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3.1 Norwegian Sea ecoregion – Ecosystem overview

Ecoregion description

The Norwegian Sea, the Greenland Sea, and the Iceland Sea comprise the Nordic seas, which are separated from the rest of the North Atlantic by the Greenland–Scotland Ridge. The Norwegian Sea (NwS) connects with the Northeast Atlantic Ocean to the southwest, the Icelandic Waters ecoregion and Greenland sea to the west along the edge to the shallower Iceland Sea between the Faroe Islands, and northwards to Jan Mayen. To the south it borders to the shallower North Sea along the 62˚N parallel between Norway and the Faroe Islands, and to the northeast with the shallower Barents Sea (Figure 1).

The Norwegian Sea covers more than 1.1 million km^2, consisting of two deep basins (between 3000 and 4000 m deep), the Norwegian Basin and the Lofoten Basin, separated by the Vøring plateau (between 1000 and 3000 m deep). The Norwegian Sea is separated from the Greenland Sea to the north by the Mohn Ridge. To the west, the basin slope forms the transition to the somewhat shallower Iceland Sea. The upper ocean of the Nordic seas consists of warm and saline Atlantic water to the east, and cold and fresh polar water from the Arctic to the west.

The Norwegian and Barents seas are transition zones for warm and saline waters on their way from the Atlantic to the Arctic Ocean. The major current, the Norwegian Atlantic Current (NwAC), is a poleward extension of the Gulf Stream and the North Atlantic Current that acts as a conduit for warm and saline Atlantic water from the North Atlantic to the Barents Sea and Arctic Ocean.

The fisheries in the Norwegian Sea ecoregion are managed by Norway and by coastal states, with some fisheries managed by the North East Atlantic Fisheries Commission (NEAFC). Responsibility for management of salmon fisheries rests with the North Atlantic Salmon Conservation Organization (NASCO), and for large pelagic fish with the International Commission for the Conservation of Atlantic Tunas (ICCAT). Fisheries advice is provided by the International Council for the Exploration of the Sea (ICES). Environmental issues are managed by Norwegian agencies and through OSPAR, with advice being provided by Norwegian agencies, OSPAR, and ICES. International shipping is managed under the International Maritime Organization (IMO). The International Whaling Commission (IWC) has regulations for the conservation and harvest of whales. Marine mammal issues are also considered in cooperation under the North Atlantic Marine Mammal Commission (NAMMCO).

