7.1 Greater North Sea ecoregion – Ecosystem Overview

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Key signals

Human activities and their pressures

- Fishing continues to be the main threat to ecosystem health. This is despite a decrease in fishing pressure in recent decades as can be observed from two of its main pressures, i.e. species extraction and physical seabed disturbance. A further reduction in fishing pressure is likely to improve the status of the majority of the ecosystem components.
- Shipping is responsible for the majority (53%) of the introductions of non-indigenous-species, mainly through ballast water and hull fouling, and has clearly increased over the past two decades. Aquaculture is the next important activity, responsible for a further 18% of introductions. Effects of this pressure may include: the out-competing native species, the fouling of aquaculture and fishing gear, and fish kills through toxin production.
- Energy production activities such as oil and gas extraction industries are still among the main activities impacting the ecosystem through pressures like contaminants and physical habitat loss. Pressures from oil and gas industries are expected to decrease, while pressures caused by offshore windfarms are expected to increase with the ongoing energy transition.

State of the ecosystem

- Fishing-induced physical disturbance is estimated to have resulted in an overall decrease of invertebrate benthic biomass of approximately 20% in the ecoregion compared to an unfished state. This impact is patchy and may be as high as 90% in the most heavily fished areas.
- The stock sizes of most groups of commercial species are now overall above levels that can provide the maximum sustainable yield (MSY); however, some individual species within these groups may still be below MSY levels.
- Seabird abundance appears to be declining; reasons for this may include changes in migration patterns as well as reductions in breeding success and lower survival.
- The numbers of two main seal species in the ecoregion – grey seal (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*) – have increased from an all-time low in the 1970s, with large population changes over the past decades caused by two major outbreaks of the phocine distemper virus. Trends in the abundance of cetaceans are less known.

Climate change

- Climate change is causing warming of surface water temperature. This has already changed spatial distribution of several plankton and fish species within the ecoregion and is likely to continue. Further cascading effects are likely to occur throughout the ecosystem with consequences on the spatial distribution of fisheries. Marine spatial planning should therefore consider this when planning infrastructure such as wind farms or implementing marine protected areas.

Environmental and socio-economic context

- Eutrophication was impacting the ecoregion in previous decades, peaking in the 1980s; however, the introduction of measures to reduce riverine input of nutrients since then has reduced this pressure to the point of no major concern.

- The current trend of increased fuel prices and resulting decrease of fishing with bottom-towed gears is likely to result in a further reduction of the extraction of demersal fish and disturbance of seabed habitats. If this also results in a shift toward less fuel-intensive fisheries, such as gillnets, than this is likely to result in increased bycatch risk of seabirds and marine mammals including longer-term effects from lost and abandoned fishing gear.
- In targeting specific fisheries with additional management interventions it is worth considering that small-scale coastal fisheries contribute 10% of value landed but have regional importance in terms of employment (18% FTE) and revenue (11%).

Ecoregion description

The Greater North Sea ecoregion covers the northern European continental shelf, from Brittany (France) in the south, the Danish straits in the east, and Vestland (Norway) and the Orkney and Shetlands archipelagos (Scotland) in the north. It is a temperate semi-enclosed coastal shelf sea connected to the Norwegian Sea and Celtic Seas ecoregion in the north, the Bay of Biscay and Iberian Coast ecoregion in the south and the Baltic Sea ecoregion in the east. Its oceanography is characterized by a permanently thermally mixed water column in the south and east and seasonal stratification in the north as well as exchanges with the adjacent Atlantic and Baltic waters.

The ecoregion consists of four key areas:

- The **northern North Sea** (depths 0–500 m), strongly influenced by Atlantic oceanic inflow and has the deep Norwegian trench in the east. The majority of the area is stratified in summer. The dominant human activities are fishing and oil and gas production.
- The **southern North Sea** (depths 0–50 m), characterized by large river inputs, tidal currents, and shallow waters, which result in a strongly mixed water column all year round. The dominant human activities are fishing, shipping, ports, gas production, wind farms, and aggregate (sand) extraction.
- The **Skagerrak** and **Kattegat** form the link to the Baltic Sea and are less saline and less tidal than the rest of the ecoregion. The water column is predominatly stratified. The dominant human activities are fishing, shipping, and wind farms.
- The **English Channel** joins the southern North Sea to the Atlantic. It is usually mixed and strongly influenced by wind and tidal events. The dominant human activities are fishing, shipping, and aggregate (gravel) extraction.

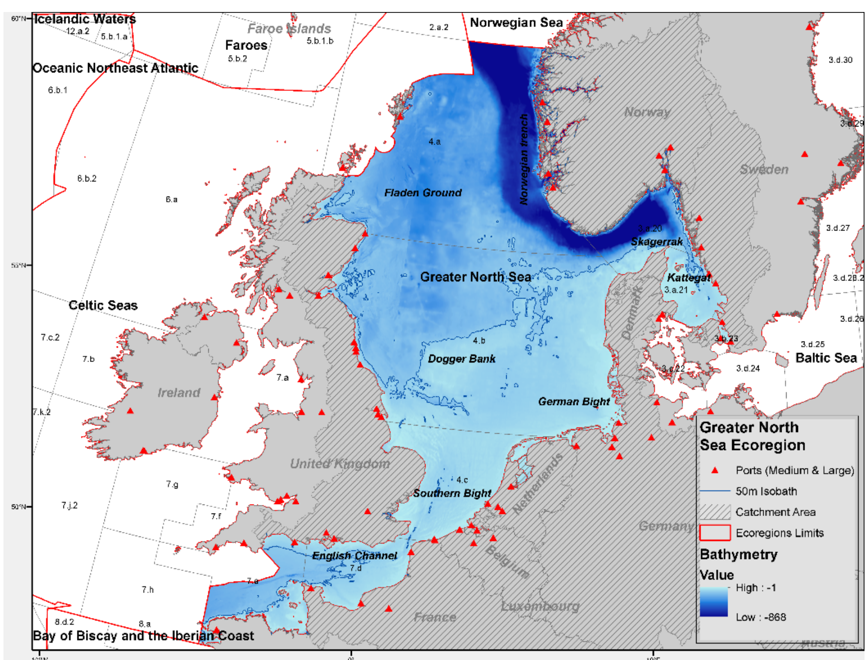

Figure 1 The Greater North Sea ecoregion, showing countries, catchment area, bathymetry (50 m isobath), neighbouring ecoregions (black text, red lines), medium and large ports (red triangles, source: ESRI), and ICES areas (dashed grey lines).

Management

The Greater North Sea ecoregion includes all or parts of the Exclusive Economic Zones (EEZ) of six EU Member States (MS; France, Belgium, the Netherlands, Germany, Denmark, and Sweden), as well as Norway and United Kingdom (UK). The ecoregion strongly overlaps with the North Sea Advisory Council (NSAC) administrative region, OSPAR Region II and large marine ecosystem (LME) 22.

The key policies for conservation in the EU are: the Birds and Habitats Directives (including the Natura 2000 ecological network), the Marine Strategy Framework Directive (MSFD), and the Biodiversity Strategy 2030. Norway and UK have similar national regulations, such as the Norwegian Integrated Management of the Marine Environment of the North Sea and Skagerrak or the UK Marine Strategy. Marine mammal issues are considered in cooperation under the North Atlantic Marine Mammal Commission (NAMMCO).

Key policies that regulate human activities in the EU are: the Integrated Maritime Policy, the Maritime Spatial Planning Directive (MSP), and the Blue Growth Strategy. International shipping is managed under the International Maritime Organization (IMO; through, for example, the International Convention for the Prevention of Pollution from Ships [MARPOL], the International Convention on the Control of Harmful Anti-fouling Systems on Ships [AFS], and the International Convention for the Control and Management of Ships' Ballast Water and Sediments). Oil and gas related activities are managed at national level (in accordance with the OSPAR Convention and the Bonn Agrement).

Fisheries management in the ecoregion are partly affected through coastal state agreements between the EU, Norway, and UK, which covers most commercial demersal fish, small pelagic fish, and Norway lobster (*Nephrops norvegicus*) fisheries. The majority of shellfish fisheries (i.e. all except Norway lobster) are determined as national responsibilities. Managerial responsibility for salmon is taken under the North Atlantic Salmon Conservation Organization (NASCO) and for large pelagic fish by the International Commission for the Conservation of Atlantic Tunas (ICCAT). Fisheries policy is determined by national governments (UK and Norway) and the EU Common Fisheries Policy. Collective fisheries advice is provided by the International Council for the Exploration of the Sea (ICES), the European Commission's Scientific Technical and Economic Committee for Fisheries (STECF), and the North Sea (NSAC), and the Pelagic Advisory Councils. Environmental policy is managed by national governments and agencies and OSPAR, with advice being provided by national agencies, OSPAR, the European Environment Agency (EEA), and ICES.

Pressures

ICES has evaluated 17 human activities and 17 pressures relevant to the Greater North Sea ecoregion. The five most important pressures are described below. These pressures are linked mainly to the following human activities: fishing, maritime transport (shipping), wastewater (sewage), oil and gas exploration and production, and agriculture. The main pressures identified below are described in the ICES ecosystem overviews Technical Guidelines.

