designating existing fishing areas within which bottom fishing is permitted. Outside these areas bottom fishing is prohibited, and any new fishery wanting to be developed must do so under an exploratory fishing protocol. In addition, extensive areas within the fishing areas have been closed to protect vulnerable marine ecosystems (VMEs). NEAFC has banned targeted fisheries on deep-sea elasmobranchs. Individual parties to NEAFC have implemented additional measures for their own fleets fishing in international waters, e.g. the recent changes in EU fishing opportunities for deep-sea species. NEAFC measures are legally binding, and activity by contracting parties or third parties not complying with the measures is regarded as illegal and may lead to sanctions, such as the blacklisting of vessels. All fishing vessels in the NEAFC area are monitored by electronic vessel monitoring systems (VMS). NEAFC receives scientific advice on stocks and ecosystem components from ICES. The Long Distance Fleet Advisory Council (LDAC) also provides advice via the European Commission.

The International Commission for the Conservation of Atlantic Tunas (ICCAT) is the regulatory authority for the fisheries of tuna and other large pelagic species. The North Atlantic Salmon Conservation Organization is the regulatory authority for the distant-water salmon fisheries, such as those off Greenland and Faroes, as these are largely confined to EEZs rather than to the ABNJ.

Regulation of other human activities

The International Whaling Commission (IWC) and national authorities regulate the harvesting of whales. None are harvested from the ecoregion at present. Advice to some nations is provided by the North Atlantic Marine Mammal Commission (NAMMCO). The International Seabed Authority (ISA) is the regulatory authority for mineral extraction (mining). There is, as yet, no mineral exploration or extraction activity in the area. The International Maritime Organization (IMO) is the regulatory authority for shipping; this is extensive across the area, especially in the southern part of the ecoregion.

Environmental protection

The OSPAR Commission is the regional environmental management organization that promotes protection and conservation in the Northeast Atlantic. Though OSPAR has a limited regulatory mandate in the high seas, it has introduced seven high-seas marine protected areas (MPAs) since 2010. Some of these, but not all, overlap spatially with areas closed to fisheries by NEAFC to protect VMEs. OSPAR maintains a list of “threatened and declining species and habitats”. OSPAR’s actions serve to raise awareness on needs for management actions by national authorities and organizations with the appropriate mandates. OSPAR and NEAFC collaborate and promote common processes, in relation to the other organizations mentioned above and relevant international mechanisms such as the Convention on Biodiversity (CBD). States with extended continental shelf claims within the ecoregion are also obliged to implement conservation measures if appropriate.

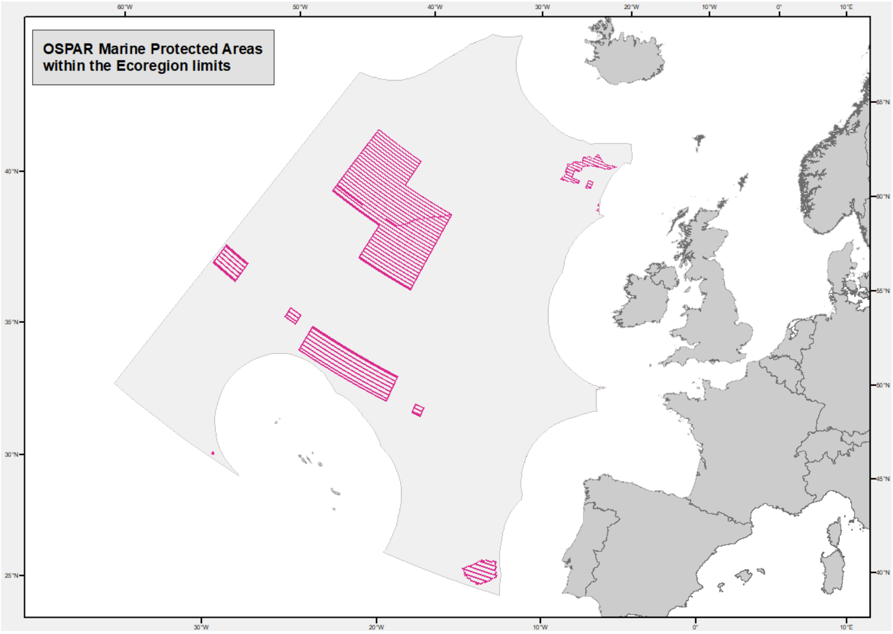

Figure 2 OSPAR marine protected areas within the ICES Oceanic Northeast Atlantic ecoregion (Source: OSPAR MPA Map Tool; http://carto.mpa.ospar.org/1/ospar.map).

