

9.1 Greater North Sea Ecoregion – Ecosystem overview

Ecoregion description

The Greater North Sea ecoregion includes the North Sea, English Channel, Skagerrak, and Kattegat. It is a temperate coastal shelf sea with a deep channel in the northwest, a permanently thermally mixed water column in the south and east, and seasonal stratification in the north.

Fisheries management in the Greater North Sea ecoregion is conducted in accordance with the EU Common Fisheries Policy (CFP), by Norway, and by coastal state agreements. Managerial responsibility for salmon is taken by the North Atlantic Salmon Conservation Organization (NASCO) and for large pelagic fish by the International Commission for the Conservation of Atlantic Tunas (ICCAT). 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 and Pelagic ACs. 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. International shipping is managed under the International Maritime Organization (IMO).

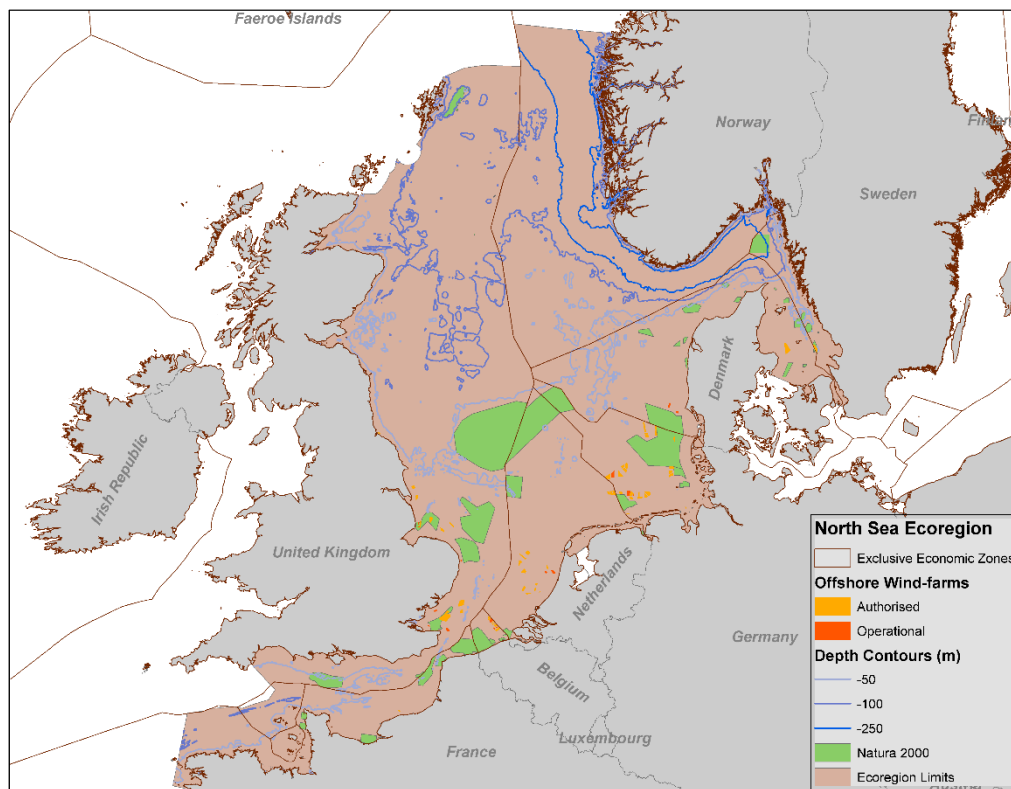


Figure 1 Greater North Sea ecoregion, showing EEZs, larger offshore Natura 2000 sites, and operational and authorized wind farms.

The ecoregion consists of four key areas:

- Northern North Sea (depths 0–500 m) is strongly influenced by oceanic inflow and has a deep channel in the east. The majority of the area is stratified in summer. The dominant human activities are fishing and oil and gas production.
- Southern North Sea (depths 0–50 m) is characterized by large river inputs and strongly mixed water. The dominant human activities are fishing, shipping, ports, gas production, wind farms, and aggregate (sand) extraction.
- The Skagerrak and Kattegat forms the link to the Baltic Sea and is less saline and less tidal than the rest of the ecoregion. The water column is usually mixed. 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 heavily influenced by wind events. The dominant human activities are fishing, shipping, and aggregate (gravel) extraction.

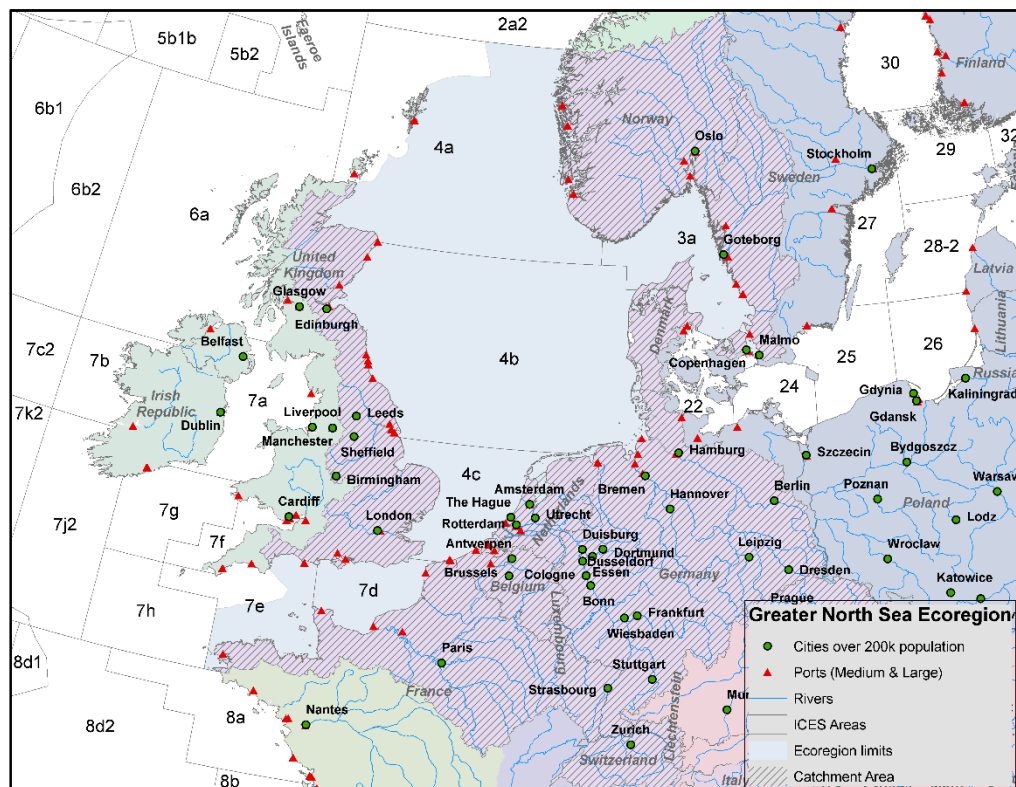


Figure 2 Catchment area for the Greater North Sea ecoregion showing major cities, ports, and ICES areas.

Key signals within the environment and the ecosystem

- The North Sea is characterized by episodic changes in the productivity of key components of the ecosystem. Phytoplankton, zooplankton, and demersal and pelagic fish have all exhibited such cycles in variability. Managers should expect change and ensure that management plans have the potential to respond to new circumstances. Examples of these changes include the gadoid 'outburst' in the 1970s, and a reduced productivity of herring *Clupea harengus* since 2002.
- The changes have been described as regime shifts; a notable example is the composition of the zooplankton community, which changed both in terms of species and size composition in the late 1980s and again around 2000.
- The temperature trends of the North Sea are linked to these ecosystem changes. Whilst the mechanisms underlying this link are not known, it is clear that the temperature cycle of the North Atlantic (the Atlantic Multidecadal Oscillation, AMO) affects the North Sea. Examples of this include the outbursts of anchovy *Engraulis encrasicolus* in the 1930s and the 2000s.
- Recent years have seen an increase in the addition of new artificial hard substrate to the North Sea (platforms, wind turbines, and rocks). These additions have changed the biodiversity and productivity in local areas.