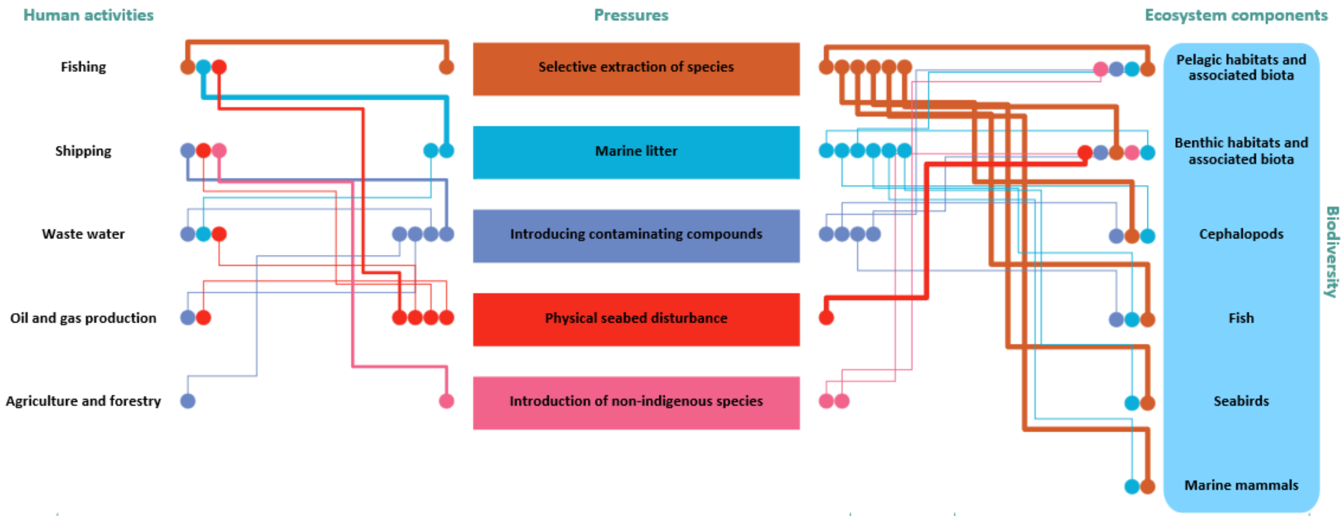

Figure 2 Greater North Sea ecoregion overview with the major regional pressures, human activities, and ecosystem state components. The width of the lines indicates the relative importance of the main individual links. Each human activity and pressure is listed in decreasing order of its relative contribution to the total risk score. The absence of a line does not necessarily imply a total absence of any link; only the main links are shown. Climate change affects human activities, the intensity of the pressures, some aspects of state, and the links between these. For methodology and definitions, see ICES ecosystem overviews Technical Guidelines.

Selective extraction of species

The main contributing activity to selective extraction of species in the Greater North Sea is commercial fisheries, which peaked at 4 million tonnes in the 1970s but have since declined to about 2 million tonnes. In addition, recreational fisheries can be expected to significantly contribute to the pressure for at least some species. There has been a significant decline in the overall fishing effort in the ecoregion resulting in lower catches of both commercial (Figure 3) and non-target species. The categories of landings of commercial species can be assumed to represent to some degree the magnitude of the pressure on different non-target ecosystem components. For example pelagics represent the risk from the pressure on marine mammals, while the demersal and specifically the benthic categories are indicative of the risk to the benthic habitats and associated biota. There have been shifts in fishing techniques towards gear types that require less fuel (e.g. pulse trawl, sum-wing, twin-rigging, and flyshooting) but also differ in terms of their catchabilities of both commercial species and bycatch of non-target species. Sustainable fisheries management aims to minimize long-term negative effects on ecosystem components (notably the commercial species) while seeking long-term economic and social viability of the fisheries. The impact of the EU/UK landing obligation on fishing behaviour, data gathering, and stock assessments remains under review.

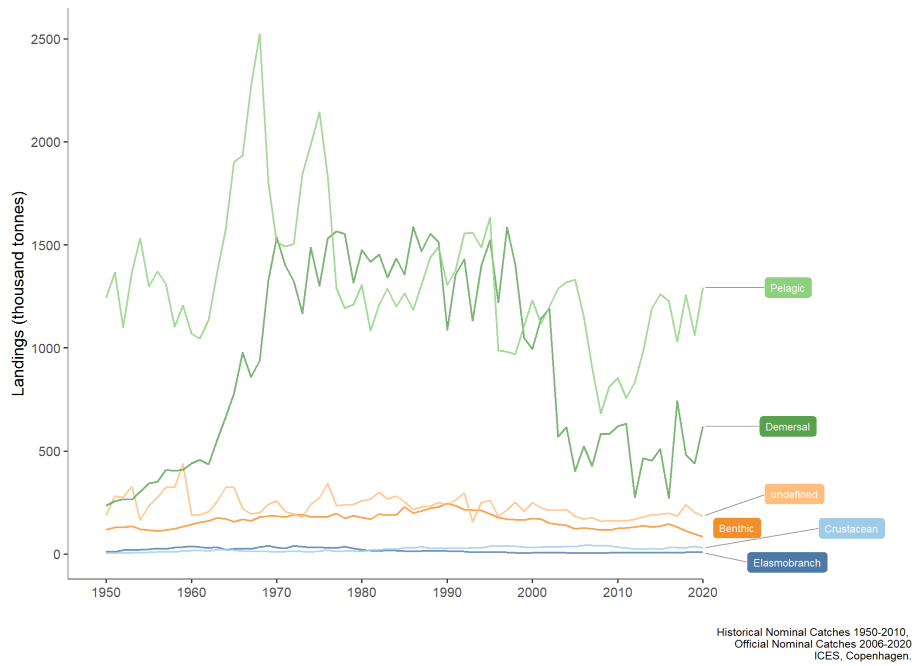

Figure 3 Landings (thousand tonnes) from the Greater North Sea in 1950–2020, by fish category.

Effects on commercial stocks

Most North Sea fish stocks for which ICES undertakes an assessment are now fished at rates at or below F_{MSY}. Average fishing mortality (F) for shellfish (Norway lobster), demersal, and pelagic fish stocks has been reduced since the late 1990s (Figure 4). Even if the average fishing mortality is at or below MSY, there may still be several stocks with fishing mortality rates above F_{MSY} such as cod (*Gadus morhua*), saithe (*Pollachius virens*), mackerel (*Scomber scombrus)*, blue whiting (*Micromesistius poutassou),* and sole (*Solea solea)* in the English Channel, as well as some Norway lobster stocks. There are also fisheries on forage fish in the North Sea such as sandeel (Ammodytidae), sprat (*Sprattus sprattus)*, Norway pout (*Trisopterus esmarkii)*, and herring (*Clupea harengus*). These are primarily for fish meal and oil (except for herring, where most of the catch is for human consumption). Notably, the demersal fisheries in the ecoregion take bycatches of other commercial species even when targeting a particular species. Detailed information on fisheries is provided in ICES Greater North Sea ecoregion Fisheries Overview.

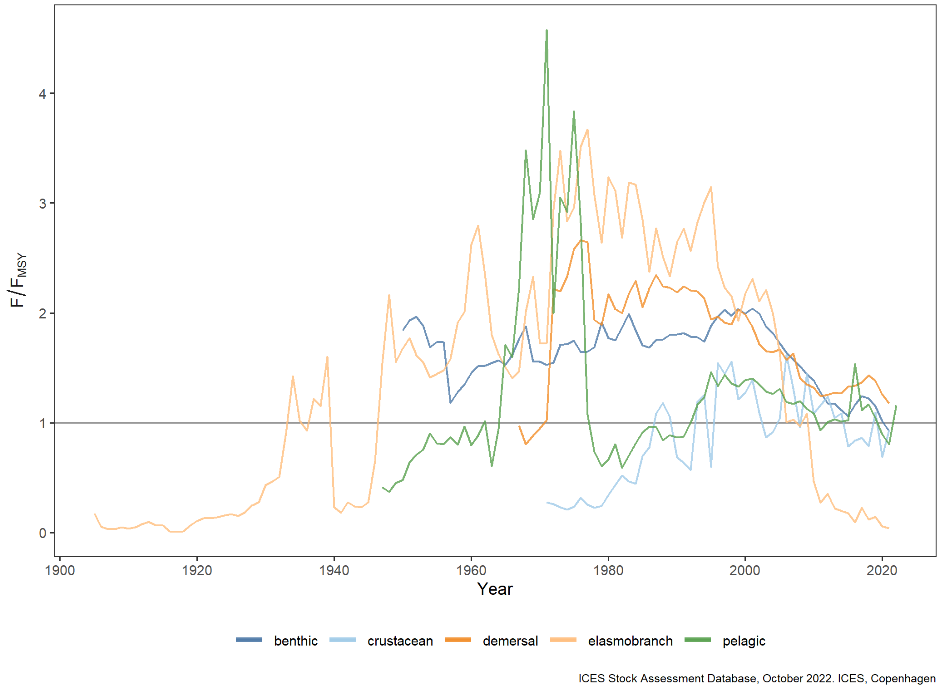

Figure 4 Time-series of annual relative fishing mortality (F to FMSY ratio) by fisheries guild for benthic, demersal, crustaceans, pelagic stocks.

European eel migrates throughout the Greater North Sea ecoregion as a larval recruit and maturing adult, and its status remains critical. ICES has advised in 2022 that there should be zero eel catches of in all habitats. This includes catches in both recreational and commercial fisheries and catches of glass eels for restocking and aquaculture. In addition, all non-fisheries related anthropogenic mortalities of eel should be zero, and the quantity and quality of eel habitats should be restored.

Effects on non-target species

Fishing is known to extract many other species not specifically targeted including those of fish, cephalopods, benthic invertebrates, seabirds and marine mammals. Incidental bycatches of protected, endangered, and threatened species (PETS) occur in several North Sea fisheries. A list is available for the ecoregion of species of bycatch relevance (fish, marine mammals and seabirds; annexes 1 and 2 in ICES [2022c]). The fish species are mainly bycatch in demersal fisheries and may include several elasmobranchs such as spurdog (*Squallus acanthias*), the common skate complex (*Dipturus* spp.), angel shark (*Squatina squatina*), porbeagle (*Lamna nasus*), and some deep-water sharks. In 2021, most of the fish records were for tub gurnard (*Chelidonichthys lucerna*) in bottom trawls.

Bycatch in fisheries is probably the human activity that has the greatest effect on the population abundance of marine mammals in the ecoregion. The highest multiannual bycatch rates during 2017–2021 were recorded for common dolphin (*Delphinus delphis*) in purse seines and harbour porpoise (*Phocoena phocoena*) in set gillnets. Bycatch of seabirds in the ecoregion occurs but is not believed to be a large pressure on seabird populations. The highest seabird multiannual bycatch rate during 2017–2021 was recorded for northern fulmar (*Fulmarus glacialis*) in set longlines. For further bycatch information see the Greater North Sea ecoregion Fisheries Overview.

Discarding by commercial fisheries

Discarding as a fisheries-related practice linked to the extraction of species, is predominantly associated with other pressures such as 'Nutrient and organic enrichment' and 'physical seabed disturbance' (through smothering), potentially affecting several ecosystem components (e.g. known to attract seabirds) and foodweb functioning. In 2016–2020, discard rates were highest in the demersal (10–20%) and benthic (20–30%) fisheries, while discard rates of pelagic species were close to zero.