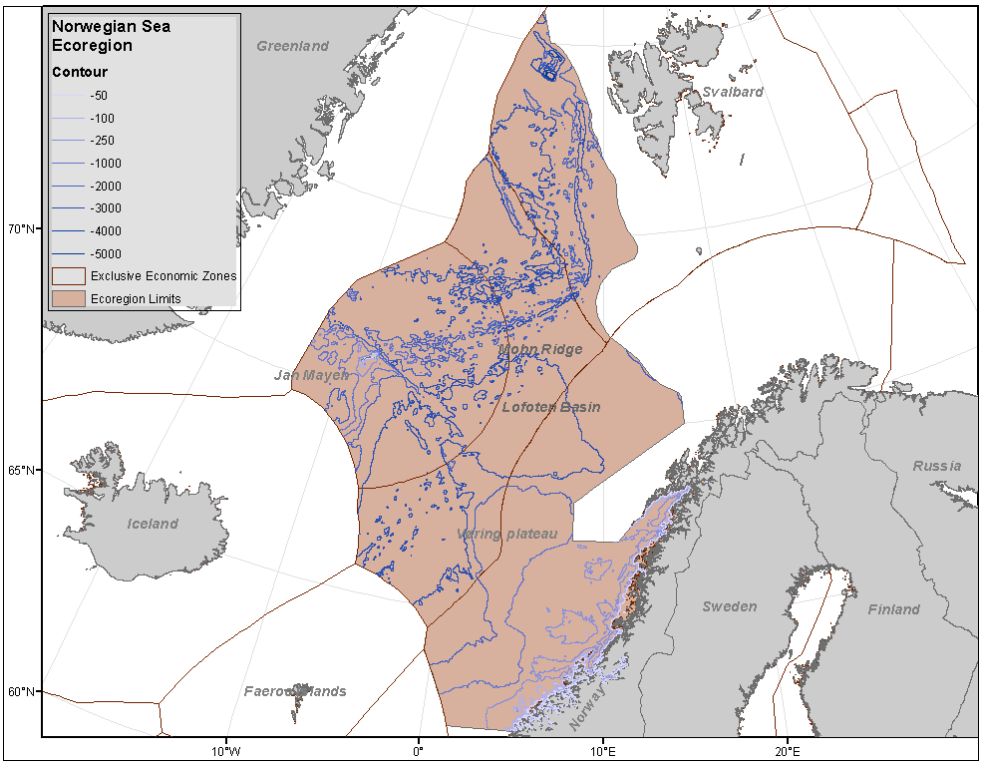

Figure 1 The Norwegian Sea ecoregion, showing EEZs and depth contours.

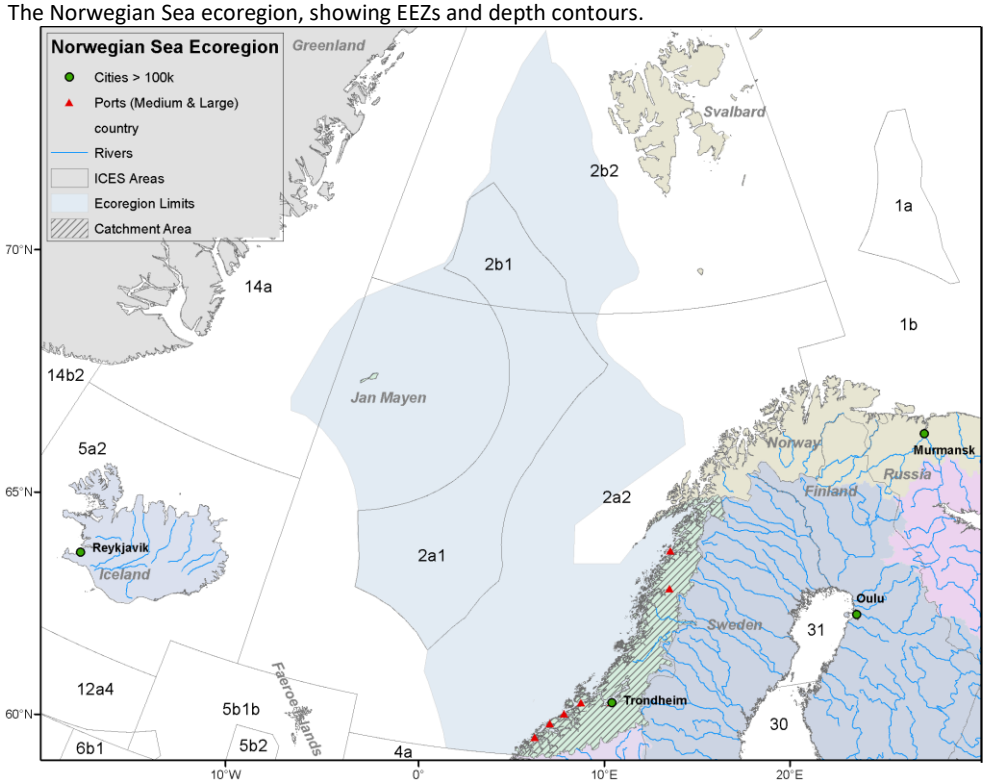

Figure 2 Catchment area for the Norwegian Sea ecoregion, showing major cities, ports, and ICES areas.

Key signals within the environment and the ecosystem

Water temperatures, both at the surface and in deeper waters in the Norwegian Sea have been above the long-term trend since around the beginning of the 2000s, peaking in 2007 at almost 1.5˚C above the long-term mean at water depths of 50–500 m. Though the 2014 level was near and slightly above and the 2015 level at and below the long-term mean, the temperature trend is still positive because of inflow of Atlantic waters at the western entrance. The heat content of Atlantic water in the Norwegian Sea has been above the long-term mean since 2000.

The decrease in the zooplankton biomass index observed during the last decade for the whole Norwegian Sea has stopped. The index increased again from 2010 to 2014, but had a drop in 2015.

Since the mid-2000s, the mackerel *Scomber scombrus* stock has increased both its geographic distribution during summer feeding and its stock size.