Oceanography

The oceanography of the ecoregion is dominated by the Subtropical and Subpolar Gyres. These systems are bounded by the Subpolar Front (SPF), which divides the ecoregion into a relatively cold area to the northwest and a relatively warm area in the south. The Subpolar Gyre carries cold, low-salinity, and highly oxygenated intermediate Labrador Sea Water to the ecoregion. The northern branch of the Subtropical Gyre (the North Atlantic Current, NAC) transports warm waters to the northeastern part of the region (Figure 3). Both gyres are integral components of the Atlantic Meridional Overturning Circulation (AMOC), a large-scale ocean circulation process that also has profound consequences for atmospheric climate. The Subpolar and Subtropical gyres have profound influence on the processes underlying the distribution and productivity of biota, and the exchange between neighbouring ecoregions.

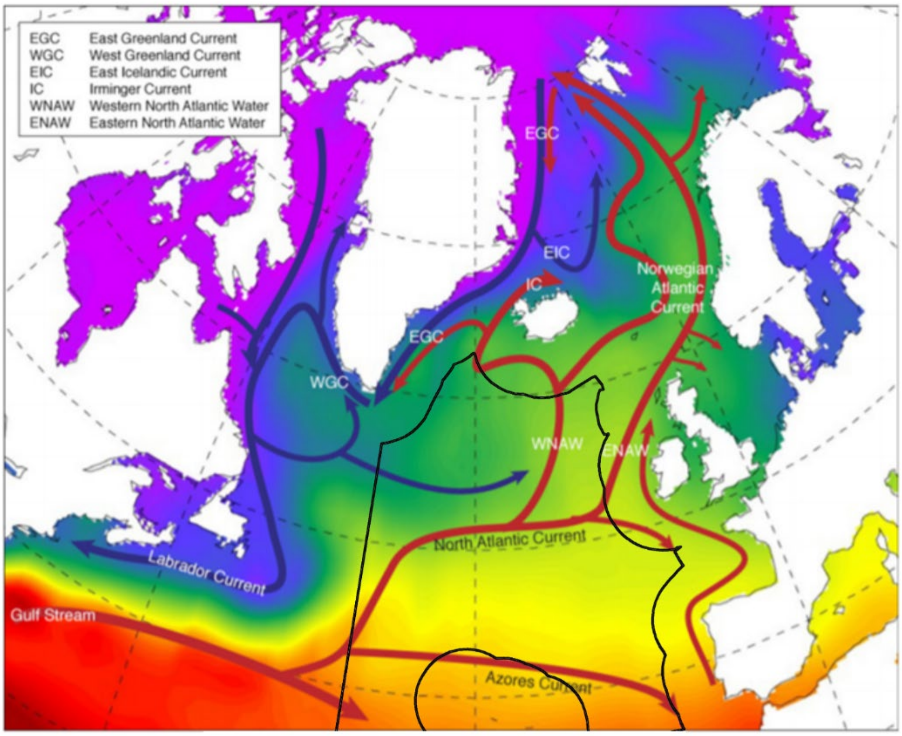

Figure 3 Sea surface temperatures and diagrammatic representation of the main currents in the North Atlantic. Where cold and warm currents co-occur, warm water overlays cold water (ICES Report on Ocean Climate (IROC) 2017 – Gonzalez-Pola *et al.*, 2018).

Key signals within the environment and the ecosystem

The Subtropical Gyre influences the southernmost waters of the ecoregion, where surface conditions have recently been warmer than average. In recent years, however, there has been a persistent cold anomaly in the Subpolar Gyre. The subpolar cold anomaly increased in size and intensity during 2013–2015 when it exceeded 2°C below average, but since 2016 it has diminished in intensity (by around 1°C) and areal extent. Since 2014 the surface temperature anomaly has been accompanied by a near-surface low salinity anomaly along the Greenland coast in both the Labrador and Irminger basins. The low salinity near-surface water may be a result of increased precipitation and of Greenland ice sheet melting.

Phytoplankton pigment concentrations, estimated from satellite data (1998–2017) and Continuous Plankton Recorder (CPR) Phytoplankton Colour Index data (1958–2017), suggest that phytoplankton biomass is greater now than in the previous 20 to 60 years. These pigment trends, however, are not matched in the major plankton group abundances. This suggests that micro-phytoplankton communities (those not caught by the CPR) may be contributing to the pigment concentration increases. CPR diatom and dinoflagellate abundances (1958–2017) were increasing in the far western part of the ecoregion but decreasing in the east, with no long-term trend in the central areas.