Recreational fishing

Recreational fishing is an increasingly important activity in parts of the ecoregion, with a diverse range of species exploited from a variety of platforms (e.g. shore and boat) using many gears (e.g. rod and line, speargun, nets, pots, and traps), along with hand collecting/harvesting from the shoreline. The relative contribution of recreational fishing is increasing as a proportion of the total catch of specific species in certain locations. Recreational fisheries in the ecoregion target a wide range of species, but few of these fisheries are monitored or evaluated. Recreational catches of sea bass (*Dicentrarchus labrax*) and salmon (*Salmo salar*; including freshwater catches) are significant and are included in ICES assessments of these species. A comparison of the recreational catches to the commercial catches of sea bass in the ecoregion and beyond (i.e. ICES divisions 4.b–c, 7.a, and 7.d–h) based on information from the main countries, estimates that the total retained catches by recreational fisheries of 2192 tonnes exceed those by the commercial fleet (1869 tonnes).

Marine litter

Occurrence

Depending on the material type, marine litter can float on the sea surface, wash up on the beach, circulate in the water column, settle on the seabed, or be buried in the sediment.

Seabed litter is widespread in the Greater North Sea with plastic being the most dominant material. The overall probability of occurrence of seabed litter in standardized survey samples is 69%, and this has been increasing in recent years. The most common litter items are plastic sheets (occurrence probability 32%), synthetic ropes (26%), monofilament fishing line (24%), and plastic bags (15%).

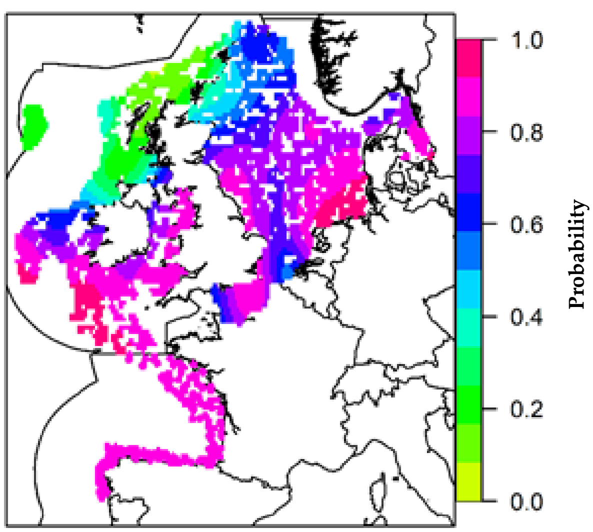

Figure 5 Probability of occurence of litter in seabed survey samples in the Greater North Sea ecoregion and adjacent areas.

Plastic and polystyrene pieces, nets and ropes, and plastic caps and lids dominate beach litter with over 70% of the total items found. The highest amounts of litter by weight were found in the Skagerrak region. Across the ecoregion there are more instances of beaches with decreasing trends in marine litter compared to those with increasing trends.

Effects

The effects of marine litter, especially micro- and nanoplastics, on marine organisms in the ecoregion are currently poorly known and are under investigation. One of the best pieces of evidence of the potential effects originates from the stomach analyses of stranded fulmars in the North Sea. This indicated that of all birds analysed, 93% had some ingested plastic, with average values per bird at 33 particles and 0.31 g. Ingestion of plastic litter is recognized as a potential threat contributing to the status of fulmar populations, given that it is probable that reduced body condition and health affect a significant proportion of individuals in the population.

Monitoring of stranded seabirds on North Sea coasts shows that seabirds such as gannets (*Morus bassanus*) can become entangled in litter. The species remains the one most frequently found entangled among all beached birds in the Dutch and German part of the southern North Sea. Marine mammals also regularly come into contact with litter, however porpoises and seals are observed to ingest small amouts of plastic.

Abandoned, lost, or otherwise discarded fishing gear (ALDFG) represents an unsolved and "silent" problem. Such gear may continuously catch fish, birds, and marine mammals. The significance of the impact of ALDFG in the ecoregion still has to be evaluated.

Introduction of contaminating compounds

Contamination in the Greater North Sea is mainly derived from shipping (including inputs as a result of fishing effort), industrial and urban inputs (wastewater and inputs from rivers and the atmosphere), agricultural run-off, oil and gas extraction, and renewable energy installations.

There are many sectors that introduce various synthetic and non-synthetic compounds into the marine environment. As many of the contaminating compounds are (sometimes extremely) persistent, nearly all habitats and ecological components are affected (Figure 2). Inputs of many contaminant sources are regulated, monitored, and managed within the ecoregion. Overall contamination in the North Sea is showing some downward trends, and the concentrations are typically below adverse effect levels. Recent monitoring trends show increases in metals (cadmium, mercury, and lead) in some parts of the southern North Sea, decreases in polycyclic aromatic hydrocarbon (PAHs), and polychlorinated biphenyls (PCBs) in the northern North Sea, and decreases in polybrominated biphenyl ethers (PBDEs) for both subregions. However, contaminants remain high-risk both due to the numerous sources and the broader range of chemicals entering use for which there is limited understanding on the fate, behaviour, and ecotoxicological effects, especially in mixtures. Such contaminants of emerging concern (CECs) are currently not included in routine monitoring programmes.

Ships give rise to a range of different liquid and gaseous waste streams, which often consist of complex chemical mixtures. Bilge water originates from ship machinery spaces and contains oily residues from fuel oil and lubricants, detergents, and metals from wear and tear. International regulations limit the oil content of treated bilge water to maximum 15 ppm, but treated bilge water has been reported to contain metals (vanadium, manganese, nickel, copper, and zinc) and PAHs, which are not regulated. Although all ships produce bilge water, the total load of contaminants is small compared to metal and PAH loads from exhaust gas cleaning systems, also known as scrubbers. The use of scrubbers has increased as a response to the stricter regulations limiting the maximum allowed sulphur content in marine fuels. Inside sulphur emission control areas (SECA), most ships use very low sulphur fuel oil (VLSFO) or ultra low sulfur fuel oil (ULSFO), which are a mix of a residual fraction and a distilled fraction to meet maximum 0.5%(w/w) sulphur in the fuel. These two types of oil behave differently, as they are less buoyant and so tend to sink and then resurface. For all types of fuel, there is a knowledge gap with respect to deposition of contaminants on the sea surface, although it is known that ship plumes cause deposition of metals such as iron and vanadium. In addition to liquid waste streams and atmospheric deposition of contaminants from ships, the single most important ship-borne source of copper, and to a lesser extent zinc, is antifouling paint.

There are also contaminant inputs of wastewater into the marine environment arising from industrial and urban inputs as well as agricultural run-off from rivers. While inputs are mostly regulated, the persistent nature of many of these contaminants represents an additional risk factor. Other noted contaminant inputs are related to oil and gas extraction and to renewable energy (e.g. wind farm) installations; for example, considerable amounts of trace metals are emitted through the corrosion protection measures (galvanic anodes) used in installations such as wind farms. Among these are also ecotoxicologically critical metals such as cadmium, lead, and zinc. The main component of galvanic anodes is an aluminium alloy, which contains a large proportion of aluminium (about 95%), as well as zinc (about 5%) and other trace metals: copper, iron, indium, and cadmium (< 1%).

Effects

Acute and chronic effects include toxicity to marine organisms and foodwebs (including humans). Additionally, bioaccumulation in higher trophic levels and the interacting effects of multiple contaminants remain difficult to assess. For example, marine mammals may experience immune or reproductive system effects through the bioaccumulation of contaminants (especially legacy compounds like chlorinated pesticides, chlorinated benzenes [CBs], brominated diphenyl ethers [BDEs], as well as CECs such as per- and polyfluoroalkyl substances [PFAs]) from their food sources.

Since the global ban on tributyltin (TBT) in ship antifouling systems since 2008, there has been a marked improvement in the levels of imposex in marine gastropods (whelks), with continued decreases noted in the North Sea.

There is evidence indicating either stable or declining trends of several biomarkers of contaminants observed in the common dab (*Limanda limanda*) sampled in the ecoregion (Marine online assessment tool, 2022).

Physical seabed disturbance

Physical disturbance of benthic habitats by mobile bottom-trawl fishing gear in the > 12 m vessel category is evaluated using vessel monitoring system (VMS) and logbook data and provides information on the extent of the pressure, its magnitude, and potential impact on the seabed habitats and associated benthic communities. Results show that this pressure varies geographically across the ecoregion. ICES estimates that commercial fisheries have been deployed over approximately 569 000 km^2 of the ecoregion in the period 2018–2021, corresponding to ca.85% of the ecoregion's spatial extent (Figure 6).

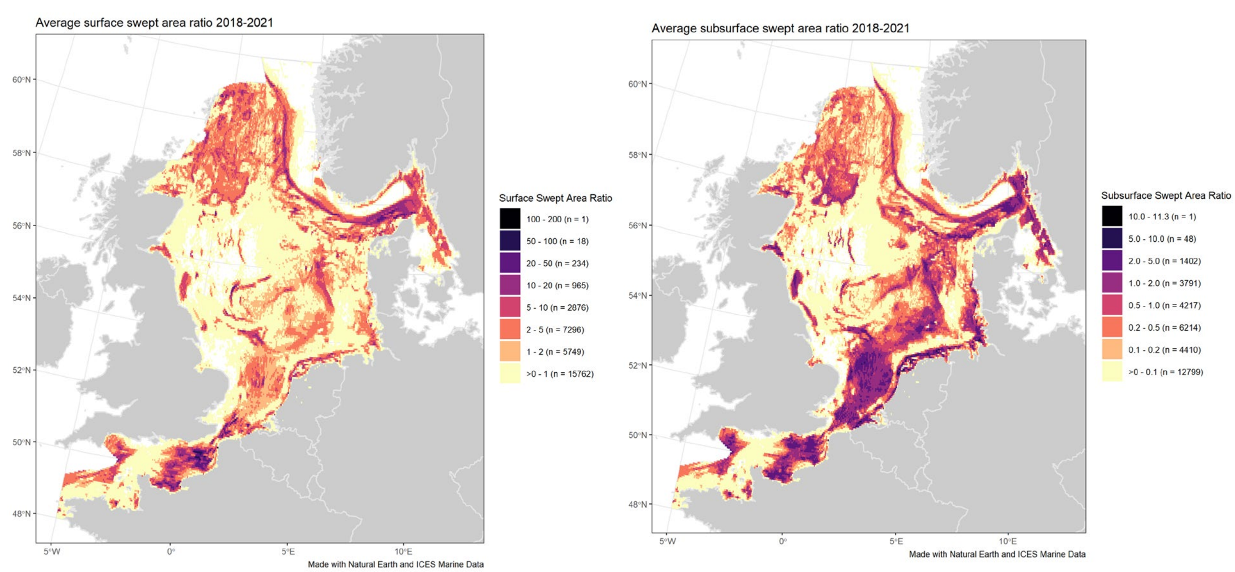

Figure 6 Average annual surface (left) and subsurface (right) disturbance by mobile bottom-contacting fishing gear (bottom otter trawls, bottom seines, dredges, beam trawls) in the Greater North Sea during 2018–2021 (with available data), expressed as average swept area ratios (SAR).