The Norwegian spring-spawning (NSS) herring *Clupea harengus* stock has not produced large year classes after the relatively productive period of 1998–2004, causing decreasing SSB since 2009 to around B_{pa} in 2016 (5 million tonnes).

The blue whiting *Micromesistius poutassou* biomass reached a maximum level in the mid-2000s, declining thereafter until around 2010. Since then blue whiting has shown an upward trend with production of strong year classes.

Populations of seabirds breeding (and therefore feeding) in the ecoregion have declined greatly since 1980.

Pressures

The NwS is influenced by human activity; historically involving fishing as well as the hunting of marine mammals. More recently, human activities also involve transportation of goods, oil, gas, and tourism, with contaminants coming from outside the boundaries of the ecoregion.

Human-induced climate change and ocean acidification may have a large influence on the NwS in future.

Changing distributions of valuable fish stocks (e.g. mackerel and NSS herring) lead to international disputes on harvest rights and quota sharing. It may also lead to changes in spawning success and to changes in migration patterns and ecological cascades with unknown outcome. The main pressures described below are defined in the ICES glossary of human pressures.

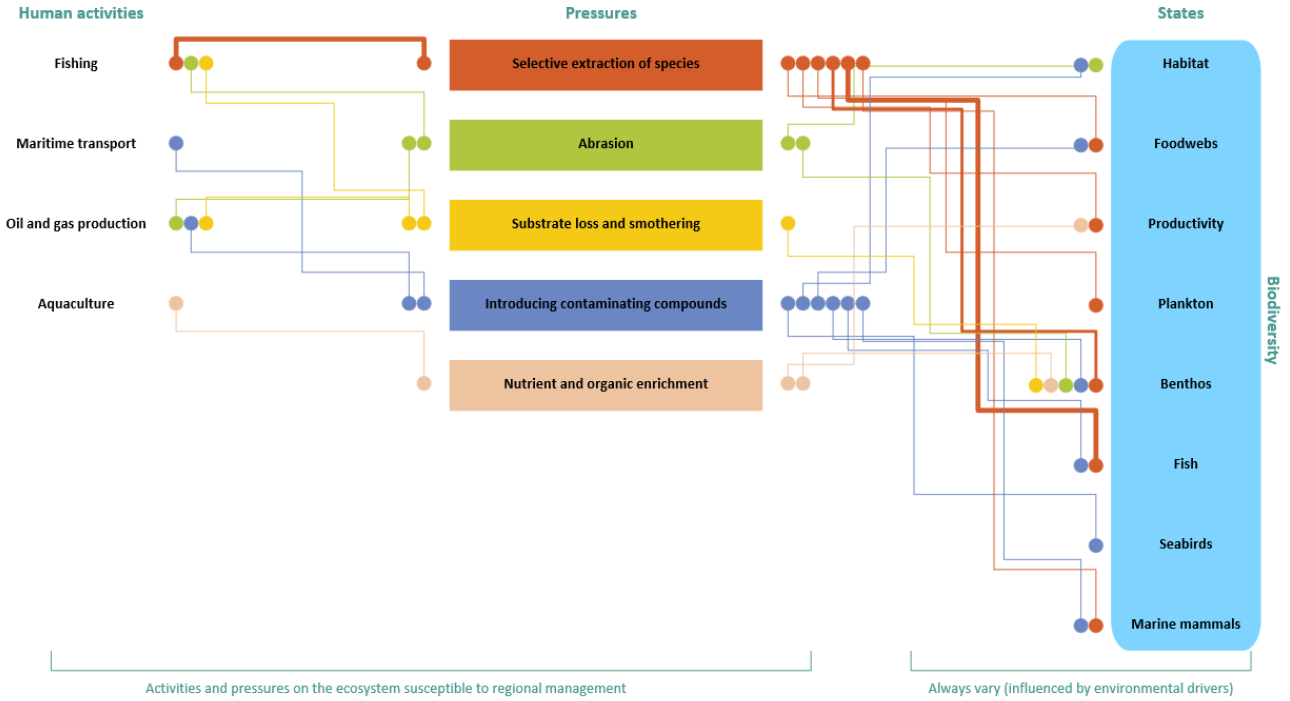

Figure 3 Norwegian Sea ecoregion overview with the major regional pressures, human activities, and state of the ecosystem components. The width of lines indicates the relative importance of individual links (the scaled strength of pressures should be understood as a relevant strength between the human activities listed and not as an assessment of the actual pressure on the ecosystem).