Pressures

The Oceanic Northeast Atlantic ecosystem currently and historically has fewer human activities than other ICES ecoregions, as the latter are closer to land and have more readily exploitable resources. Despite being far from land, water flows bring contaminants and litter to the ecoregion from land-based sources. The main pressures described below are defined in the ICES Technical Guidelines.

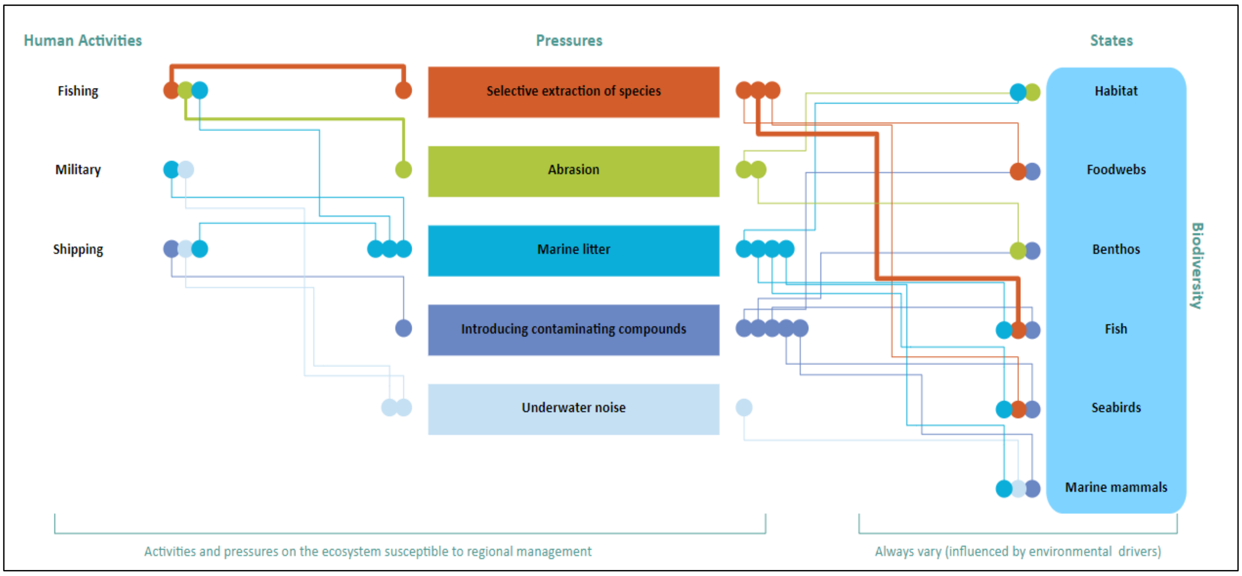

Figure 4 Overview of the major regional pressures, human activities, and ecosystem state components for the Oceanic Northeast Atlantic ecoregion. The width of lines indicates the relative importance of main individual links (the scaled strength of pressures should be understood as a relevant strength between the human activities listed, and not as an assessment of the intensity of the pressure on the ecosystem). Climate change affects human activities, the intensity of the pressures, and some aspects of state, as well as the links between these.

Selective extraction of species (including non-target species)

Multispecies fisheries for deep-sea species developed in the early 1970s and peaked at 30 000 tonnes in 1975. Since then, effort has declined and landings now amount to less than 4000 tonnes per year. The current relatively small fisheries are mainly conducted by a few trawlers and longliners, primarily from the EU and the Faroe Islands.

The historical data on fishing effort and catches on high seas deep-sea species stocks does not constitute a satisfactory basis for carrying out analytical assessments. Consequently, the ICES advice issued each year is based on ICES precautionary approach framework. Demersal deep-water fisheries have large bycatches of non-target fish, including deep-sea sharks.

The main fishery in the area has been a multinational pelagic fishery, fishing on two pelagic beaked redfish stocks (shallow pelagic and deep pelagic) that commenced in the early 1980s. The number of vessels participating in the fishery decreased substantially as the stocks were depleted to a historical low point. The combined catch of both stocks peaked in 1996 when 180 000 tonnes were caught; this has since declined to an annual catch of about 30 000 tonnes, mainly taken from the deep pelagic stock.