Other activities contributing to this pressure are navigational and capital dredging and disposal operations, which have not changed recently. The total annual amounts disposed at sea have varied between 80 and 130 million tonnes (dry weight) in the OSPAR area. However, much of this is associated with port expansion, sea defences, and the deepening of navigation channels, of which about 90% of disposed sediments in the OSPAR area is associated with dredging operations in the ecoregion. This is largely from maintaining navigation channels to major seaports such as Hull, Felixstowe, Southampton, Antwerp, Rotterdam, Hamburg, and Esbjerg. Ship traffic and vessel size are predicted to increase, which will, in turn, increase the need to maintain (and possibly deepen) navigation channels.

Physical loss

Extensive lengths of coastline in the North Sea are protected against erosion by coastal defence structures. The almost unbroken line of coastal defence schemes protecting the coast of the southern North Sea has caused extensive fragmentation and loss of habitats. Since 1998, OSPAR countries have reported on the *reclamation* of around 145 hectares from the sea and coastal wetlands, with the majority of this activity occurring in the ecoregion. The largest land reclamation in Europe, Maasvlakte 2, is in Rotterdam port. However, both UK and Dutch authorities are also allowing coastal realignment (managed retreat) in the southern North Sea as part of flood defences, creating more coastal wetlands. One scheme alone in England has re-flooded some 600 hectares.

Many permanent or semi-permanent structures have been placed offshore in the ecoregion, most associated with oil and gas production. Offshore wind farm development has started in the last decade with greater developments planned for areas further offshore. Cable laying activities have increased (and are projected to continue to increase) in proportion to current plans for offshore wind farm development.

Non-indigenous species

This ecoregion has 470 non-indigenous (NIS) and cryptogenic (obscure or of unknown origin) species recorded between 1950 and 2022. The annual discovery rate has steadily increased since the early 1990s (Figure 7).

The main vector for primary introductions is shipping, mostly through ballast water and hull fouling, accounting for 53% of NIS introductions. Transport of NIS as contaminants and parasites on animals (primarily associated with aquaculture) is responsible for 18% of introductions while for 12% of cases the introduction pathway remains unknown.

While the importance of ballast water in new NIS detections has increased over time, that of ship fouling and aquaculture (contaminants/parasites) has been more variable during the past two decades without a clear trend (potentially confounded by uneven search effort). Importantly, the rate of detection of new NIS with unknown pathways is higher during the past decade than before (Figure 8).

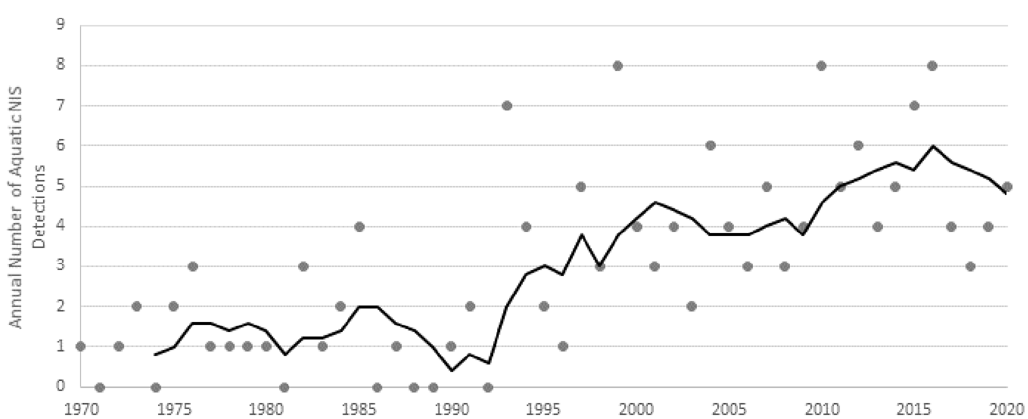

Figure 7 Chronology of detections of new non-indigenous species (NIS, primary introductions) in the Greater North Sea ecoregion during 1970–2020. Annual detections shown as grey dots, with a five-year moving average as the trendline.

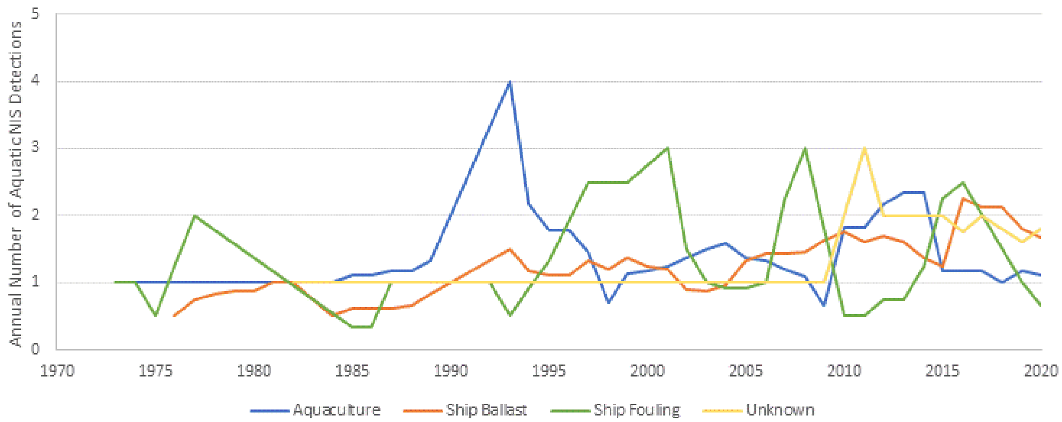

Figure 8. Chronology of detections of new non-indigenous species (NIS, primary introductions) in the Greater North Sea ecoregion during 1970–2020, by pathway: aquaculture (n = 35), ship ballast (39), ship fouling (32), and unknown (23). NIS associated with more than one pathway are tallied using a weighted approach. Trendlines show five-year moving averages. Pathway data includes 216 NIS (no cryptogenic species) only until 2020, and do not include UK records.

The observed ecological impacts include significant reductions in the abundance of several important native species and changes to the physical and chemical composition of both sediments and the water column. Additional effects include out-competition of native commercial species, fouling of aquaculture and fishing gear, and fish kills through toxin production. Some of the examples include the ctenophore *Mnemiopsis leidyi*, an apex predator, which has been shown to induce community cascade effects in the pelagic foodweb in a fjord in the Skagerrak area. This was evidenced by a five-fold reduction in their target prey, grazing copepods, and doubled biomass of primary producers released from the grazing pressure.

Climate change effects

Since the early 1980s, the annual mean North Sea sea-surface temperature (SST) has increased by more than 1 degree and has been above the long-term mean for 24 out of 30 years between 1990 and 2019 (Figure 9).

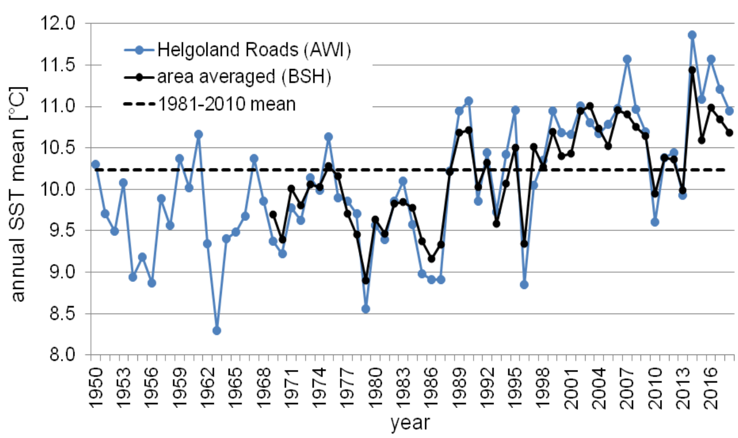

Figure 9 Annual mean of area-averaged North Sea sea-surface temperature (SST). AWI: Alfred Wegener Institute; BSH: Bundesamt für Seeschifffahrt und Hydrographie.

Coinciding with the observed abrupt changes in temperature conditions, both dinoflagellate and copepod abundances have exhibited pronounced alterations in both monthly and annual scales, with notably lower abundances observed generally since the late 1990s and the 1980s, respectively (Figure 10). For details on these changes and associated relations/implications, please see section on pelagic habitat and associated biota.

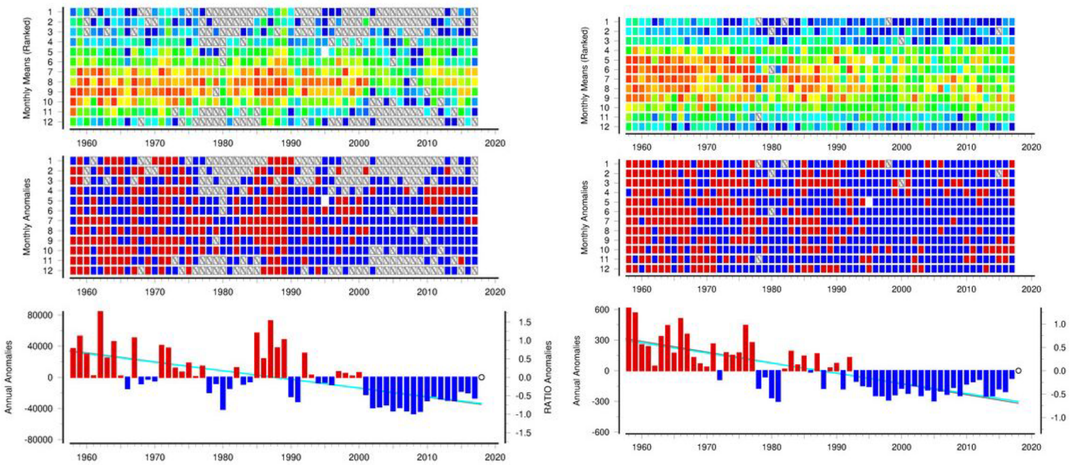

Figure 10 MBA/CPR Survey standard area C2 (western central North Sea). Left panels: total Dinoflagellates (numbers/m^3); Right panels: total copepods (numbers /m^3). Upper panels: matrix of monthly mean (total copepod) abundances over time. Middle panels: monthly anomalies. Bottom panels: annual anomalies. The decreasing trend in total copepods is driven by the portion of “small copepods”.