- Fishing has reduced the number of large fish in the North Sea ecosystem (mostly cod *Gadus morhua*, saithe *Pollachius virens*, ling *Molva molva*, sturgeon *Acipenser sturio*, and some elasmobranchs). In historical times, the large whale populations of the North Sea were depleted or extirpated by hunting. Whilst the impact of these removals on the ecosystem functioning is not clearly understood, it should be assumed that the North Sea ecosystem is currently in a perturbed state. Several of these elasmobranch species are now considered threatened or endangered by OSPAR and IUCN and are still caught as bycatch in fisheries.
- However, it is clear that fishing effort has reduced in the North Sea since the 2002 CFP reforms; this can now be detected in the reduction of fishing mortality in most assessed fish stocks and an increase in the amount of larger fish present. The majority of assessed fish stocks are now fished at or below MSY fishing mortality targets (F_{MSY}).
- There have been reports of a shift from pelagic to benthic production. The plaice stock in the North Sea has increased almost fourfold in the last 15 years and is now larger than when monitoring began in the 1950s. Flatfish are not included in the current multispecies models for the North Sea. The consequences of this large stock for the ecosystem are unknown.
- The seabird population showed an overall increasing trend until 2000, after which it declined. Recent changes in fisheries management policy (e.g. reduction in effort and the landing obligation) will likely affect seabirds as well as other parts of the ecosystem.
- There have been no significant changes in the cetacean populations of the North Sea. The centre of distribution of the harbour porpoise *Phocoena phocoena* population moved southwards from off the east of Scotland to the southern North Sea between the mid-1990s and the mid-2000s. These animals are caught as bycatch in bottom-set gillnets. The abundance of grey seals has been increasing for at least 30 years.

Pressures

The five most important pressures are described below. These pressures are linked mainly to the following human activities: fishing, coastal construction, maritime transport, oil and gas exploration and production, tourism and recreation, navigation dredging, aggregate extraction, military, and wind farm construction. The pressures are described in the ICES glossary of principal pressures in ICES ecoregions (ICES, 2015a).

Information on the distribution of environmental pressures is limited and as such data on the distribution of activities are often used as a proxy.

NORTH SEA

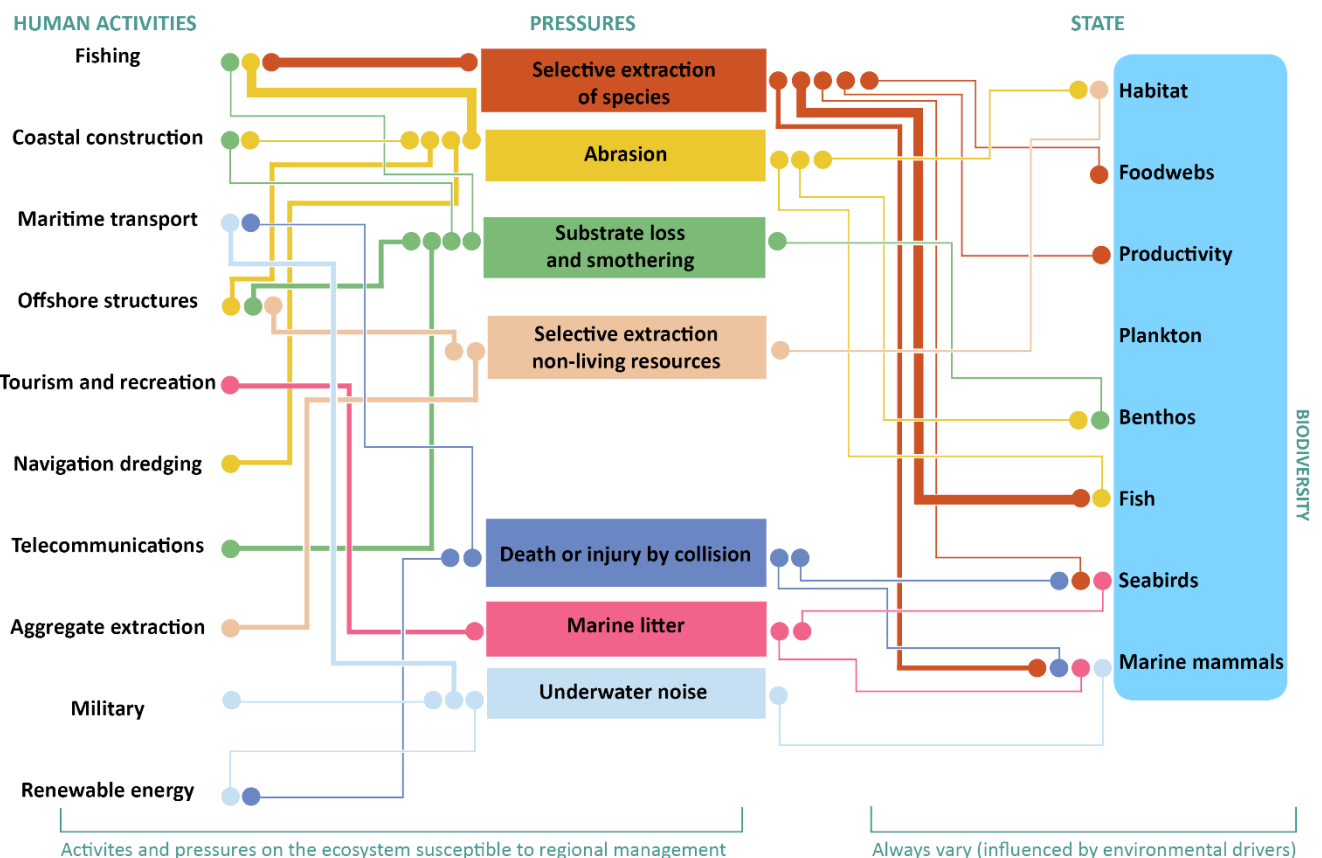


Figure 3 Greater North Sea ecoregion overview with the major regional pressures, human activities, and state of the ecosystem components. The width of lines indicates the relative importance of individual links.

Selective extraction of species, including incidental non-target catch

The main contributing activity to selective extraction of species in the Greater North Sea is fisheries. Sustainable fisheries management aims to minimize long-term negative effects on ecosystems while seeking long-term economic and social viability of the fisheries. Overall fishing effort in the Greater North Sea has fallen by approximately 50% (2004–2012, Figure 4). This decline in effort has resulted in a decline in the fishing mortality rate of commercial fish stocks. There have been shifts in fishing techniques. Beam trawling has been increasingly replaced by pulse beam trawling, sum-wing, twin-rigging, and flyshooting, gear types that all require less fuel. The impact of the EU landing obligation is difficult to predict, but fishing behaviour, data gathering, and stock assessments will be affected.