Fishing for tuna and other large pelagic species by long-distance longliners occurs across much of this ecoregion, depending on target species and season. The stocks and fisheries range over a much wider area than the ecoregion. Stocks and fisheries peaked in the 1970s, then declined to much reduced levels. There has been a decrease in fishing mortality rate and an increase in stock size over the last decade. Bluefin tuna (*Thunnus thynnus*) is harvested in the central parts of the ecoregion, with annual catches since 2010 rising from 4400 tonnes to 7200 tonnes in 2017. Pelagic sharks are fished on longline in the North Atlantic, but there is no information on volumes caught specifically in this ecoregion.

Further pelagic fisheries for species such as blue whiting and demersal fisheries for haddock occur in the Rockall–Hatton area, but amount to a small proportion of the total fisheries on these species. The total catch of blue whiting was 1 558 000 tonnes in 2017, but ICES estimated that about 80% was taken from inside EEZs rather than in the ABNJ; it is, therefore, unlikely that the state of the stock is strongly influenced by fishing in the ecoregion. A single-vessel fishery uses semi-pelagic gear for orange roughy (*Hoplostethus atlanticus*) on the Fangorn Bank and the Mid-Atlantic Ridge.

Abrasion

Abrasion is primarily caused by bottom-contacting fishing gear. Current bottom trawl fisheries operate in very specific areas such as along bank slopes, e.g. Hatton Bank, or on seamounts, e.g. Fangorn Bank (Figure 5). These data illustrate that bottom trawl fishing is very patchy and restricted by the spatial management plans introduced by NEAFC. Within the areas that remain open to fishing (existing bottom fishing areas), certain sites and tracks are preferred and fished repeatedly.