In addition to shifts in the size composition and distributions of zooplankton, shifts in zooplankton spring phenology are also occurring in response to higher temperatures. For example, the seasonal cycle of some species occurs four to five weeks earlier in the year. Such shifts in phenology may lead to the uncoupling of trophic interactions.

The deepening of the North Sea demersal fish assemblage by around 3.6 m per decade was observed in response to the 1.6°C temperature increase during 1980–2004, and the deepening was coherent for most assemblages. However, the latitudinal response to warming was heterogeneous and reflects: (i) a northward shift in the mean latitude of abundant and widespread thermal specialists, and (ii) the southward shift of relatively small, abundant southerly species with limited occupancy and a northern range boundary in the North Sea.

Social and economic context

Fishing

Socio-economic interests related to fisheries (represented by effort, landings, and values) are widely distributed around the coasts of the Greater North Sea ecoregion (Figure 11). The fleet associated with specific ports varies in vessel size and time spent at sea, with busier ports indicated by larger circles (e.g. Peterhead, Hantsholm, Skagen, and Ijmuiden). Analyses of the fishing activity in the ecoregion indicate that most of the fish landed and fishing effort are associated with the countries bordering the ecoregion, with few landings associated with other countries, e.g. in Ireland, Faroe Islands, and Spain.

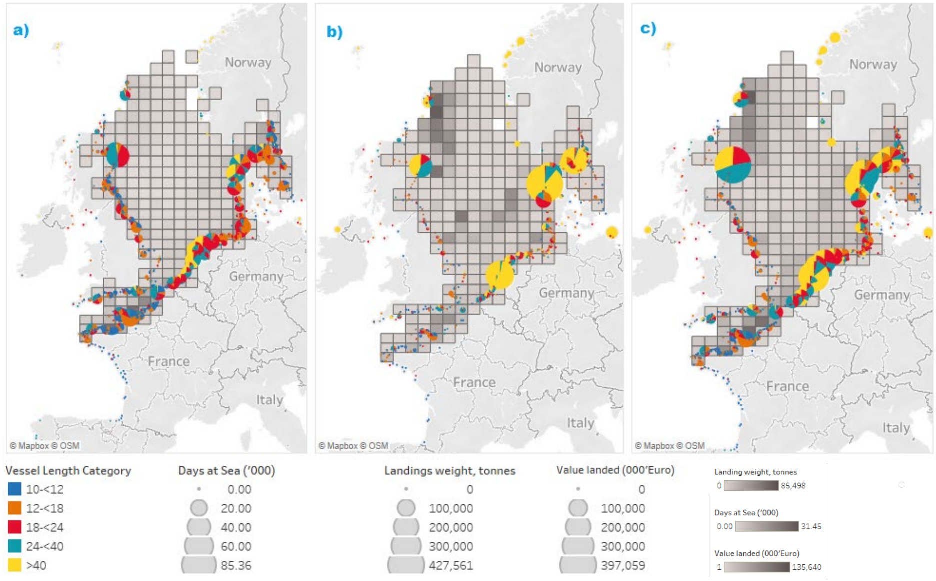

Figure 11 Fishing effort (panel a), landings by weight (b), and value landed (c) for each port with vessels operating in the Greater North Sea ecoregion, 2017–2019. The size of circles indicates magnitude; colours indicate the vessel length category. Small-scale fisheries (vessels < 10 m) are not included due to a lack of data. Note: Norwegian data are missing. Data source: [ICES RDB](#)

The fleet in the region consists of mainly (59%) small-scale vessels. These account for around 39% of the days at sea, provide job for around 18% of full-time equivalent (FTE) employees that produce 10% of value landed, and generate 11% of value added. The rest of the fleet is represented by larger scale vessels and a distant fleet. The distant fleet represents a small proportion of vessels that contribute to 5% of total days at sea and employs 12% of FTE employees that generate 31% of value landed in the region.

Over the period 2012–2019, fishing effort in days at sea from EU Member States and UK (i.e. excluding Norway), declined by 11%, reaching around 560 000 days at sea in 2019. The highest fishing effort was reported by UK, followed by France, Denmark, Netherlands, Sweden, Germany, and Belgium.

The weight of EU Member States and UK fishing fleet landings in 2017–2019 was about 1.6 million tonnes, while the value was about EUR 2 billion, representing 26% of the total revenue for both fleets. The fleets operating in this ecoregion contributed EUR 1083 million gross value to coastal nation economies and produced EUR 477 million gross profit in 2019, a decrease of 10% in gross value added and 16% in gross profits compared to 2018.

The ecoregion provided jobs for around 15 000 fishermen in 2017–2019, or around 10 000 FTE jobs.

Specific socio-economic drivers

The COVID-19 pandemic impacted fisheries in the ecoregion. The governments of coastal states enforced lockdowns, fishers were prevented from going to sea, and processing factories, hotels, restaurants and catering were all negatively affected.

Since 01 January 2021, UK has been an independent coastal state (i.e. Brexit), with full responsibility over its EEZ, which constitutes a significant proportion of the ecoregion. The current challenge in the ecoregion is to ensure the sustainable management of more than 100 fish stocks with respect to the *relative stability* agreement in allocations between the EU, Norway and now UK following Brexit, through cooperation. For 2021 this resulted in collective overfishing above scientific advice by northeast Atlantic countries in the ecoregion for species such as mackerel, herring, and blue whiting.

Since the winter of 2022, disruption to the energy markets has resulted in increased fuel prices that have, in turn, directly impacted the operating costs of fishing with bottom-towed gears, the most fuel-intensive fisheries. In the ecoregion, some countries operate mainly towed gears (e.g. Germany, the Netherlands, Belgium, and Denmark), while others operate mainly passive gears (Sweden, UK, and France).

State of the ecosystem

Oceanographic conditions and circulation

Variations in the bathymetry and strength of tidal currents are responsible for the substantial subregional differences observed in seasonal temperature stratification within the ecoregion. Greater North Sea oceanographic conditions are largely determined by the inflow of saline and nutrient-rich Atlantic Water (Figure 12) and the tightly coupled ocean–atmosphere heat exchange.

There is a pronounced annual cycle in the temperature of the near-surface water layer, which reaches a maximum of about 16°C in summer (averaged over the North Sea area) and a minimum of about 6°C in late winter. Climatological large-scale distributions of the near-surface temperature reveal a northwest-southeast gradient over the winter months, with higher temperatures in the northwestern North Sea and lower temperatures at the German and Danish coasts in the southeast. Summer distributions show a reversed pattern with the highest temperatures in the English Channel and the German Bight and the lowest temperatures near Scotland.

The circulation (Figure 12) is influenced by the bottom topography and the import of saline water from the Atlantic Ocean, low salinity water from the Baltic Sea and freshwater from rivers. The latter is especially prominent in the English Channel, the southern North Sea, and the German Bight. The Atlantic water mixes with river run-off and Baltic outflow along the Norwegian coast creating the Norwegian coastal current. Atlantic water inflow through the northern entrances and, to a lesser degree, through the English Channel can be strongly influenced by the North Atlantic Oscillation (NAO).

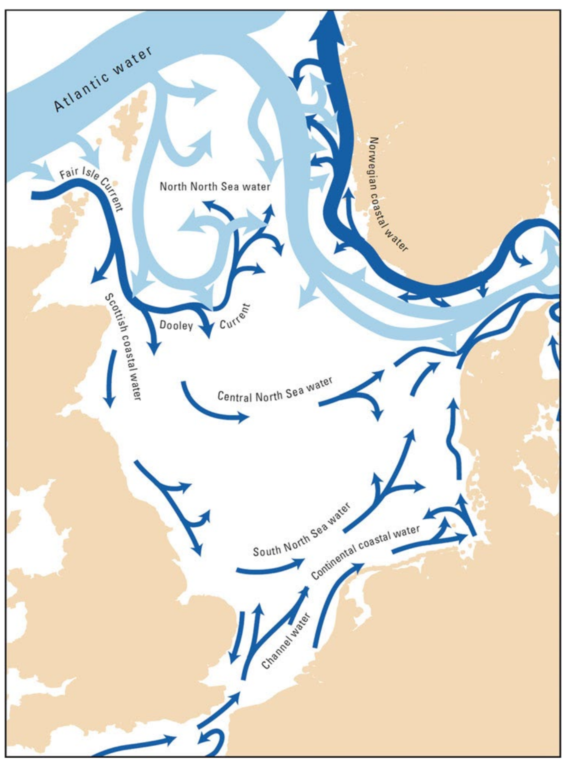

Figure 12 Circulation system of the North Sea.

Further details on time-series at key monitoring sites can be assessed in ICES Report on Ocean Climate and its online data portal.

Pelagic habitat and associated biota

Phytoplankton

Temporal dynamics of phytoplankton biomass and chlorophyll *a* concentration exhibit variable and often contrasting patterns in different spatial scales during the past several decades. At least two major trends are currently affecting phytoplankton dynamics in the North Sea: warming and the decline in eutrophication as a result of measures to reduce riverine nutrient inputs that started in the 1980s. Both these trends affect primary production through altered water column stratification and the corresponding effects on the physiology of phytoplankton species.

Primary production is generally highest in the coastal regions due to nutrient inputs from the rivers and turbulent mixing in the water column. Net primary productivity has generally been lower and below average since 2015 compared to the previous years but has been gradually increasing since 2018 (Figure 13).