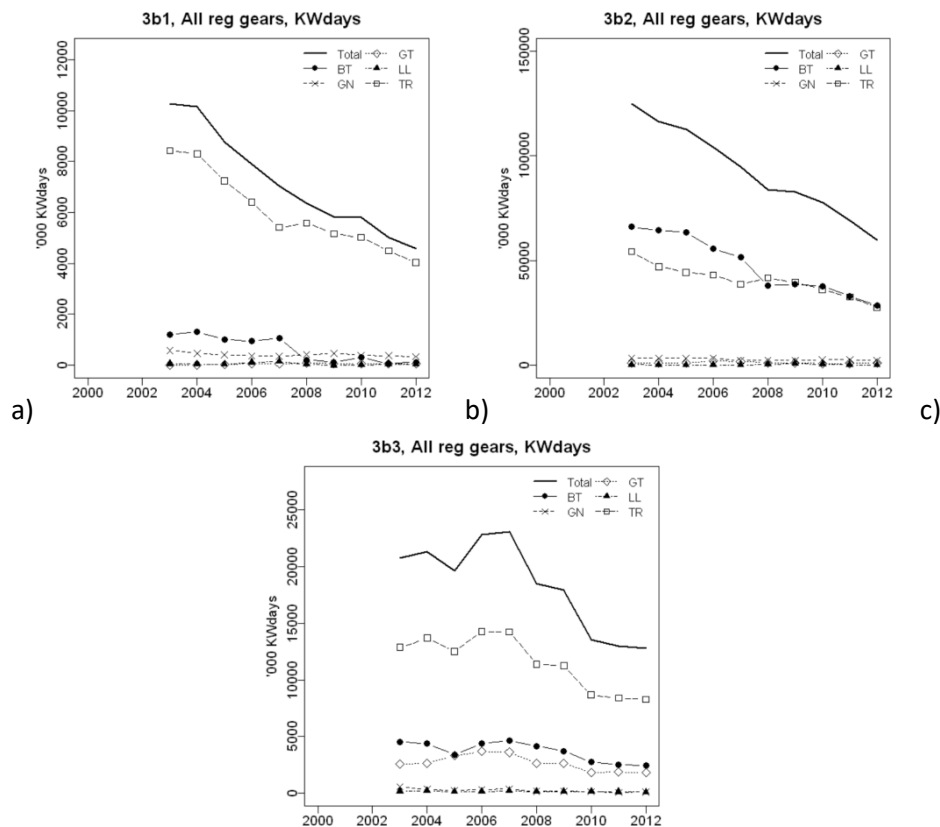


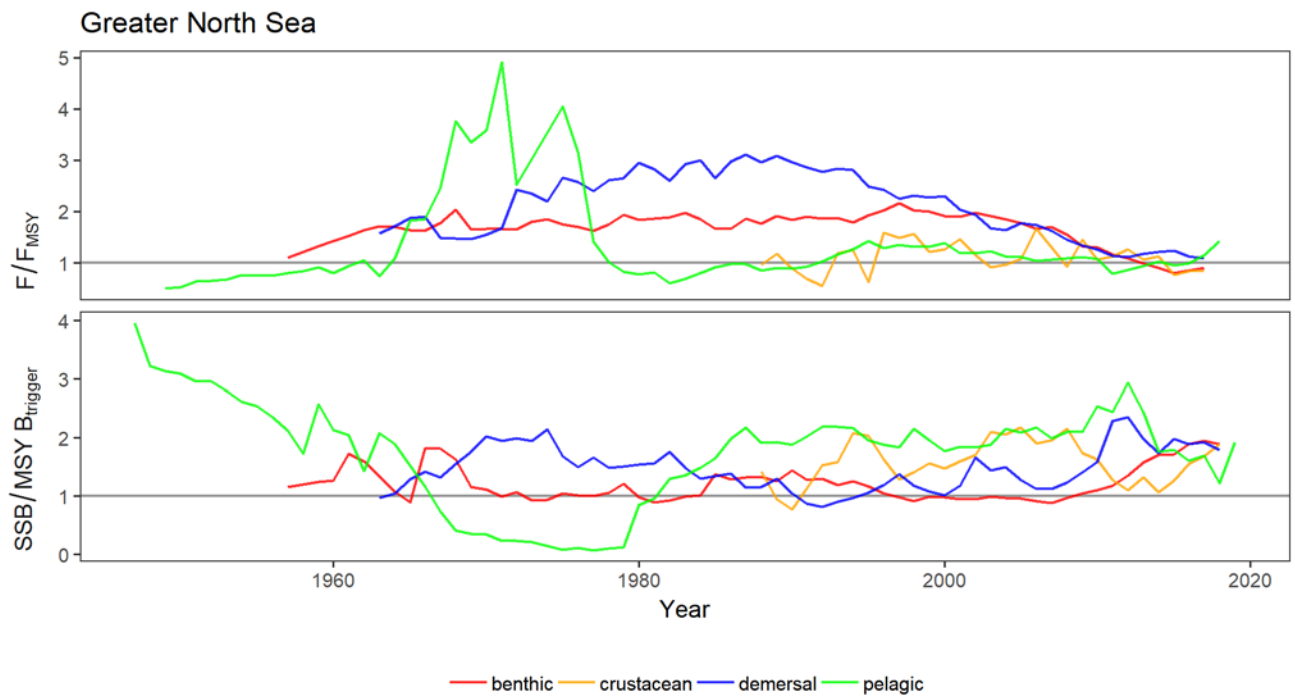
Figure 4 Effort trends for regulated gear types in a) Skagerrak/Kattegat, b) North Sea proper, and c) eastern English Channel. TR = demersal otter trawl and demersal seine, BT = beam trawl, GN = gillnet, GT = trammelnet, LL = longline. (STECF, 2013.)

Impacts on commercial stocks

The majority of North Sea fish stocks are now fished at rates at or below F_{MSY} . Overall fishing mortality (F) for shellfish, demersal, and pelagic fish stocks has reduced since the late 1990s (Figure 5). The fishing mortality on 24 stocks has been evaluated in Figure 5 against MSY reference points. The relative spawning-stock biomass has also increased since 2000 and is now above or close to the biomass reference points used in stock assessments of most stocks in the Greater North Sea. A number of stocks still have a relatively high fishing pressure, namely mackerel *Scomber scombrus*, blue whiting *Micromesistius poutassou*, sole *Solea solea* in the English Channel, and some *Nephrops* 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, primarily for fish meal and oil (except for herring, where the majority of the catch is for human consumption). Currently, multispecies assessment models (which include trophic interactions) are used to evaluate the impact of fisheries and main predators (gadoids, birds, and sea mammals) on the forage fish stocks. An area

in the northwestern North Sea is closed for sandeel fishing to protect food stocks for predators. The proportional impact of recreational fishing is increasing as commercial operations are restrained.



ICES Stock Assessment Database, November/2018. ICES, Copenhagen

Figure 5 Time-series of average of relative fishing mortality (F to F_{MSY} ratio) and biomass (SSB to B_{MSY} trigger ratio) by fisheries guild for benthic, demersal, crustaceans, pelagic stocks (see Annex A).

Impacts on foodwebs

Fishing changes both community structure and foodwebs. The depletion of larger predatory species has likely perturbed the structure and functioning of the ecosystem. Multispecies assessment methods can account for some of the interactions and indicators like the large fish indicator (LFI) index (describing the proportion -by weight of the demersal fish community catch on surveys that is larger than regional length thresholds) can be used to monitor changes in the fish populations. In the Greater North Sea, the LFI index declined in the mid-1980s and has been relatively stable with annual changes since 2004 (Figure 6).

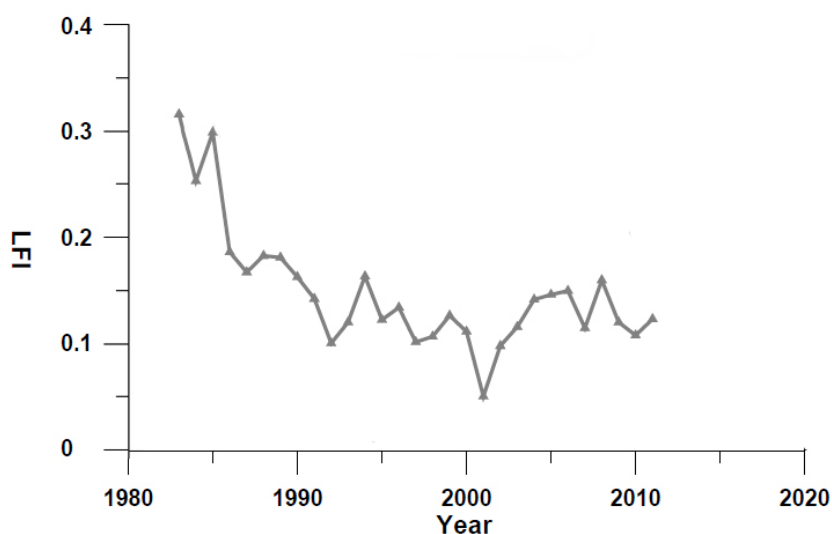


Figure 6 Time-series of the large fish indicator (LFI) for the Greater North Sea. (ICES, 2014.)