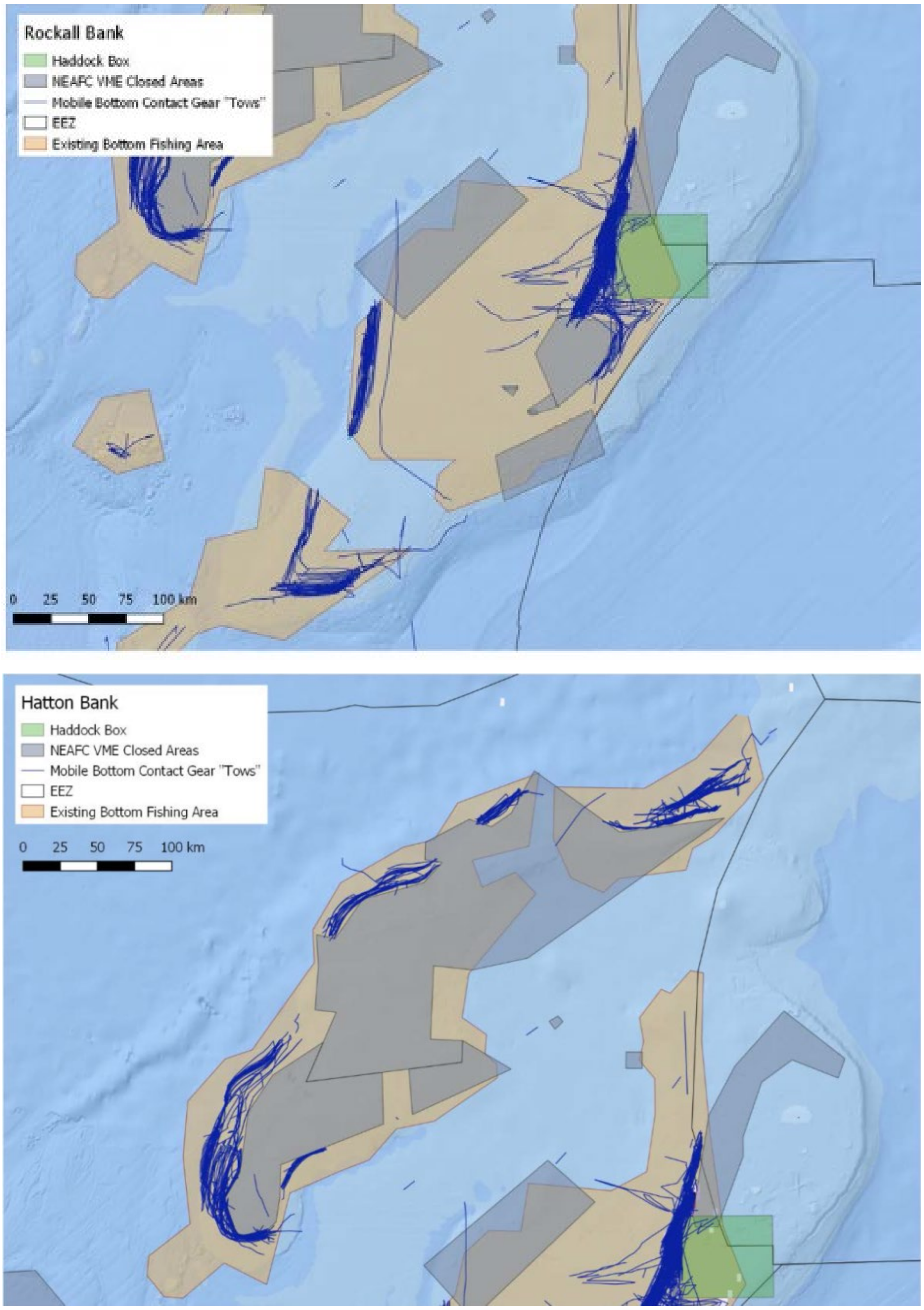

Figure 5 Examples of tracks of fishing vessels (VMS records; dark blue lines) on Rockall and Fangorn banks (upper) and Hatton Bank (lower). The light brown areas are NEAFC "existing bottom fishing areas" that are open to fishing, while grey polygons are closed to bottom fishing. The outer limits of the EEZs are shown as solid grey lines. Bottom fishing is not allowed within the Haddock Box (green) to protect juvenile haddock (source: https://doi.org/10.17895/ices.advice.5580).

No commercial fisheries have operated deeper than approx. 1600 m; thus, a large proportion of the seabed in the area has never been abraded by fisheries. Although vessel monitoring data exist for the area for recent years, the most intense fishing happened prior to the advent of VMS, so it is very difficult to assess the historical abrasion footprint.

Marine litter

Shipping used to be a significant source of litter, but since the introduction of IMO regulations on waste management the amount per vessel may have reduced while overall traffic has increased. Lost fishing gear is likely to be a localized source of marine litter. Ship and submarine wrecks occur across the area. The military is a source of litter, e.g. sonar buoys and spent munitions.

Plastic litter is ubiquitous in the oceans, and there is evidence from the Northwest Atlantic that microplastics enter the food chain and are present in the guts of mesopelagic fish species. Although studies have yet to be done, it is reasonable to assume this will also be the case in the Northeast Atlantic.

Introduction of contaminating compounds

The ecoregion has no direct land-based sources of contaminants or litter but is influenced by inputs from outside its boundaries, from the atmosphere as well as from ships passing through or visiting the area. Studies indicate that levels of contaminants are below thresholds of concern in sediments and benthic organisms, although there is evidence that they become bio-magnified up the food chain. From the 1940s to the 1980s, low-level radioactive waste was dumped at several sites in the Oceanic Northeast Atlantic. Disposal sites were all at depths > 2000 m and mostly in the southeastern (outer Bay of Biscay) area. Disposal drums were expected to last between 10 and 40 years, before releasing radioactivity into the surrounding environment. Monitoring of radioactivity sites continued up to the year 2000, but has since ceased.

Noise

The most widespread noise-generating activity in the ecoregion is shipping. This produces relatively low-frequency continuous sound that will affect most of the ecoregion. Noise generated by military activities in the ecoregion will include some continuous sound from vessels, as well as low- and mid-frequency impulsive sounds from sonar used to find submarines and in a few cases from explosives. These sounds have been known to lead to the deaths of marine mammals, especially beaked whales. The scale of the military activities is not known, but not likely to be great.

Potential for future pressures and activities in the ecoregion

Mineral and hydrocarbon extraction

The geology of the Hatton–Rockall area has been explored for oil and gas (the Hatton–Rockall Plateau); currently there is no extraction because of an inability to fly helicopters to the area. Deep-sea mineral extraction is also being considered, but thus far the mining interests have primarily focused on areas further south in the Atlantic and in the Norwegian Sea. The ISA is considering approaches for environmental impact assessments.

Fishing

There is increasing interest in exploring options for harvesting mesopelagic fish and plankton. Studies in the North Atlantic indicate that the biomass of mesopelagic species is particularly high in the Irminger Sea.