Pelagic fishing by multinational fleets is the major activity in the ecoregion. The number of fishing vessels is declining while the sizes of the vessels are increasing. The Norwegian commercial fleet has the highest fishing activity in the shelf area, particularly along the coast of Norway and along the continental shelf edge (Figure 4a and 4b). Icelandic vessels operate mainly with pelagic trawl in the ecoregion (Figure 4c). Other fisheries in the ecoregion are predominantly pelagic fisheries targeting NSS-herring, mackerel, and blue whiting.

Bottom trawls are regulated along the Norwegian continental slope through closed areas to avoid extended damage on fragile and vulnerable benthic communities and reef-building organisms.

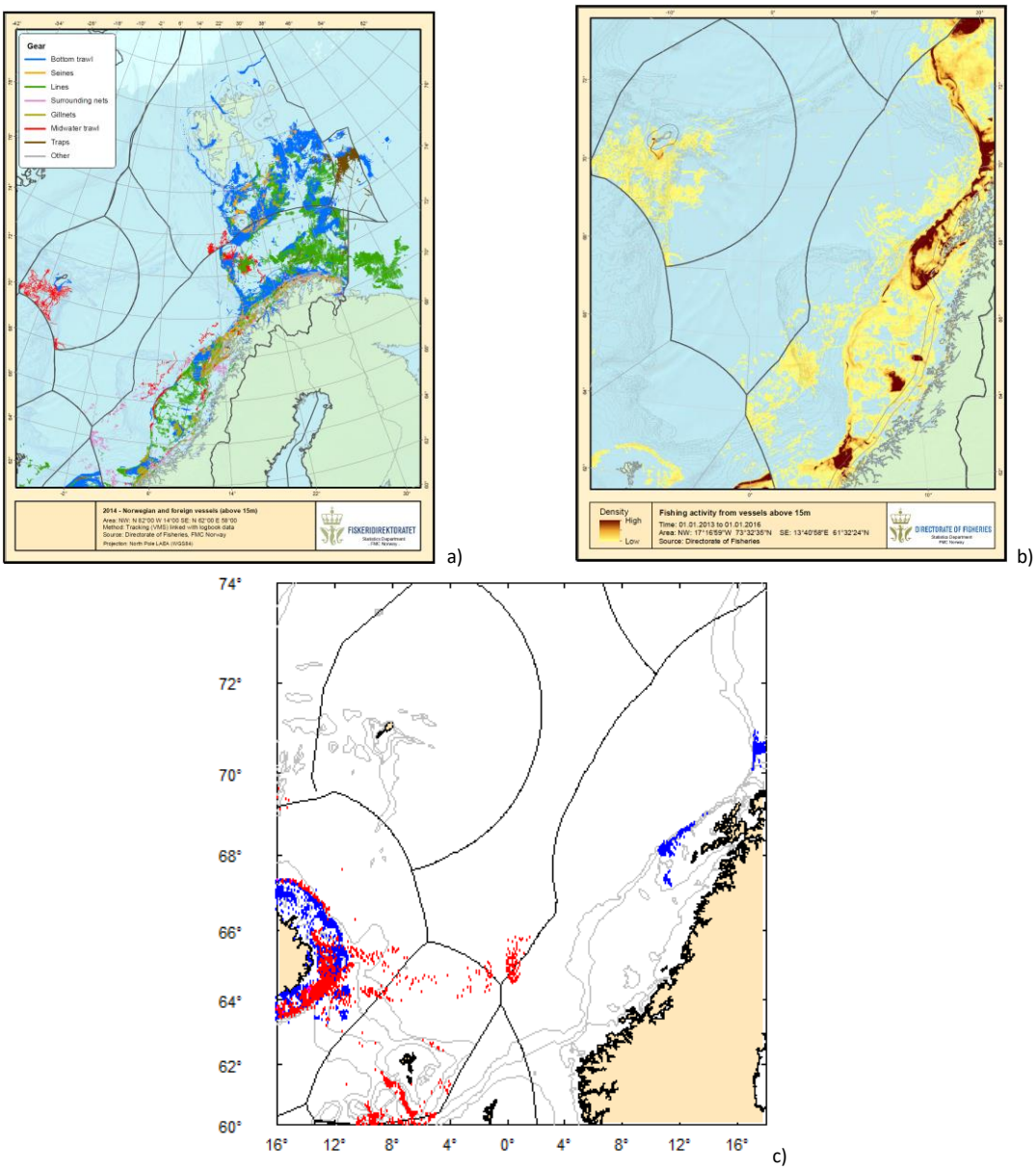

Figure 4 Representation of fishing activity in the Norwegian Sea by (a) the Norwegian fleets (larger than 15 m) in 2014 with pelagic trawls (red dots), bottom trawls (blue dots), gillnets (light green), longlines (green), and seines (orange); (b) Norwegian and foreign fishing commercial fleets (larger than 15 m) and fishing vessels used for research purposes from 01.01.2013 to 01.01.2016, as reported through vessel monitoring systems (VMS) to Norwegian authorities (Sources: ICES, 2015b, 2016a; Norwegian Directorate of Fisheries, http://www.fiskeridir.no/English); and (c) the Icelandic fishing fleet in 2014 with midwater trawls (red dots) and bottom trawls (blue dots; no purse-seine fishery is in the area).

The oil- and gas-related activities are managed through governmental licences (figures 8–9 below). Seismic investigations occur annually and are prohibited in the Norwegian sector during the spawning periods of Northeast Atlantic (NEA) cod *Gadus morhua* and NSS herring.

Non-fishing marine traffic shows a slightly increasing trend, in particular in tourist traffic. Most ships follow the main traffic lanes near the coasts (Figure 5).