Impacts on threatened and declining fish species

Several fish species have been depleted by fishing in the past and are now on the OSPAR list of threatened and declining species (see full list below). These include spurdog *Squalus acanthias*, the common skate complex *Dipturus* spp., angel shark *Squatina squatina*, porbeagle *Lamna nasus*, and some deep-water sharks. Despite zero TACs or prohibited listings for these species, several elasmobranchs are caught as bycatch in some fisheries.

Impacts on seabirds and marine mammals

Bycatch in bottom-set gillnets is probably the greatest anthropogenic activity affecting population abundance of harbour porpoises *Phocoena phocoena* in the North Sea. Bycatch of seabirds in the North Sea occurs, but is not believed to be a large pressure on the seabird populations.

Abrasion

Physical disturbance of benthic habitats by bottom trawl fishing gear is described by using vessel monitoring system (VMS) and logbook data. The extent, magnitude, and impact of mobile bottom-contacting fishing gear on the seabed and benthic habitats varies geographically across the North Sea (Figure 7).

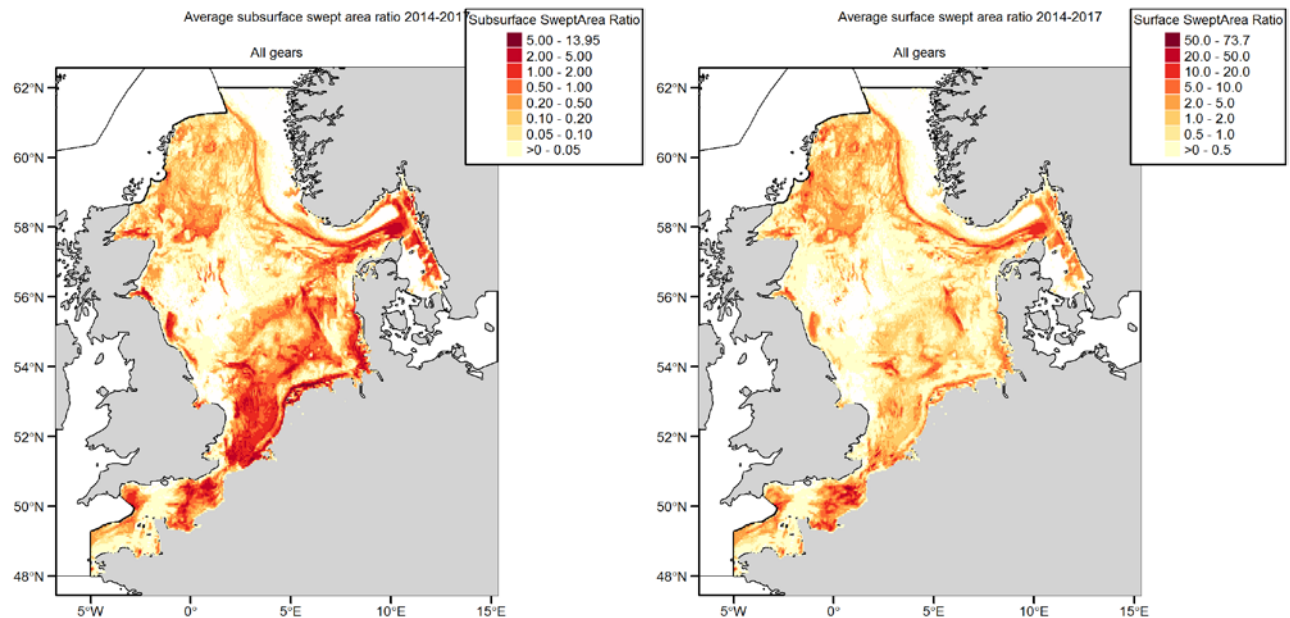


Figure 7 Average annual subsurface (left) and surface (right) disturbance by mobile bottom contacting fishing gear (Bottom otter trawls, Bottom seines, Dredges, Beam trawls) in the Greater North Sea during 2014-2017, expressed as average swept area ratios (SAR).

Smothering

Dredging and dumping operations and techniques have not changed recently. The total annual amounts dumped at sea have varied between 80 and 130 million tonnes (dry weight); much of this activity is associated with port expansion and deepening of navigation channels. In 2005, there were around 350 dumpsites in the OSPAR area. About 90% of all sediments dumped each year are dredged and dumped in the southern North Sea. This is largely from maintaining navigation channels to major seaports such as Hull, Antwerp, Rotterdam, Hamburg, and Esbjerg. Cable laying activities have increased (and are projected to continue to increase) proportionate to current plans for offshore wind farm development. Ship traffic and vessel size are predicted to increase from the present until 2020, which will increase the need to maintain (and possibly deepen) navigation channels.

Substrate 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 southern coast of the 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 in the Greater North Sea. The largest land reclamation in Europe, Maasvlakte 2, is in Rotterdam port. However, both UK and Dutch authorities are also allowing sea re-encroachment 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 North Sea, most associated with oil and gas production. Offshore wind farm development has started in the last decade with greater development planned for areas further offshore.

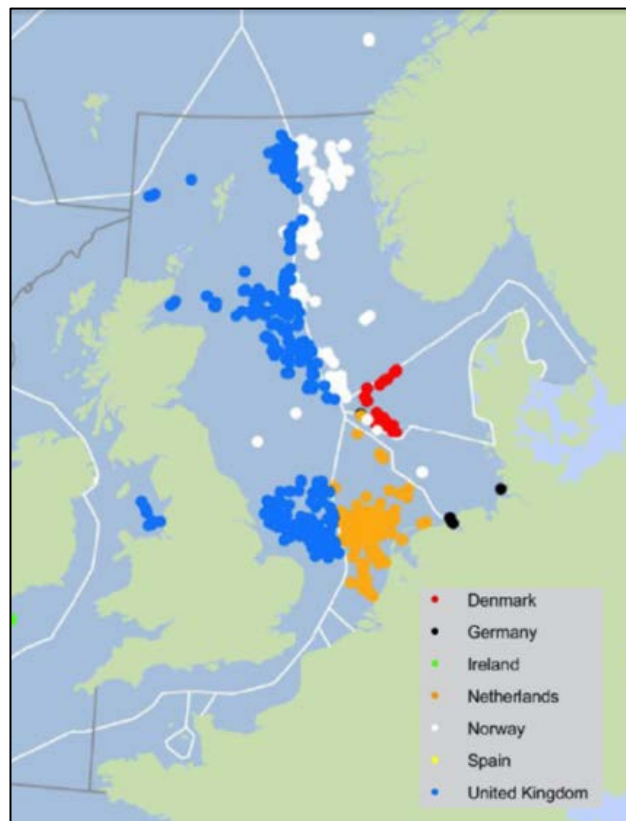


Figure 8 Oil and gas installations in the Greater North Sea, data from OSPAR. The dots are out of scale; in reality the ca. 600 structures with a safety zone (non-fishing area) of 500 m together occupy approx. 500 km², which is less than 0.07% of the total North Sea area. In comparison, the present wind farms, also with non-fished safety zones of 500 m, occupy about 400 km². All authorized wind farms (see Figure 8) cover an area of 2 584 km². Due to decommissioning, the area occupied by oil and gas structures will decrease. If the planned increase in power of wind farms to 72 GW is established, the area occupied would be around 12 000 km², representing 1.6% of the total North Sea area.