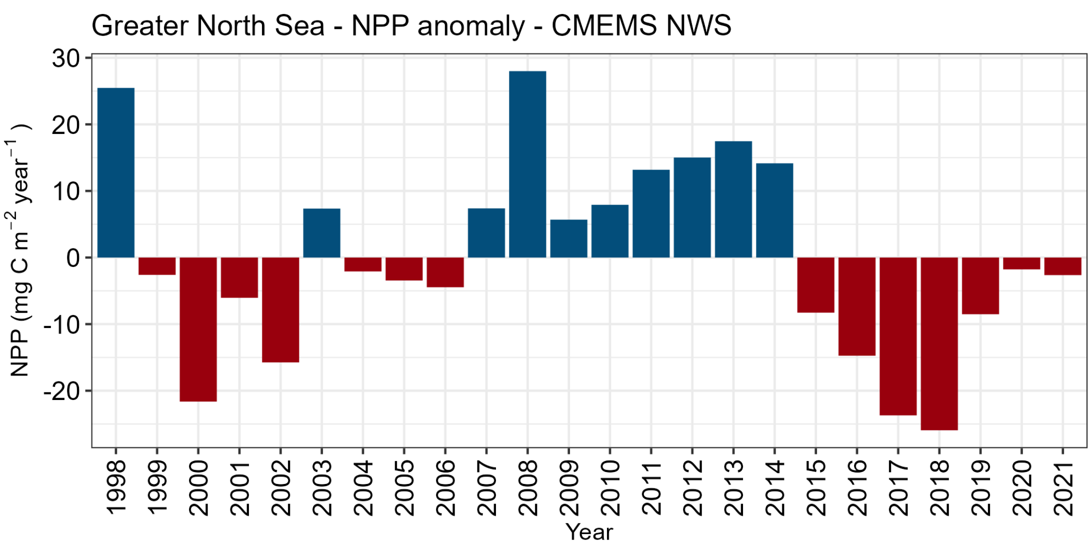

Figure 13 Net primary productivity (NPP; mg C per m^{-2} $year^{-1}$) anomaly plot for the Greater North Sea ecoregion, illustrating variation from the mean of the entire 24-year time-series (1998–2021). Data provides depth integrated estimates of NPP from the surface to the euphotic zone.

Continuous plankton recorder (CPR) and coastal station records have shown a decreasing trend in dinoflagellate abundance over time, whereas the total abundance of diatoms has remained unchanged. This has resulted in the dominance of diatoms. Among the dinoflagellate species, *Tripos furca, Protoperidinium* spp., and to a lesser extent *Prorocentrum* spp., have shown a substantial reduction in summer since the beginning of the 2000s.

Zooplankton

Based on the CPR data, zooplankton communities in the northern North Sea are generally composed of offshore cold water species (such as *Calanus finmarchicus* and *Metridia lucens*) owing to the stratification of the water column during the summer months. The zooplankton community of the southern North Sea primarily consists of neritic and coastal species (the copepods *Centropages hamatus* and *Calanus helgolandicus* and decapod larvae) which are adapted to the mixed warmer waters of this region.

There has been a clear trend for a poleward distributional shift in the northeast Atlantic zooplankton community, progressing at a rate of around 200–250 km per decade. The consequence of this shift has been to increase the diversity of calanoid copepods in the North Sea due to an influx of southern warmer-water species.

Species with warmer-water affinities, e.g. *C. helgolandicus*, continue to move northward in the ecoregion. However, *C. helgolandicus* never reaches high population densities and the species usually occurs later in the season. Population abundance of the previously dominant copepod *C. finmarchicus* has declined in biomass by 70% between 1960s-2010s. A redistribution of *C. finmarchicus* relative to *C. helgolandicus* will result in lower total zooplankton biomass available for higher trophic levels with consequences for the fisheries targeting them.

Small copepods have decreased by about 50% during the last three decades, particularly in the central and southern areas of the North Sea. The declining trend in small copepods has been attributed to a combination of earlier spring blooms and lower summer food quantity and quality, suggesting an overall bottom-up control of the foodweb structure in the North Sea. Also, the abundance of *Pseudocalanus/Paracalanus* spp. has decreased across the North Sea, the change being linked to the decrease in dinoflagellates.

Zooplankton size decreased and total abundance increased in the English Channel in winter during 1991–2013. Zooplankton abundance was influenced by temperature, chlorophyll *a* concentration, and North Atlantic Oscillation index, whereas zooplankton size was influenced by depth and Atlantic water inflow.

The observed changes in zooplankton composition and distribution might have a cascading effect on their predators and even the human activities targeting these predators. For example the decline in *C. finmarchicus* has been linked to the reduced survival of fish larvae (e.g. cod) and the growth of lesser sandeel in the North Sea. The northward shift in the distribution of *C. finmarchicus* may have caused a northward shift in the feeding migration of North Sea herring resulting in different spatial distributions of the pelagic fisheries effort targeting them.

The gelatinous macro- and megazooplankton community in the North Sea can be quite diverse, especially in terms of smaller-sized hydromedusae. Due to the very patchy spatial distribution, strong seasonal abundance signals and accumulation in shallow coastal areas, it is difficult to reliably assess their population size and role in the ecosystem. For the North Sea, the highest abundances are reached for the large sized scyphozoan jellyfish species *Cyanea capillata, C. lamarckii, Chrysaora hysoscella, Aurelia aurita*, and *Rhizostoma pulmo* as well as the hydrozoans *Aequorea vitrina, Aglantha digitale,* and *Tima bairdii* and the ctenophores *Pleurobrachia pileus, Beroe* sp., and *Bolinopsis infundibulum*.

Benthic habitat and associated biota

The benthic substrate of the Greater North Sea is predominantly characterized by soft sediments (from muds to gravel beds; Figure 14). The spatial distribution of habitats follows gradients with respect to depth and latitude. The relatively shallow southern North Sea (0–50 m) is subject to greater natural disturbance due to wave and tidal effects giving rise to relatively coarse seabed sediments, for example the Dogger Bank and parts of the Southern Bight. Further north, beyond the Dogger Bank, mud content increases, as observed in the Fladen Ground at depths of 100–150 m and in the Norwegian trench at depths of 400 m. Coarse gravel and rock habitat types are predominately located in the English Channel.

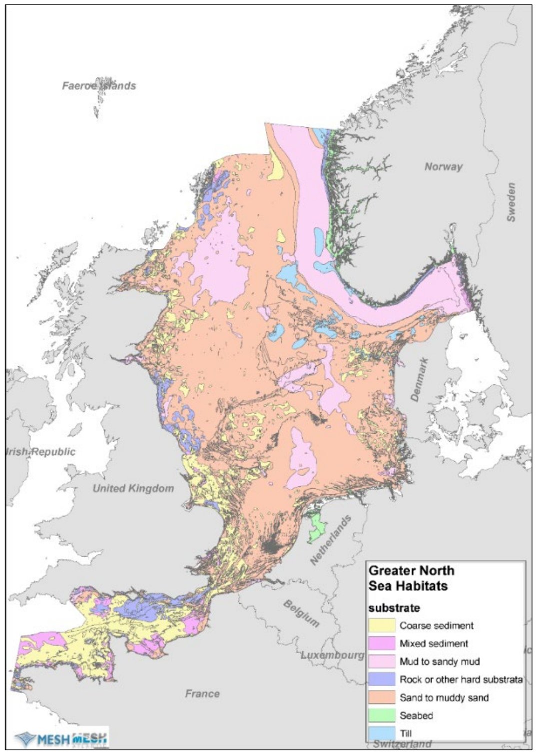

Figure 14 Major substrates on the shelf in the Greater North Sea (excluding Kattegat; as compiled by EMODNET seabed habitats; www.emodnet-seabedhabitats.eu).

The combination of depth, nearbed hydrodynamic conditions, and sediment types give rise to a large diversity of benthic communities within the ecoregion. Nearbed hydrodynamic stress is an important determinant of the species composition of benthic communities. High nearbed tidal forcing results in the transport of sands and fine gravel which act as natural stressors on the benthos, favouring benthic organisms that have specific traits adapted to such conditions (e.g. relatively short-lived and fast-growing species), whereas more hydrodynamically stable conditions with low levels of nearbed stress favour a greater diversity of life strategies. More locally, especially in the southern part of the North Sea, seabed geomorphological variations create localized habitats which can favour disturbance-resistant and long-lived species.

The impacts on seabed habitats and associated benthic community by bottom trawling in the ecoregion have been assessed by combining data on benthic species-specific longevity, local depth, sediment data, and bottom-trawling intensity to generate a map of potential benthic impacts (Figure 15).

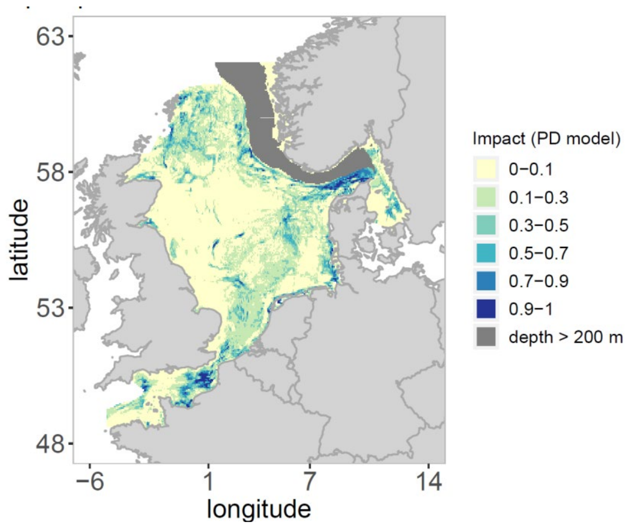

Figure 15 Impact of physical disturbance (abrasion by bottom trawling) on the benthic invertebrate community biomass. The highest impact is found in areas with high sensitivity and high abrasion. Low impact means low abrasion, low sensitivity or both.

Fishing-induced physical disturbance is estimated to have resulted in an overall decrease of invertebrate benthic biomass of approximately 20% in the ecoregion when compared to an unfished state. This impact is patchy and may be as high as 90% in the most heavily fished area.