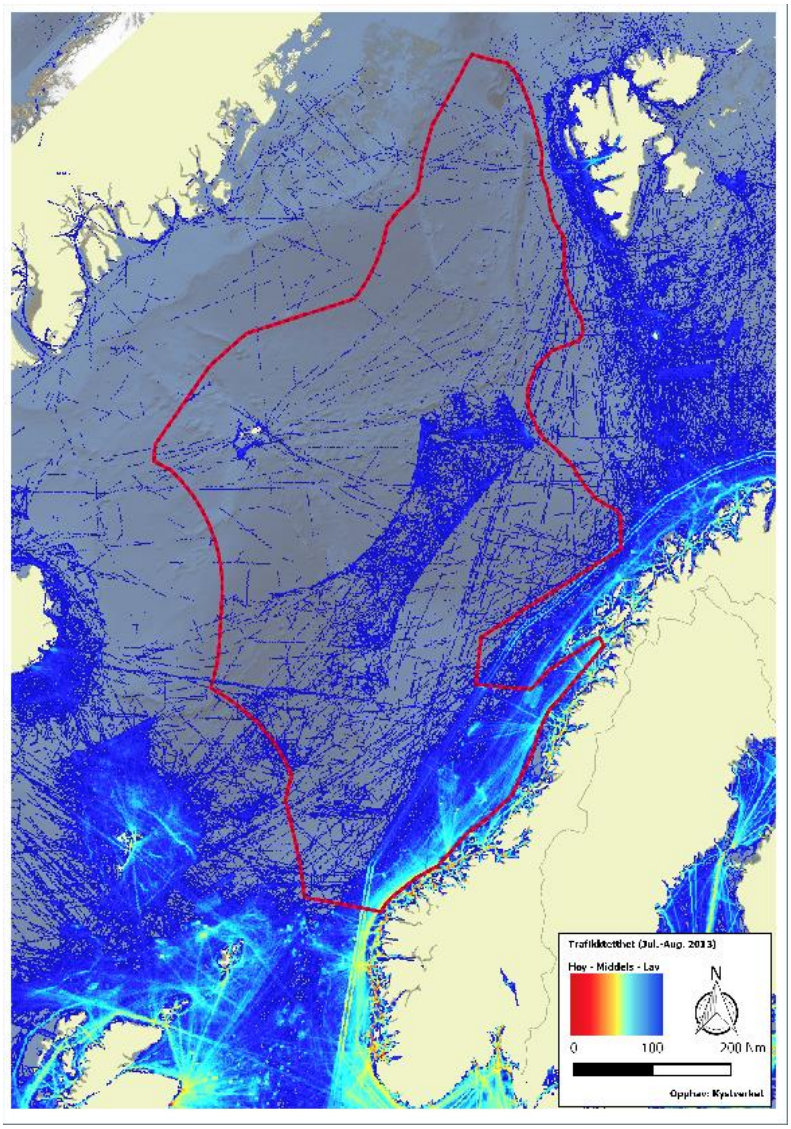

Figure 5 Density plot for vessel (including fishing vessels) movements (AIS-data) in the Norwegian Sea for July through August 2013. The traffic seen in international waters in the centre of the ecoregion is predominantly fishing vessels. (Source: Norwegian Maritime Authority, www.sjofartsdir.no.)

Selective extraction of species (including non-target catch)

A multinational fishery currently operates in the NwS using different fishing gears and targeting several species. The annual catch in the ecoregion varies between 700 000 tonnes to almost 1 million tonnes (2012) from the stocks of NSS herring, mackerel, blue whiting, NEA saithe *Pollachius virens*, redfish *Sebastes* sp., and silver smelt *Argentina silus*. The fishing pressure on the largest commercially exploited fish stocks (NSS herring, blue whiting, and mackerel) have varied since the 1980s, for a number of reasons (Figure 6). They are now harvested at fishing mortalities close to those in the management plans and have full reproductive capacity. While the golden redfish *S. norvegicus* stock is at a historical low point, the beaked redfish *S. mentella* stock has recovered from a low SSB and fishing quotas (until 2017) are set at 30 000 tonnes annually. The small coastal cod *Gadus morhua* stock is overfished. The fisheries management plan sets the upper limits for landings in the region. Other stocks are