Selective extraction of non-living resources from the seabed and subsoil

OSPAR reported in 2010 the extraction of 50 to 60 million m³ of marine mineral deposits each year in the OSPAR area, mainly for the construction industry, for use as fill sand on land, or for beach nourishment. About 80% of the total volume extracted in this area is extracted from the Greater North Sea. The biggest extractors are the Netherlands, the UK, France, and Denmark, showing a 30% increase in the total quantity of marine sand and gravel extracted. However, the total geographical extent of extraction areas has been relatively stable as new concessions have been offset by extraction activity ceasing in some areas. In the western English Channel, thick beds of maerl declined in extent and quality, partly as a result of damage resulting from maerl extraction for use as an agricultural soil conditioner.

Other pressures

Various emerging environmental pressures in the Greater North Sea are receiving greater public and political attention and are the subject of research initiatives to assess the nature and scale of impact. These include:

- **Death or injury by collision** – The growing amount of wind farms increases the possibility of seabirds colliding with the turning blades of the turbines.
- **Marine litter** – Marine debris, also known as marine litter, is man-made waste that has deliberately or accidentally been released in the sea, ocean, or waterway. Major contributing activities are tourism, fishing, and shipping.
- **Underwater sound** – Sound from the human world disrupts life below the surface, where many living creatures depend on sound as a primary sense for mating, hunting, and survival. The main anthropogenic activities that produce sound are shipping, oil exploration, and pile-driving of wind farm foundations.

State of the ecosystem

Habitat

The benthic substrate of the Greater North Sea is predominantly characterized by soft sediments (from muds to gravel beds, Figure 9). Sediments from mobile muds to coarse sands are present throughout the region. Gravel beds are mainly distributed in the English Channel and the southern North Sea. The North Sea contains limited biogenic and geogenic reefs, except for patches of *Sabellaria spinulosa* reefs and scattered boulder fields. The shores consist mainly of mobile sediment types, i.e. mud, sand, and boulder beaches, while rocky shores are mostly found in the northern North Sea and the English Channel. The North Sea benthic habitats are impacted by bottom trawling, sand and gravel extraction, and recently also the growing introduction of offshore renewable energy structures such as wind farms, leading to pressures of abrasion, smothering, habitat loss, and selective extraction of non-living resources. Artificial hard substrates, such as hydrocarbon production platforms, wind turbines, and ship wrecks may act as new hard substrate habitat types that increase local biodiversity.

Before 1900, biogenic oyster *Ostrea edulis* reefs were a large separate habitat type in the central part of the North Sea, but this disappeared most likely due to changes in currents and overfishing. Sea grasses (Zosteraceae) were common along the coasts of the southern North Sea; these have also mostly disappeared.

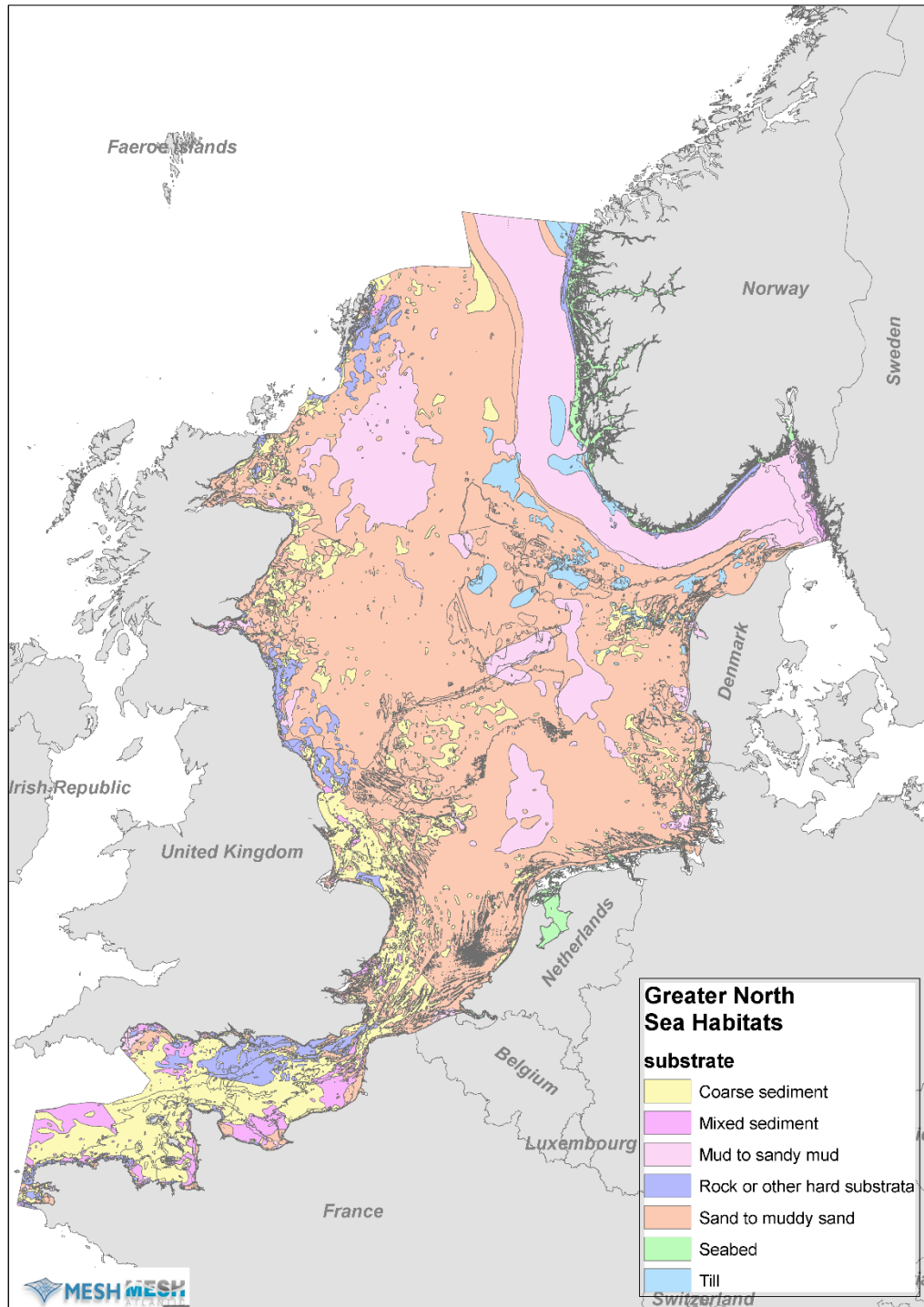


Figure 9 Major substrates on the shelf in the Greater North Sea (as compiled by EMODNET seabed habitats; www.emodnet-seabedhabitats.eu).

The pelagic habitat of the North Sea is dominated by the difference between the mixed waters in the southern and eastern parts of the region and the stratified waters in the north. Pelagic organisms are also affected by the frontal dynamics of the sea. Many of these fronts are semi-permanent.

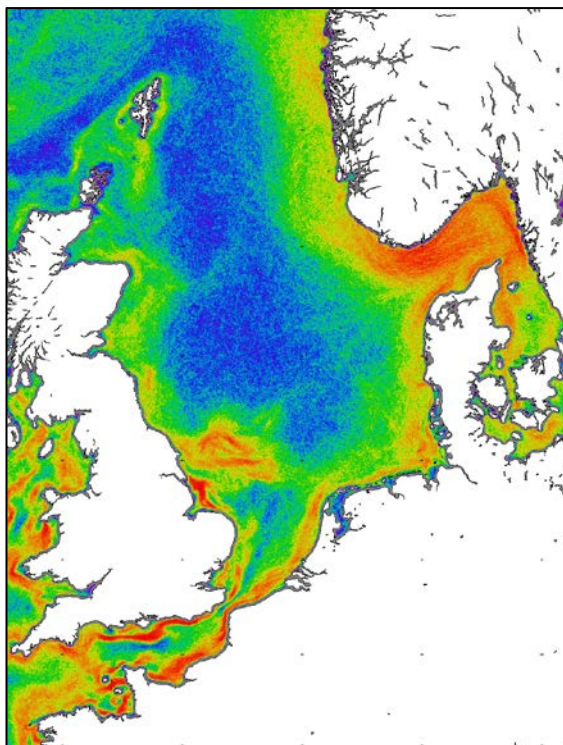


Figure 10 The probability of thermal fronts in summer in the North Sea. Red = 100% and blue = 0%. Remote sensing data 1999–2011. (Plymouth Marine Laboratory.)