State of the ecosystem

Habitats (substratum)

Only a few small areas of the ecoregion have been mapped with acoustic methods, and there is even less direct evidence in the form of visual surveys or benthic sampling. Some areas have undoubtedly been affected by fishing, but most studies are inconclusive with respective to the scale and significance of the effect. There are no time-series or repeated studies from the ecoregion, although a recent increase in research activity in the area provides baseline data for the future. There is thus limited scope for currently assessing the state of benthic habitats, or for making judgements based on past states and temporal changes. As deep-sea fishing does not generally operate at depths beyond 1600 m, it can be assumed that direct fishing effects have only occurred in areas shallower than this.

Benthos

Cold-water coral species such as *Lophelia pertusa* have been reported from multiple sites across the area, including the Hatton and Rockall banks, Edoras Bank, Lousy Bank, and the Mid-Atlantic Ridge. Video records from three different sections along the Mid-Atlantic Ridge found some lost fishing gear in areas of coral, but no evidence of trawl door tracks. Degraded or damaged cold-water coral reefs have been reported from existing fishing areas, and there is evidence of recent damage by bottom trawl fisheries to cold-water corals on Rockall Bank. The majority of sites where there is evidence of the presence of coral reefs are now protected by NEAFC closures. Recovery of corals from damage is expected to take decades.

Deep-sea sponge grounds have been recorded from the Hatton–Rockall Basin, and are also likely to be found elsewhere in the area at depths less than 2000 m. Limited video surveys suggest that some areas are in an undisturbed state. Sponges from some areas of the Mid-Atlantic Ridge have been mapped.

The only active hydrothermal vent and associated fauna in the area (at 45ºN on the Mid-Atlantic Ridge) is known as Moytirra, and was discovered in 2011. The vent field is assumed to be pristine. An area in the Hatton–Rockall Basin has been identified as having seabed conditions that would suggest the presence of a cold-seep ecosystem. There are no indications that the area has been affected by fishing, and NEAFC has closed the area to bottom fishing.

The ecoregion has numerous seamounts (Figure 6). Some seamounts with summits at depths < 1500 m were explored for fisheries, but too few have been studied by video or photography to assess the state of the sessile benthic communities. Many seamounts are now protected by NEAFC closures and affected communities may be assumed to be recovering, although this may take decades. Many of these NEAFC-closed areas are included within OSPAR’s network of high seas MPAs.