commercially harvested (Greenland halibut *Reinhardtius hippoglossoides*, halibut *Hippoglossus hippoglossus*, deep-water shrimps *Pandalus borealis*, the copepod *Calanus finmarchicus,* and minke whale *Balaenoptera acutorostrata*).

Regulations established in 2011 have restricted the use of bottom trawls in areas with coral reefs and at depths exceding 1 000 m. Some bycatch of seabirds and marine mammals is known to occur, but numbers have not been quantified. Only minke whales are exploited in the NwS.

A Norwegian hunt for minke whales is conducted in the Norwegian Sea, Barents Sea, North Sea, and the Jan Mayen area. Quotas are set in accordance with IWC's Revised management procedure and the total annual catch has ranged between 450 and 750 animals in all waters. Survey population estimates are provided every six years and have shown the population to be stable over the past five survey cycles.

A small trial commercial fishery (< 1000 tonnes annually) for *Calanus finmarchicus* has been developed along the Norwegian coast for more than a decade. Norway is currently considering to upscale this fishery for offshore parts of the NwS.

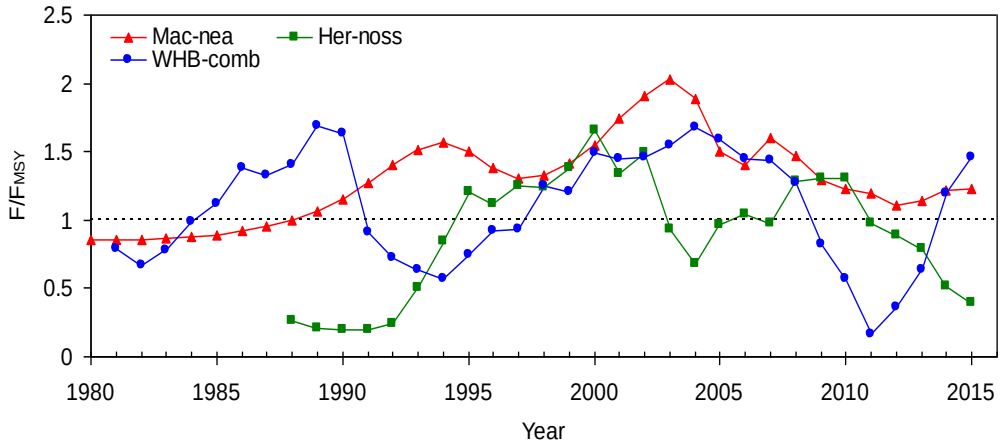

Figure 6 Time-series of average of relative fishing mortality (F to F_{MSY} ratio) for Northeast Atlantic mackerel (Mac-nea), Norwegian spring-spawning herring (Her-noss), and blue whiting (WHB-comb), based on ICES 2016 assessments.