Foodwebs

Characteristics of the North Sea foodweb are a 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 ones in the ICES area. In the past big fish, including elasmobranchs, were major predators in the ecosystem. The North Sea foodweb can now be considered as perturbed as many of these big fish are either absent or present only in reduced numbers. The recovering of these big fish populations will likely have consequences for the large forage fish populations in the North Sea (herring, sprat, sandeel, and Norway pout).

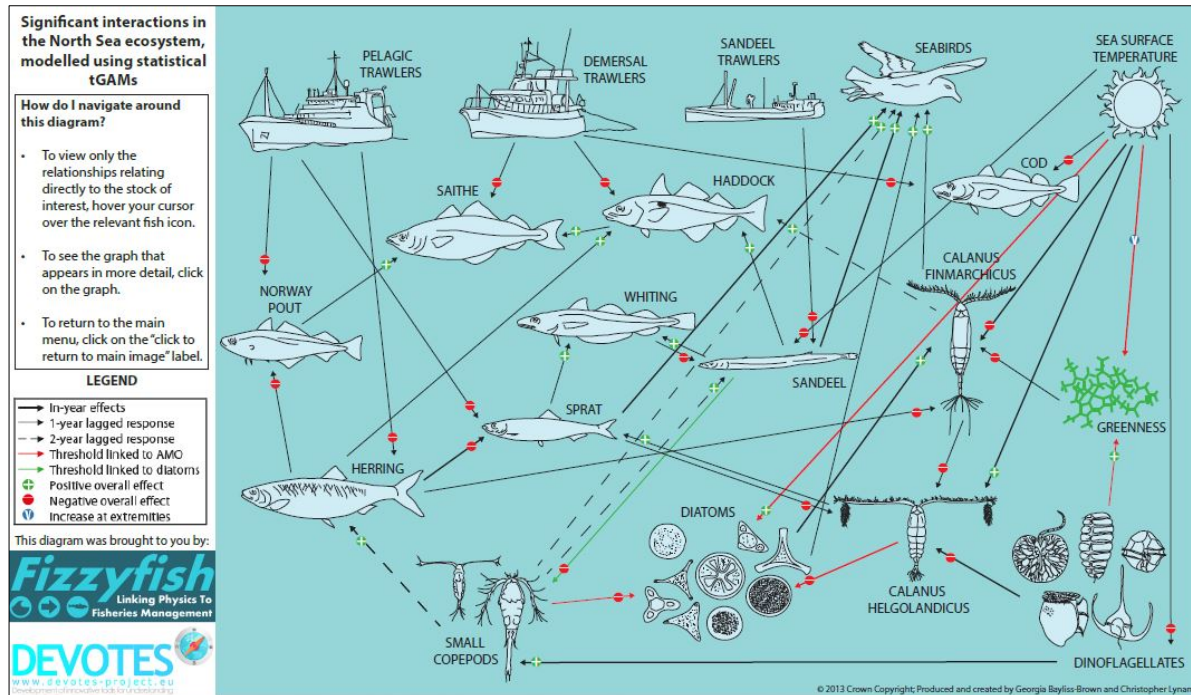


Figure 11 The major components of the Greater North Sea foodweb.
http://www.ices.dk/community/Documents/Expert%20Groups/Lynam_tGAMmodel_key_mov.pdf.

Productivity

Primary production is highest in the coastal regions due to nutrient inputs from the rivers and mixed water columns. This production was higher during the 1980s as a result of eutrophication. Primary production in the coastal zone decreased with the decline of the phosphate input in particular.

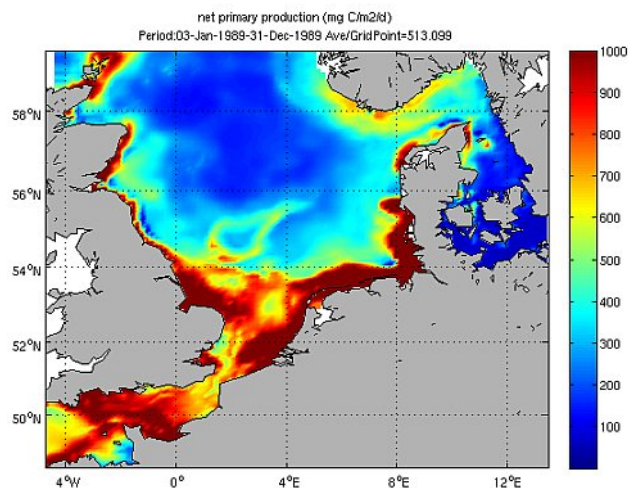


Figure 12 Net primary production (data from ERSEM model, NIOZ).

Plankton

The northern North Sea was, until recently, a cold-temperate boreal province, which, after the late 1980s regime shift, became a warm-temperate province (Figure 13). Zooplankton communities in the northern North Sea are generally comprised of Atlantic and offshore species (such as *Calanus finmarchicus* and *Metridia lucens*) as these waters are stratified during summer months (Figure 14). The zooplankton community of the southern North Sea primarily consists of neritic and coastal species (such as decapod larvae *Centropages hamatus* and *Calanus helgolandicus*) which are well-suited to the mixed waters of this region. For the most part changes in plankton in the southern North Sea are driven by climatic variability. Population of the previously dominant copepod *Calanus finmarchicus* has declined in biomass by 70% since the 1960s. Species with warmer-water affinities, e.g. *Calanus helgolandicus*, are moving northward to replace *Calanus finmarchicus* but are not abundant. Over the last few decades, climate warming in the southern North Sea has been noticeably faster than in the northern North Sea (due to the southern North Sea being shallower). This is reflected in the biological response of planktonic organisms; for example, phenological cycles observed in the southern North Sea have moved further forward in time than in the northern North Sea. A new invasive copepod species, *Pseudodiaptomus marinus* (originating from east Asiatic waters), was found in the southern North Sea in 2011.