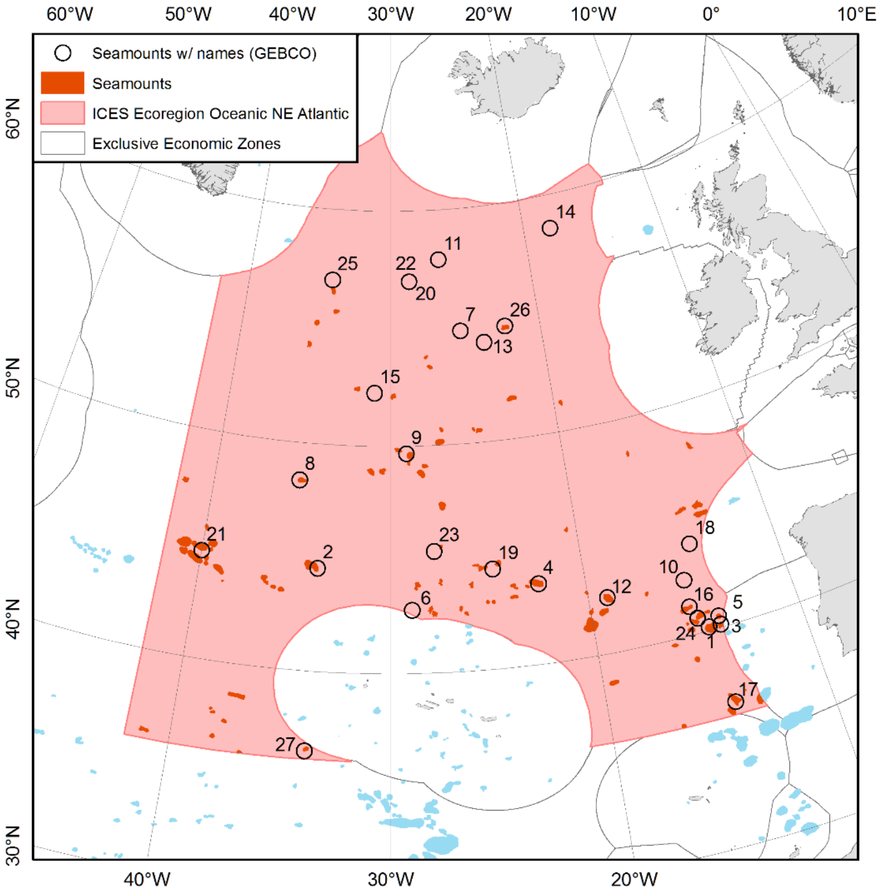

Figure 6 Seamounts predicted by gravitational anomalies (red patches; source: Harris *et al.,* 2014) and seamounts listed in the IHO IOC GEBCO Gazetteer of Undersea Feature Names (circles and numbers). (1) Almeida Carvalho, (2) Altair, (3) Andromeda, (4) Antialtair, (5) Auriga, (6) Chaucer, (7) Eriador, (8) Evlanov, (9) Faraday, (10) Fernandes Lopes, (11) Franklin, (12) Georgiy Zima, (13) Gondor, (14) Hatton Bank, (15) Hecate, (16) Hugo de Lacerda, (17) Josephine Bank, (18) La Coruña, (19) Lukin-Lebedev, (20) Marietta, (21) Milne, (22) Minia, (23) Olympus Knoll, (24) Pedro Nunes, (25) Prilyudko, (26) Rohan, and (27) Unnamed.

Productivity (phytoplankton and zooplankton)

Productivity varies across the area, with notably high planktonic diversity and abundance associated with oceanic fronts (e.g. the Subpolar Front) and topographic features (e.g. the Charlie–Gibbs Fracture Zone; see the "Key signals within the environment and the ecosystem" section).

There are no time-series of data for zooplankton and micronekton of the meso- and bathypelagic zones, i.e. deep-living components that are highly significant in the foodwebs of ridges, seamounts, abyssal plains, and continental slopes of this ecoregion.

Fish

Spawning-stock biomass of blue whiting has increased since 2010 and is currently is above MSY $B_{trigger}$. Recruitment in 2017 was estimated to be low, following a period of high recruitments.

The two stocks ("deep pelagic" and "shallow pelagic") of the beaked redfish in the Irminger Sea both have declining spawning-stock biomass, and they are currently at levels below the limit reference points. ICES advises zero TACs.

A range of deep-sea species have been fished in this ecoregion since the early 1970s, but ICES cannot provide quantitative stock sizes for species other than deep-pelagic redfish. There are many species of deep-water shark in the ecoregion, some of which (e.g. Portuguese dogfish (*Centroscymnus coelolepis*) and leaf-scale gulper shark (*Centrophorus squamosus*)) are considered severely depleted.

Spawning-stock biomasses of bluefin tuna and swordfish (*Xiphias gladius*) have increased in recent years, and neither are considered to be overfished.

Among the pelagic shark species occurring in the ecoregion, three are considered more significant and vulnerable to fishing: blue shark (*Prionace glauca*), shortfin mako (*Isurus oxyrinchus*), and porbeagle (*Lamna nasus*). Porbeagle is considered to be severely depleted. Blue shark and mako are considered fully exploited or overfished.

European eel (*Anguilla anguilla*) is not fished in the ecoregion, but adult eels migrate through it and pelagic larvae transit the area during the drift phase between southwest Atlantic reproduction areas and the European continent. ICES concluded that the status of eel remains critical, and advises strict regulations wherever eel is fished or otherwise affected by human activity. Recruitment is poor, but it is unknown to what extent processes in oceanic waters influence recruitment rates.

The salmon fisheries in the ecoregion are very minor, and the now relatively small oceanic catches are taken within EEZs or in the ABNJ in more northerly waters. Continued low abundance of Atlantic salmon (*Salmo salar*) combined with low return rates to river systems indicate poor survival in the marine environment, and suggest that factors acting on survival at sea (in the first and in some cases second years) at both local and broad ocean scales are constraining abundance of salmon.

Seabirds

There are no nesting sites for seabirds within the ecoregion. However, tracking data and direct observations suggest that the ecoregion is an important area for seabirds during all seasons. Several petrel species forage in the area during the breeding season, including Northern fulmar (*Fulmarus glacialis)* from Scotland, Iceland, and the Faroes, the rare and endangered Zino's petrel (*Pterodroma madeira)* from Madeira, Bermuda petrel (*Pterodroma cahow)* and Audubon's shearwater (*Puffinus lherminieri baroli)* from the Azores, Madeira, and the Canary Islands. Many other species migrate through or winter in the ecoregion in large numbers, both Northern hemisphere breeders such as black-legged kittiwake (*Rissa tridactyla*), Atlantic puffin (*Fratercula arctica*), and little auk (*Alle alle*), and Southern hemisphere breeders such as great shearwater (*Ardenna gravis*) and sooty shearwater (*A. grisea*). BirdLife International has identified, on the basis of tracking data, three "Important Bird Areas" in the southern parts of the ecoregion. These fall within a larger area covering more than 600 000 km^2 that OSPAR is considering as an MPA. Trends based on nesting sites suggest many breeding seabird species in the North Atlantic are declining, although a few such as Northern gannets (*Morus bassanus)* have increased.