Abrasion

Abrasion occurs from towed bottom-contacting gear with some damage to benthic organisms and habitats. Relatively little such gear is used in the NwS, mainly on the shelf in the southern part of the ecoregion (Figure 7). Some abrasion can occur near offshore oil and gas operations – these also are limited in extent and numbers in the NwS.

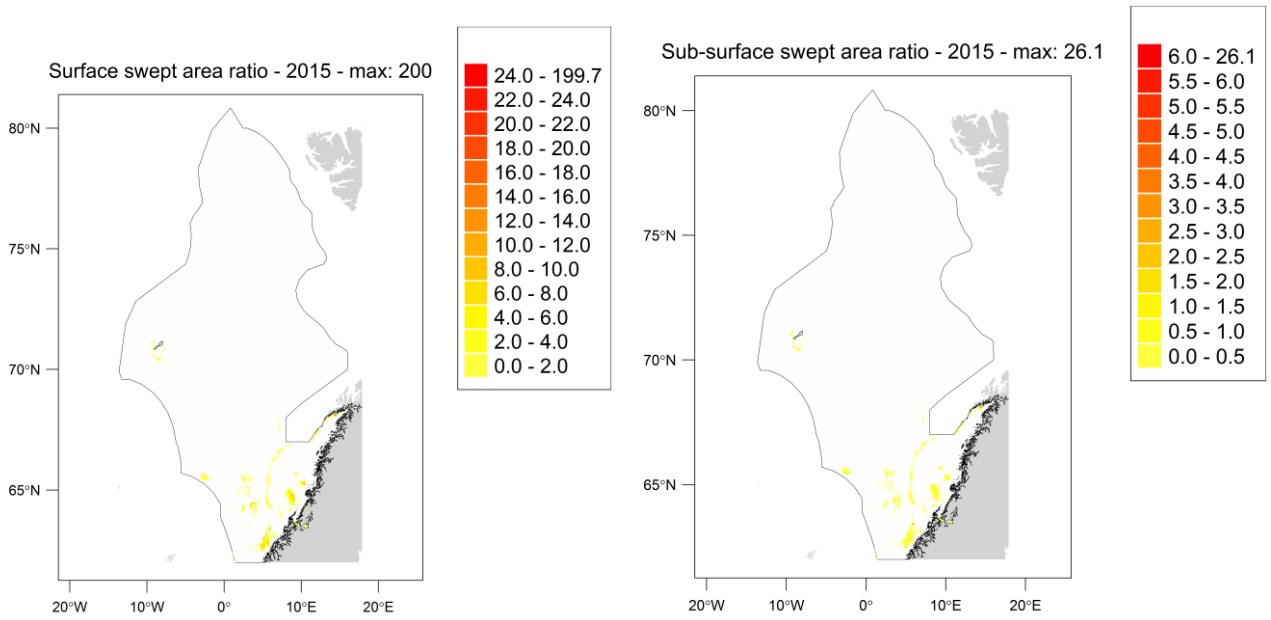

Figure 7 Surface and subsurface abrasion pressure expressed as the swept-area ratio obtained from VMS data from 2015 in the Norwegian Sea ecoregion.

Coral reef areas are protected from bottom fishing. Relatively large areas are closed to petroleum-related activities in the Norwegian EZZ, in particular at the Møre plateau (Figure 8).