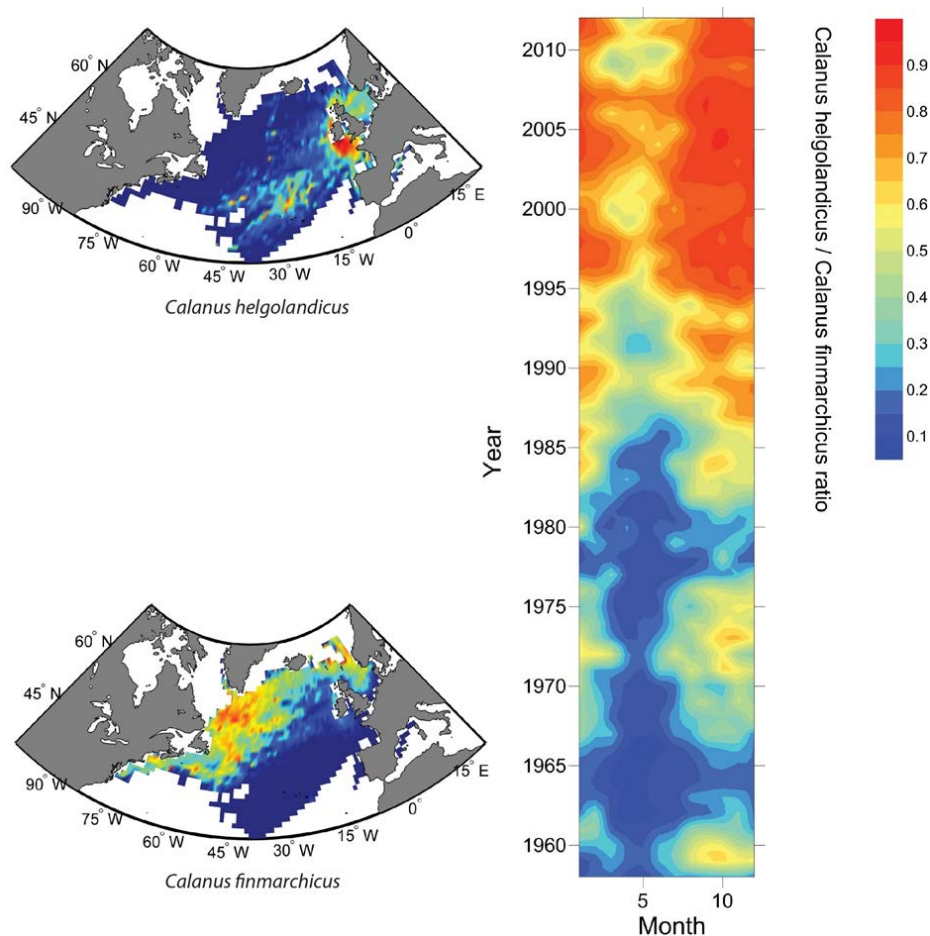


Figure 13 A simple ratio between a warm-water species (*Calanus helgolandicus*) and a cold-water species (*Calanus finmarchicus*) per month from 1958 to 2012 in the North Atlantic. Red values indicate a dominance of the warm-water species and blue values the dominance of the cold-water species.

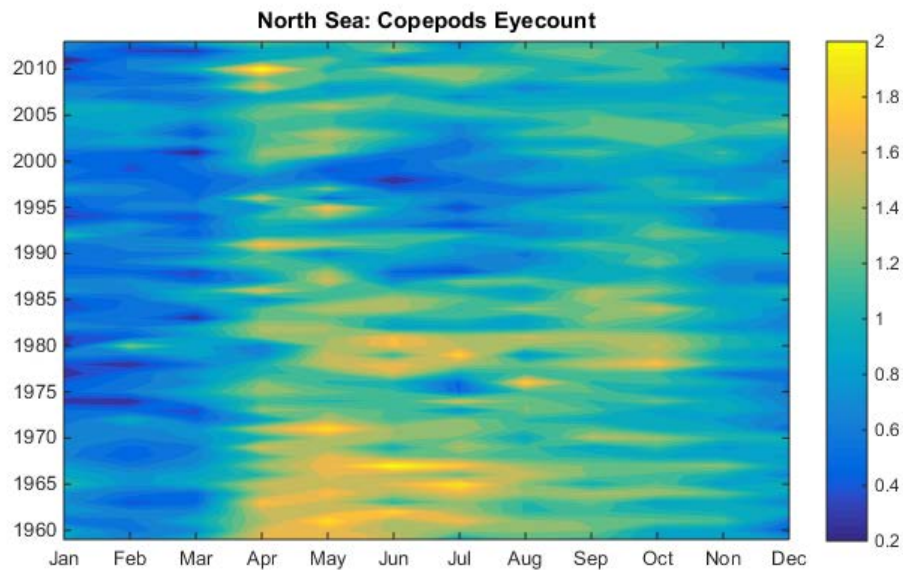


Figure 14 Long-term trends in copepod abundance from the Continuous Plankton Recorder (CPR) survey (log-mean abundance per cubic meter), aggregated for the Greater North Sea region 1958–2014 (data source: <https://www.cprsurvey.org/>).

Benthos

The Greater North Sea benthic communities show a division between communities in the mainly shallow inshore waters in the south (English Channel to German Bight) from those in deeper waters (>50 m) north of the Dogger Bank. In between, the offshore communities of the sandy and muddy areas are also well distinguished (including the Oyster Ground and the sandy Dogger Bank). Coarser substrata, especially in the southwestern North Sea and the eastern English Channel generally supports species-rich communities, contrasting the latitudinal (south-to-north) trend towards higher diversity in finer sediments.

Cephalopods

The most abundant species are *Alloteuthis subulata* and long-finned squid *Loligo forbesii*, which have seasonal migration patterns throughout and into the North Sea. The main exploited species is *Loligo forbesii*.

Fish

In the Greater North Sea the main forage fish (herring, sandeel, sprat, and Norway pout) feed mainly on plankton and are an important food source in the foodweb. Smaller piscivorous fish (e.g. whiting *Merlangius merlangus*, haddock *Melanogrammus aeglefinus*, and grey gurnard *Eutrigla gurnardus*) and stocks that enter the North Sea only in specific seasons such as western horse mackerel *Trachurus trachurus* and mackerel, all eat forage fish and juvenile gadoids to a large extent. Benthic-feeding fish include all kinds of flatfish feeding on prey on or near the bottom. Fish that can eat large fish (>25 cm) are mainly large cod, saithe, and elasmobranchs, but species like seals and harbour porpoise are also important top predators. Trends in fishing pressure and stock size are presented in the ‘Selective extraction of species’ section. Natural mortality is now the main source of mortality for many commercial species due to a successful reduction in fishing mortality in recent years.

Seabirds

At least 19 species of seabird breed on the coasts of the Greater North Sea, in particular large numbers of northern gannet *Morus bassanus*, herring gull *Larus argentatus*, lesser black-backed gull *Larus fuscus*, black-legged kittiwake *Rissa tridactyla*, and common guillemot *Uria aalge*. Broadly, the numbers of breeding seabirds increased until about 2000, after which there was a decline. The North Sea is used for feeding, both by breeding species on its coasts and by birds from further afield during the non-breeding season. Immigrants during winter from the north and east are of particular note.

Numbers of some of these immigrants have been declining, possibly due to milder winters, meaning that these migrants can remain in waters closer to their breeding grounds.

Marine mammals

Two species of seal occur commonly in the North Sea: grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina*. Four cetacean species occur commonly or are resident: minke whale *Balaenoptera acutorostrata*, harbour porpoise *Phocoena phocoena*, white-beaked dolphin *Lagenorhynchus albirostris*, and bottlenose dolphin *Tursiops truncatus*. A further five species are considered regular but less common, short-beaked common dolphin *Delphinus delphis*, Atlantic white-sided dolphin *Lagenorhynchus acutus*, long-finned pilot whale *Globicephala melas*, killer whale *Orcinus orca*, and Risso's dolphin *Grampus griseus*.

Both seal species have gone through large population changes over the past century. The abundance of harbour seals reached an all-time low in the 1970s but subsequently increased steadily at an annual rate of 4%; however, this increase was affected by two major interruptions due to outbreaks of the phocine distemper virus (PDV) in 1988 and 2002. Over the last 15 years, declines in the harbour seal population have occurred in the northwestern North Sea. The reasons for these recent declines are unknown, although they are thought to be different in different areas. Grey seals occur predominantly along the British coasts of the North Sea and have been increasing at an annual rate of up to 10%.

Trends in the abundance of cetaceans are less well known, but it is known that the centre of summer distribution of harbour porpoises moved southwards between 1994 and 2005, possibly in response to changes in availability of main prey. Minke whales and white-beaked dolphins are found mainly in the northern North Sea, with no obvious changes in distribution between the two surveys. The resident population of bottlenose dolphins lives along the coasts of eastern Scotland and is considered to be stable or increasing.

Trends in non-indigenous species

This ecoregion has 274 non-indigenous (NIS) and cryptogenic (obscure or of unknown origin) species. The majority (142 species) arrived between 1950 and 1999, with 60 species arriving since the beginning of the 21st century. Since 2000, a total of 21 new species have been recorded, all of which are new to Europe. The discovery rate increased between 1950–1999 and 2000–2014 (Figure 15).

The main vector for primary introductions is vessels, either through ballast water or hull fouling, followed by aquaculture. Natural spread from neighbouring countries is considered to account for a third of the introduced species.

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 impacts include: out-competing native commercial species, fouling of aquaculture and fishing gear, and fish kills through toxin production. However, some NIS are considered as valuable resources.