Except for patches of *Sabellaria spinulosa* (Ross worm) and *Modiolus modiolus* (horse mussel) reefs and scattered glacial erratic boulder fields, the North Sea contains limited biogenic and geogenic reefs. However, until the 1920s, dense oyster beds (*Ostrea edulis*) were widespread in parts of the southern central North Sea, creating diverse and productive benthic habitat. This biogenic habitat has, however, largely disappeared following the mechanization of fishing fleets. In this respect, the North Sea remains one of the most impacted shelf sea regions in the world. Other human-mediated disturbances on the seabed consist mainly of sand and gravel extraction and the growing introduction of offshore renewable energy structures such as wind farms, leading to potential smothering and habitat loss. Artificial hard substrates, such as hydrocarbon production platforms, wind turbines, and ship wrecks provide new different habitat types that can locally increase biodiversity. Sea grasses (Zosteraceae) used to be common off the coasts of the southern North Sea; however, their extent is now more limited due to the loss of shallow intertidal and delta areas.

Cephalopods

Generally, cephalopods in the ecoregion are of relative low abundance and do not play a large role in the foodweb. There are a total of 24 cephalopod species, including the important commercial inshore common squid (*Loligo vulgaris*) and long-finned squid (*Loligo forbesii*) as well as *Alloteuthis* spp., the offshore short-finned squid (*Illex coindetii*), lesser flying squid (*Todaropsis eblanae)*, and flying squid (*Todarodes sagittatus*) (all three of family Ommastrephidae), and the common cuttlefish (*Sepia officinalis*). Bobtail squids belonging to the family Sepiolidae are diverse but rare and have no commercial importance. Octopods are represented by a single species, the curled octopus (*Eledone cirrhosa*).

Fish

Both commercial but also non-target fish are heavily impacted by fishing, the dominant activity in the ecoregion. Due to more stringent fisheries management in past decades resulting in a reduction in fishing mortality rates, natural mortality is now back to being the main source of mortality for many commercial species. The mean relative spawning-stock biomass (SSB) has increased since 2000 and is now above the reference point that can provide the maximum sustainable yield (i.e.the SSB to $B_{MSY\ trigger}$ ratio > 1) for most stocks in the ecoregion (Figure 16). Among those with a high ratio are hake (*Merluccius merluccius*) and plaice (*Pleuronectes platessa*), while four stocks (North Sea cod, saithe, witch [*Glyptocephalus cynoglossus*], and whiting [*Merlangius merlangus*]) have an SSB below the sustainable threshold and a fishing mortality that exceeds it. More detailed information is provided in ICES Greater North Sea ecoregion Fisheries Overview.

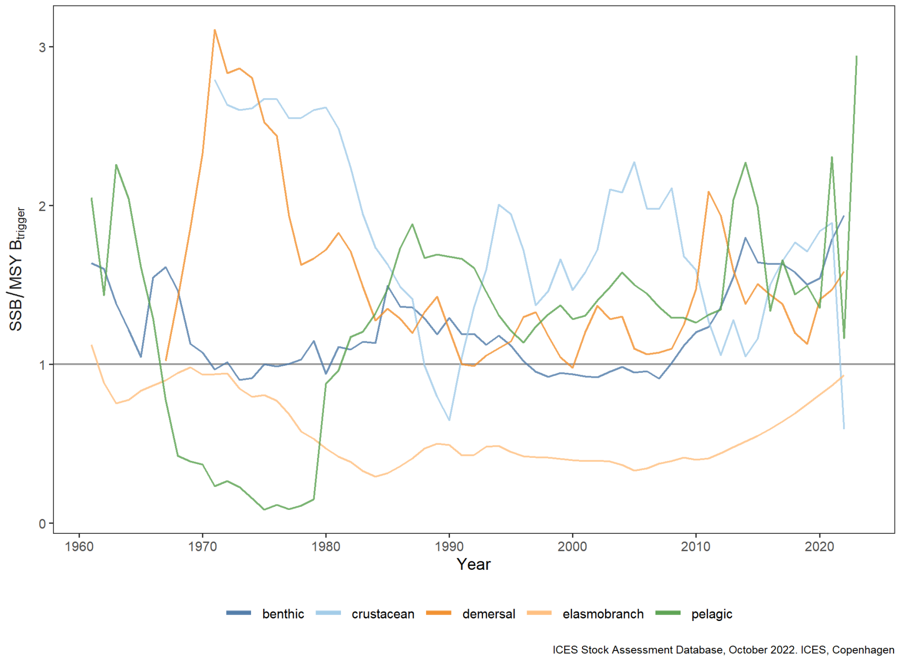

Figure 16 Time-series of mean annual biomass (SSB to $B_{MSY\ trigger}$ ratio) by fisheries guild for benthic, demersal, crustaceans, and pelagic stocks (see Annex 1 for species).

The commercial fish species are connected through predator–prey relationships. In the ecoregion the main forage fish (herring, sandeel, sprat, and Norway pout) feed predominantly on plankton and are an important food source in the North Sea foodweb. Smaller piscivorous fish (e.g., whiting, haddock [*Melanogrammus aeglefinus*], and grey gurnard [*Eutrigla gurnardus*]) and stocks that enter the ecoregion only in specific seasons such as western horse mackerel (*Trachurus trachurus*) and mackerel, all eat forage fish and juvenile gadoids. Benthic-feeding fish include various flatfish species (e.g. plaice and sole) feeding on prey at or near the bottom. Top predators that eat large fish (> 25 cm) are mainly fish like large cod, saithe, and some shark species but also include marine mammals like seals and harbour porpoise. The depletion of larger predatory species in the ecoregion has likely perturbed the structure and function of the ecosystem by reducing predator top-down controls on certain lower tropic level species.

The Greater North Sea is an important migratory corridor for Atlantic salmon. Juvenile smolts migrate from rivers to northern oceanic feeding grounds, and the adults migrate back to natal rivers throughout almost all of the ecoregion. Knowledge of the role of the species in the ecosystem is limited. The North-East Atlantic Commission (NEAC) area has seen a general reduction in catches in both fresh and marine waters since the 1980s, which reflects a decline in fishing effort as a consequence of management measures as well as a reduction in the size of stocks. Environmental conditions in both freshwater and marine environments have a marked effect on the status of salmon stocks. In the marine environment, return rates of adult salmon have declined since the 1980s and, for some stocks, are now at their lowest levels in the time-series, even after the closure of marine fisheries. Climatic factors modifying ecosystem conditions and the impact of salmon predators at sea are considered to be the main contributing factors to lower productivity, which is expressed almost entirely in terms of lower return rates.

Seabirds

The ecoregion is an important feeding area for many seabird populations preying on fish and invertebrates. More than 20 species of seabird breed on the coasts of the ecoregion, with numbers generally increasing until 2000, followed by a decline.

The Greater North Sea is an important wintering area for migratory birds from the north and east. Generally, the number of immigrant seabirds has declined in past years, likely due to milder winters, suggesting that the flocks that used to reach the region in winter remain now closer to their breeding grounds.

The main threats come from climate change, fishing (including bird bycatch and competition for prey items), disturbance from shipping, and detrimental interactions with offshore renewables (including collisions with wind turbine blades).

Marine mammals

Twenty-six cetacean and seven seal species occur in the ecoregion, many only as vagrants or occasional visitors. Two species of seal are common in the ecoregion: grey seal and harbour seal. Four cetacean species also occur commonly or are resident: minke whale (*Balaenoptera acutorostrata*), harbour porpoise, white-beaked dolphin (*Lagenorhynchus albirostris*), and bottlenose dolphin (*Tursiops truncatus*). A further six species are considered regular but less common: common dolphin, Atlantic white-sided dolphin (*Lagenorhynchus acutus*), long-finned pilot whale (*Globicephala melas*), killer whale (*Orcinus orca*), Risso's dolphin (*Grampus griseus*), and humpback whale (*Megaptera novaeangliae*).

Both seal species have experienced large population changes over the past century. The abundance of harbour seals reached an all-time low in the 1970s but subsequently increased at an annual rate of 4%; however, this increase was then affected by two major outbreaks of the phocine distemper virus in 1988 and 2002. Over the last 15 years, local declines in the harbour seal population have occurred in the northwestern North Sea, for unknown reasons. Grey seals occur predominantly along the British coasts, where they have been increasing at an annual rate of up to 16% in some areas.

Trends in the abundance of cetaceans are less known. The spatial distribution of harbour porpoises was observed to shift southwards following changes in the availability of prey, such as sandeel. Minke whales and white-beaked dolphins are found mainly in the central and northern North Sea, without substantial changes in abundance. The population of bottlenose dolphins off the eastern British coast has been increasing since the 2000s and over this period has extended its range southwards. Killer whales regularly occur in the northern North Sea, with at least some individuals inhabiting the waters around northern Scotland being part of the Icelandic population. In recent years, humpback whales have increasingly been recorded in the North Sea, including in the southern part where they were previously vagrant.

The main threats for marine mammals in the ecoregion are from human activities and their pressures, including fisheries (i.e. bycatch), contaminating compounds, underwater noise, and shipping (i.e. vessel strikes). Fisheries can also indirectly affect marine mammals through reduction in prey. Climate change may also be causing some distributional shifts in marine mammals for example through changes in food availability.

Foodwebs

Characteristics of the North Sea foodweb are high production by autotrophic organisms, which, in turn, are consumed by zooplankton and benthos, followed by fish, seabirds, and mammals.

The North Sea foodweb is one of the most studied in the ICES area. In the past, large-bodied fish, including elasmobranchs, were major predators in the ecosystem. The foodweb can now be considered as perturbed, as many sensitive fish species are either absent or present only in reduced numbers.

Although, future projections of ecosystem models suggest that fishing at MSY should allow large-bodied species and the size structure of communities to recover, some species may require additional measures to reduce pressure. As predator populations recover, this will likely have consequences for forage fish populations (herring, sprat, sandeel, and Norway pout) and may lead to competition between species. However, there is still a need to further improve our basic understanding of bottom-up processes and the impacts of climate change.

Sources and acknowledgments

The content for 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 the design and scope of the 3rd generation of ICES Ecosystem Overviews (WKEO3) 2019, Workshop on methods and guidelines to link human activities, pressures and state of the ecosystem in Ecosystem Overviews (WKTRANSPARENT) 2020, and the Advice Drafting Group to finalize draft Ecosystem Overviews (ADGEO) 2022, which provided the theoretical framework and final layout of the documents.