Marine mammals

A number of baleen and toothed whales utilize the ecoregion during migration and as feeding areas.

The overall assessments of baleen whales for the entire Northeast Atlantic is that the abundance of minke whale (*Balaenoptera acutorostrata*) is stable, while fin whales (*Balaenoptera physalus*) and humpback whales (*Megaptera novaeangliae*) are increasing (following heavy depletion by hunting in the past). There is no information on trends in sperm whales (*Physeter macrocephalus*), and for blue whale (*Balaenoptera musculus*) the numbers remain low but may be increasing. A total figure of 30 000 sperm whales in the entire central and eastern Atlantic was suggested by Rogan *et al.* (2017). Female sperm whales and their calves remain in the warmer lower latitudes, while so called "bachelor herds" and large bulls are found in northern waters when not breeding. Several species of beaked whales (*Hyperoodontidae*) occur in the northeastern and northwestern areas of the ecoregion. Pilot whales (*Globicephala* sp.) and Atlantic white-sided dolphins (*Lagenorhynchus acutus*) are more frequently observed in the cooler and less saline waters, while the opposite was true for common and striped dolphins.

Non-indigenous species

There is no information on non-indigenous species in this ecoregion.

Threatened and declining species

OSPAR has established lists of threatened and declining species and habitats; those listed that occur in the Oceanic Northeast Atlantic ecoregion are described below.

Fish

Fish species on the list are orange roughy, Portuguese dogfish, leaf-scale gulper shark, bluefin tuna, porbeagle, and eel.

Birds

The ecoregion is an important feeding area for breeding Barolo (Audubon's) shearwater, and for wintering black-legged kittiwake and thick-billed murre (*Uria lomvia)*.

Turtles

Leatherback (*Dermochelis corieacea*) and loggerhead (*Caretta caretta*) turtles are known to make transatlantic migrations, and may feed around seamounts in the area.

Marine mammals

Blue whales forage in central North Atlantic waters when migrating to northern feeding sites.

Threatened and declining habitats

The OSPAR list includes seamounts, coral reefs, and deep-sea sponge grounds, as well as vents and seeps. Many seamounts and areas where coral reefs or deep-sea sponge grounds are known to occur are now protected under NEAFC regulations, and are included in the OSPAR network of high seas MPAs. It is not known to what extent they have been affected by fisheries, and they can only be assumed to be either in favourable condition or slowly recovering. Only one active vent field and one cold seep have been confirmed. There is no evidence of fisheries impact, and status can be assumed to be favourable.

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, Workshop on Regional Climate Change Vulnerability Assessment for the large marine ecosystems of the northern hemisphere (WKSICCME-CVA) 2017, and the Advice Drafting Group to finalize draft Ecosystem Overviews (ADGECO) 2019, which provided the theoretical framework and final layout of the documents.

The main sections of this document are the result of the efforts of many scientists with an interests in the Oceanic Northeast Atlantic contributing toward the ICES WKABNJ. It also includes information from several ICES working groups such as the Working Group on Zooplankton Ecology (WGZE), Working Group on Marine Mammal Ecology (WGMME), Working Group on Introductions and Transfers of Marine Organisms (WGITMO), Joint Working Group on Seabirds (JWGBIRD), Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP), the Working Group on Deep-water Ecology (WGDEC), Working Group on Elasmobranch Fishes (WGEF), and Joint EIFAAC/ICES/GFCM Working Group on Eels (WGEEL). References have been removed from the text for clarity and can be found in the Sources section below.

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

1. Exclusive Economic Zones. Marineregions.org (VLIZ)
2. Depth Contours. General Bathymetric Chart of the Oceans (GEBCO)
3. Ecoregions. International Council for the Exploration of the Sea (ICES)

4. ICES Areas. International Council for the Exploration of the Sea (ICES)
5. OSPAR MPA Map Tool; http://carto.mpa.ospar.org/1/ospar.map

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