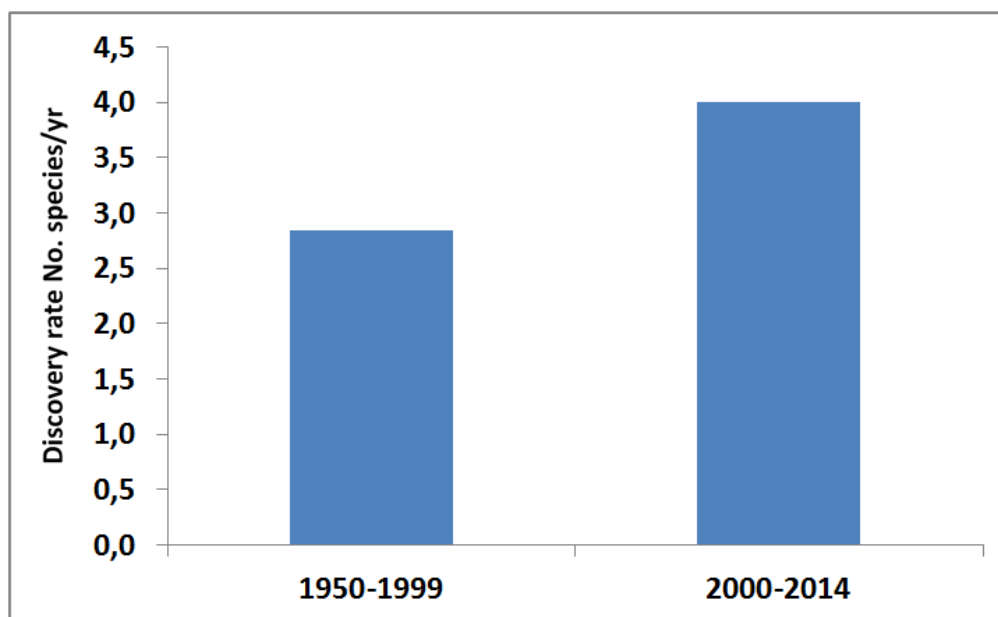


Figure 15 Annual rate of new non-indigenous and cryptogenic species discoveries in the Greater North Sea 1950–1999 and 2000–2014.

Threatened and declining species and habitats

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

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

Threatened and declining habitats in the Greater North Sea according to OSPAR

HABITATS
Coral gardens
Intertidal <i>Mytilus edulis</i> beds on mixed and sandy sediments
Intertidal mudflats
Littoral chalk communities
<i>Lophelia pertusa</i> reefs
Maerl beds
<i>Modiolus modiolus</i> beds
<i>Ostrea edulis</i> beds
<i>Sabellaria spinulosa</i> reefs
Sea-pen and burrowing megafauna communities
<i>Zostera</i> beds

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

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

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Annex A

Table A1 Stocks with analytical assessments and guilds included in Figure 5. Detailed information on the fisheries of the Greater North Sea is provided on the Greater North Sea Fisheries Overviews.

Stock code	Stock name	Fishery Guild
lez.27.4a6a	Megrim (<i>Lepidorhombus spp.</i>) in divisions 4.a and 6.a (northern North Sea, West of Scotland)	benthic
meg.27.7b-k8abd	Megrim (<i>Lepidorhombus whiffiagonis</i>) in divisions 7.b–k, 8.a–b, and 8.d (west and southwest of Ireland, Bay of Biscay)	benthic
ple.27.21-23	Plaice (<i>Pleuronectes platessa</i>) in subdivisions 21–23 (Kattegat, Belt Seas, and the Sound)	benthic
ple.27.420	Plaice (<i>Pleuronectes platessa</i>) in Subarea 4 (North Sea) and Subdivision 20 (Skagerrak)	benthic
ple.27.7d	Plaice (<i>Pleuronectes platessa</i>) in Division 7.d (eastern English Channel)	benthic
ple.27.7e	Plaice (<i>Pleuronectes platessa</i>) in Division 7.e (western English Channel)	benthic
sol.27.20-24	Sole (<i>Solea solea</i>) in subdivisions 20–24 (Skagerrak and Kattegat, western Baltic Sea)	benthic
sol.27.4	Sole (<i>Solea solea</i>) in Subarea 4 (North Sea)	benthic
sol.27.7d	Sole (<i>Solea solea</i>) in Division 7.d (eastern English Channel)	benthic
sol.27.7e	Sole (<i>Solea solea</i>) in Division 7.e (western English Channel)	benthic
nep.fu.3-4	<i>Nephrops</i> (<i>Nephrops norvegicus</i>) in Division 4.b, Functional Unit 34 (central North Sea, Devil's Hole)	crustacean
nep.fu.6	<i>Nephrops</i> (<i>Nephrops norvegicus</i>) in Division 4.b, Functional Unit 6 (central North Sea, Farn Deep)	crustacean
nep.fu.7	<i>Nephrops</i> (<i>Nephrops norvegicus</i>) in Division 4.a, Functional Unit 7 (northern North Sea, Fladen Ground)	crustacean
nep.fu.8	<i>Nephrops</i> (<i>Nephrops norvegicus</i>) in Division 4.b, Functional Unit 8 (central North Sea, Firth of Forth)	crustacean
nep.fu.9	<i>Nephrops</i> (<i>Nephrops norvegicus</i>) in Division 4.b, Functional Unit 9 (central North Sea, Moray Firth)	crustacean
pra.27.3a4a	Northern shrimp (<i>Pandalus borealis</i>) 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 (<i>Molva dypterygia</i>) in subareas 6–7 and Division 5.b (Celtic Seas, English Channel, and Faroes grounds)	demersal
bss.27.4bc7ad-h	Seabass (<i>Dicentrarchus labrax</i>) 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 (<i>Gadus morhua</i>) in Subarea 4, Division 7.d, and Subdivision 20 (North Sea, eastern English Channel, Skagerrak)	demersal
cod.27.7e-k	Cod (<i>Gadus morhua</i>) in divisions 7.e–k (eastern English Channel and southern Celtic Seas)	demersal
had.27.46a20	Haddock (<i>Melanogrammus aeglefinus</i>) in Subarea 4, Division 6.a, and Subdivision 20 (North Sea, West of Scotland, Skagerrak)	demersal
had.27.7b-k	Haddock (<i>Melanogrammus aeglefinus</i>) in Divisions 7.b–k (southern Celtic Seas and English Channel)	demersal
hke.27.3a46-8abd	Hake (<i>Merluccius merluccius</i>) 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 (<i>Pollachius virens</i>) in subareas 4, 6 and Division 3.a (North Sea, Rockall and West of Scotland, Skagerrak and Kattegat)	demersal

Stock code	Stock name	Fishery Guild
whg.27.47d	Whiting (<i>Merlangius merlangus</i>) in Subarea 4 and Division 7.d (North Sea and eastern English Channel)	demersal
whg.27.7b-ce-k	Whiting (<i>Merlangius merlangus</i>) in divisions 7.b–c and 7.e–k (southern Celtic Seas and eastern English Channel)	demersal
boc.27.6-8	Boarfish (<i>Capros aper</i>) in subareas 6–8 (Celtic Seas, English Channel, and Bay of Biscay)	pelagic
her.27.1-24a514a	Herring (<i>Clupea harengus</i>) 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 (<i>Clupea harengus</i>) in subdivisions 20–24, spring spawners (Skagerrak, Kattegat, and western Baltic)	pelagic
her.27.3a47d	Herring (<i>Clupea harengus</i>) in Subarea 4 and divisions 3.a and 7.d, autumn spawners (North Sea, Skagerrak and Kattegat, eastern English Channel)	pelagic
hom.27.2a4a5b6a7a-ce-k8	Horse mackerel (<i>Trachurus trachurus</i>) 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 (<i>Scomber scombrus</i>) in subareas 1–8 and 14 and division 9.a (the Northeast Atlantic and adjacent waters)	pelagic
whb.27.1-91214	Blue whiting (<i>Micromesistius poutassou</i>) in subareas 1–9, 12, and 14 (Northeast Atlantic and adjacent waters)	pelagic