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Figure 1: produced by ICES Secretariat GIS with data from:

- General Bathymetric Chart of the Oceans (GEBCO), for the depth contours.
- International Council for the Exploration of the Sea (ICES), for ecoregions and ICES areas
- Global Shipping Lanes and Harbors (ESRI), for ports
- European Environment Agency (EEA) and European Topic Centre on Inland, Coastal and Marine waters (ETC/ICM), for catchment area

Figure 2: produced by ICES Secretariat

Figure 3: produced by ICES Secretariat. Data: Stock Assessment Graphs: SAG

Figure 4: produced by ICES Secretariat . Data: Stock Assessment Graphs: SAG

Figure 5: produced by the Working Group on Marine Litter (WGML)

Figure 6: produced by ICES Secretariat with available data

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Figure 9: produced by González-Pola *et al*. (2019)

Figure 10: produced by the ICES Working Group on Zooplankton Ecology (WGZE)

Figure 11: produced by ICES Working Group on Social Indicators (WGSOCIAL), data from ICES RDB

Figure 12: produced by OSPAR (2000)

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Figure 14: produced using data from Substrate maps, EMODnet Seabed Habitats Mapviewer

Figure 15: produced by Hiddink *et al*. (2019)

Figure 16: Produced by ICES Secretariat. Data: Stock Assessment Graphs: SAG

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Annex 1 Stocks and fisheries guilds

Table A1 Stocks in the Greater North Sea ecoregion and their fisheries guilds. Stocks with analytical assessments and guilds included in Figure 4 and Figure 16. Detailed information is provided in the Greater North Sea Fisheries Overviews.

Stock code	Stock name	Fishery guild
ank.27.78abd	Black-bellied anglerfish (*Lophius budegassa*) in Subarea 7 and divisions 8.a-b and 8.d (Celtic Seas, Bay of Biscay)	benthic
dab.27.3a4	Dab (*Limanda limanda*) in Subarea 4 and Division 3.a (North Sea, Skagerrak and Kattegat)	benthic
lez.27.4a6a	Megrim (*Lepidorhombus spp.*) in divisions 4.a and 6.a (northern North Sea, West of Scotland)	benthic
meg.27.7b-k8abd	Megrim (*Lepidorhombus whiffiagonis*) in divisions 7.b–k, 8.a–b, and 8.d (west and southwest of Ireland, Bay of Biscay)	benthic
mon.27.78abd	White anglerfish (*Lophius piscatorius*) in Subarea 7 and divisions 8.a-b and 8.d (Celtic Seas, Bay of Bis-cay)	benthic
ple.27.21-23	Plaice (*Pleuronectes platessa*) in subdivisions 21–23 (Kattegat, Belt Seas, and the Sound)	benthic
ple.27.420	Plaice (*Pleuronectes platessa*) in Subarea 4 (North Sea) and Subdivision 20 (Skagerrak)	benthic
ple.27.7d	Plaice (*Pleuronectes platessa*) in Division 7.d (eastern English Channel)	benthic
ple.27.7e	Plaice (*Pleuronectes platessa*) in Division 7.e (western English Channel)	benthic
sol.27.20-24	Sole (*Solea solea*) in subdivisions 20–24 (Skagerrak and Kattegat, western Baltic Sea)	benthic
sol.27.4	Sole (*Solea solea*) in Subarea 4 (North Sea)	benthic
sol.27.7d	Sole (*Solea solea*) in Division 7.d (eastern English Channel)	benthic
sol.27.7e	Sole (*Solea solea*) in Division 7.e (western English Channel)	benthic
tur.27.4	Turbot (*Scophthalmus maximus*) in Subarea 4 (North Sea)	benthic
wit.27.3a47d	Witch (*Glyptocephalus cynoglossus*) in Subarea 4 and divisions 3.a and 7.d (North Sea, Skagerrak and Kattegat, eastern English Channel)	benthic
nep.fu.3-4	Norway lobster (*Nephrops norvegicus*) in Division 4.b, Functional Unit 34 (central North Sea, Devil's Hole)	crustacean
nep.fu.6	Norway lobster (*Nephrops norvegicus*) in Division 4.b, Functional Unit 6 (central North Sea, Farn Deeps)	crustacean
nep.fu.7	Norway lobster (*Nephrops norvegicus*) in Division 4.a, Functional Unit 7 (northern North Sea, Fladen Ground)	crustacean
nep.fu.8	Norway lobster (*Nephrops norvegicus*) in Division 4.b, Functional Unit 8 (central North Sea, Firth of Forth)	crustacean
nep.fu.9	Norway lobster (*Nephrops norvegicus*) in Division 4.b, Functional Unit 9 (central North Sea, Moray Firth)	crustacean
pra.27.3a4a	Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East (Skagerrak and Kattegat and northern North Sea in the Norwegian Deep)	crustacean
bli.27.5b67	Blue ling (*Molva dypterygia*) in subareas 6–7 and Division 5.b (Celtic Seas, English Channel, and Faroes grounds)	demersal
bss.27.4bc7ad-h	Seabass (*Dicentrarchus labrax*) in Divisions 4.b–c, 7.a, and 7.d–h (central and southern North Sea, Irish Sea, English Channel, Bristol Channel, and Celtic Sea)	demersal
cod.27.47d20	Cod (*Gadus morhua*) in Subarea 4, Division 7.d, and Subdivision 20 (North Sea, eastern English Channel, Skagerrak)	demersal
cod.27.7e-k	Cod (*Gadus morhua*) in divisions 7.e–k (eastern English Channel and southern Celtic Seas)	demersal
had.27.46a20	Haddock (*Melanogrammus aeglefinus*) in Subarea 4, Division 6.a, and Subdivision 20 (North Sea, West of Scotland, Skagerrak)	demersal
had.27.7b-k	Haddock (*Melanogrammus aeglefinus*) in Divisions 7.b–k (southern Celtic Seas and English Channel)	demersal
hke.27.3a46-8abd	Hake (*Merluccius merluccius*) in subareas 4, 6, and 7, and divisions 3.a, 8.a–b, and 8.d, Northern stock (Greater North Sea, Celtic Seas, and the northern Bay of Biscay)	demersal
pok.27.3a46	Saithe (*Pollachius virens*) in subareas 4, 6 and Division 3.a (North Sea, Rockall and West of Scotland, Skagerrak and Kattegat)	demersal
whg.27.47d	Whiting (*Merlangius merlangus*) in Subarea 4 and Division 7.d (North Sea and eastern English Channel)	demersal
whg.27.7b-ce-k	Whiting (*Merlangius merlangus*) in divisions 7.b–c and 7.e–k (southern Celtic Seas and eastern English Channel)	demersal
dgs.27.nea	Spurdog (*Squalus acanthias*) in Subareas 1-10, 12 and 14 (the Northeast Atlantic and adjacent waters)	elasmo-branchs

Stock code	Stock name	Fishery guild
por.27.nea	Porbeagle (*Lamna nasus*) in subareas 1-10, 12 and 14 (the Northeast Atlantic and adjacent waters)	elasmo-branchs
her.27.1-24a514a	Herring (*Clupea harengus*) in subareas 1, 2, 5 and divisions 4.a and 14.a, Norwegian spring-spawning herring (the Northeast Atlantic and Arctic Ocean)	pelagic
her.27.20-24	Herring (*Clupea harengus*) in subdivisions 20–24, spring spawners (Skagerrak, Kattegat, and western Baltic)	pelagic
her.27.3a47d	Herring (*Clupea harengus*) in Subarea 4 and divisions 3.a and 7.d, autumn spawners (North Sea, Skagerrak and Kattegat, eastern English Channel)	pelagic
hom.27.2a4a5b6a 7a-ce-k8	Horse mackerel (*Trachurus trachurus*) in Subarea 8 and divisions 2.a, 4.a, 5.b, 6.a, 7.a–c, 7.e–k (the Northeast Atlantic)	pelagic
mac.27.nea	Mackerel (*Scomber scombrus*) in subareas 1–8 and 14 and division 9.a (the Northeast Atlantic and adjacent waters)	pelagic
spr.27.7de	Sprat (*Sprattus sprattus*) in divisions 7.d and 7.e (English Channel)	pelagic
whb.27.1-91214	Blue whiting (*Micromesistius poutassou*) in subareas 1–9, 12, and 14 (Northeast Atlantic and adjacent waters)	pelagic

Annex 2 Threatened and declining species and habitats

The threatened and declining species in the Greater Norh Sea according to OSPAR (OSPAR Region II) are shown in the tables below.

Table A2.1 Threatened and declining species in the Greater North Sea ecoregion, according to OSPAR.

Scientific name	Common name
Invertebrates	
Arctica islandica	Ocean quahog
Nucella lapillus	Dog whelk
Ostrea edulis	Flat oyster
Seabirds	
Puffinus mauretanicus	Balearic shearwater
Rissa tridactyla	Black-legged kittiwake
Sterna dougallii	Roseate tern
Fish	
Acipenser sturio	Sturgeon
Alosa alosa	Allis shad
Anguilla anguilla	European eel
Cetorhinus maximus	Basking shark
Coregonus lavaretus oxyrinchus	Houting
Dipturus batis (Raja batis)	Common skate
Raja montagui (Dipturus montagui)	Spotted ray
Gadus morhua	Cod
Hippocampus guttulatus	Long-snouted seahorse
Hippocampus hippocampus	Short-snouted seahorse
Lamna nasus	Porbeagle
Petromyzon marinus	Sea lamprey
Raja clavata	Thornback skate/ray
Rostroraja alba	White skate
Salmo salar	Salmon
Squalus acanthias	(Northeast Atlantic) spurdog
Squatina squatina	Angel shark
Reptiles	
Dermochelys coriacea	Leatherback turtle
Marine mammals	
Phocoena phocoena	Harbour porpoise

Table A2.2 Threatened and declining habitats in the Greater North Sea ecoregion, according to OSPAR.

Habitats
Coral gardens
Intertidal *Mytilus edulis* beds on mixed and sandy sediments
Haploops habitat
Intertidal mudflats
Kelp forests
Littoral chalk communities
Lophelia pertusa reefs
Modiolus modiolus beds
Ostrea edulis beds
Sabellaria spinulosa reefs
Sea pen and burrowing megafauna communities
Zostera beds