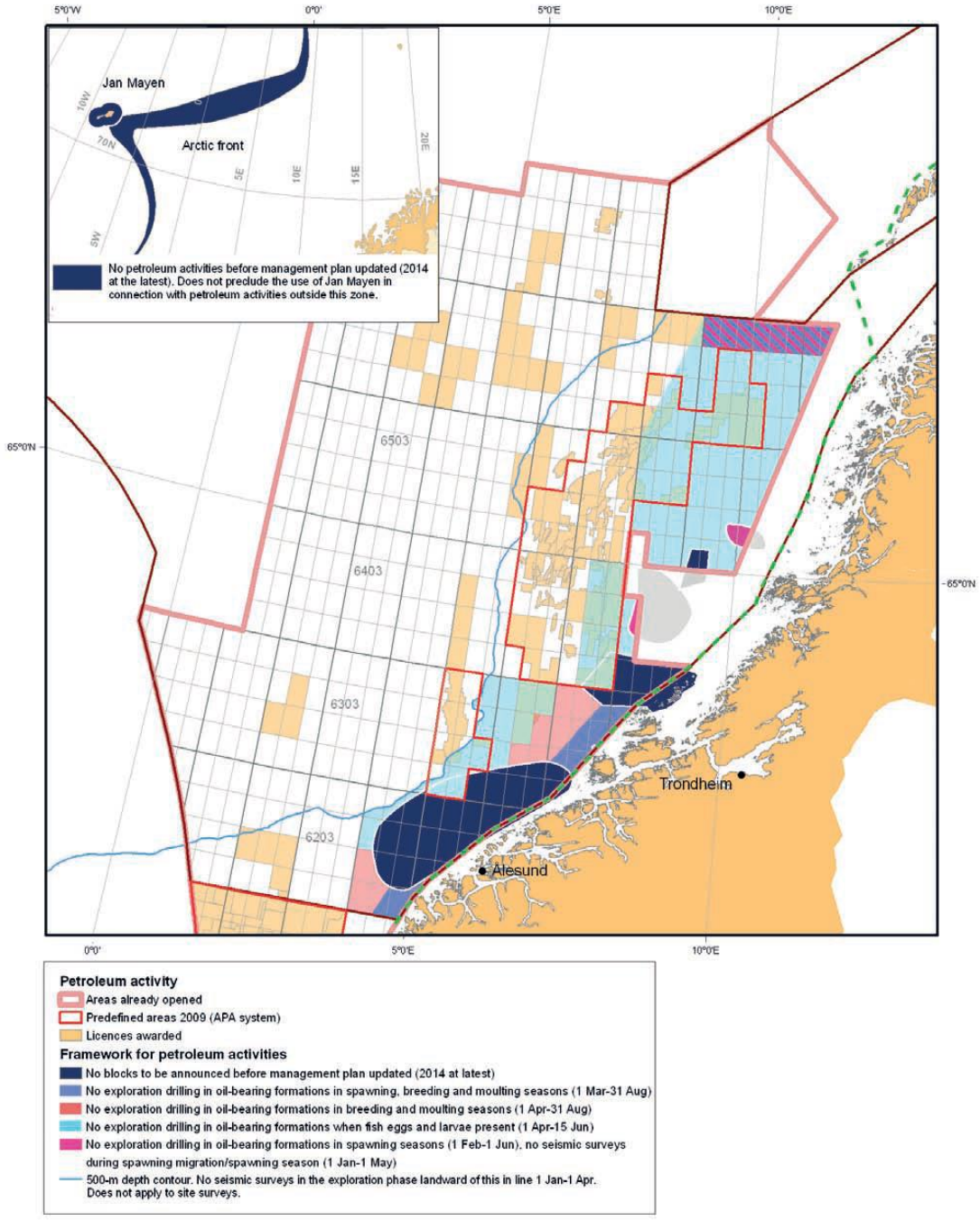

Figure 8 Framework for petroleum activities (announcement of blocks, exploration drilling, seismic surveying). (Source: Norwegian Ministry of the Environment, 2009.)

Introduction of contaminating compounds

The NwS remains relatively clean with low pollution levels compared to marine areas in many industrialized parts of the world. The Norwegian management plan covers pollution with several indicators, including sources from outside the ecoregion as well as from the oil and gas industry.

Releases of NO_x, CO_2, and pollutants (oil releases to the sea, greenhouse gases, organic acids (declining), phenols, PAH, radioactive compounds) in produced-water from the petroleum activities are fairly stable, or in some cases slowly rising.

River run-offs are negligible.

Smothering and substratum loss

This pressure derives both from towed bottom-fishing (Figure 7) and from oil and gas infrastructure development (Figure 9). Oil and gas extraction continues to develop in the NwS. Currently offshore development is limited in the Norwegian economic zone.

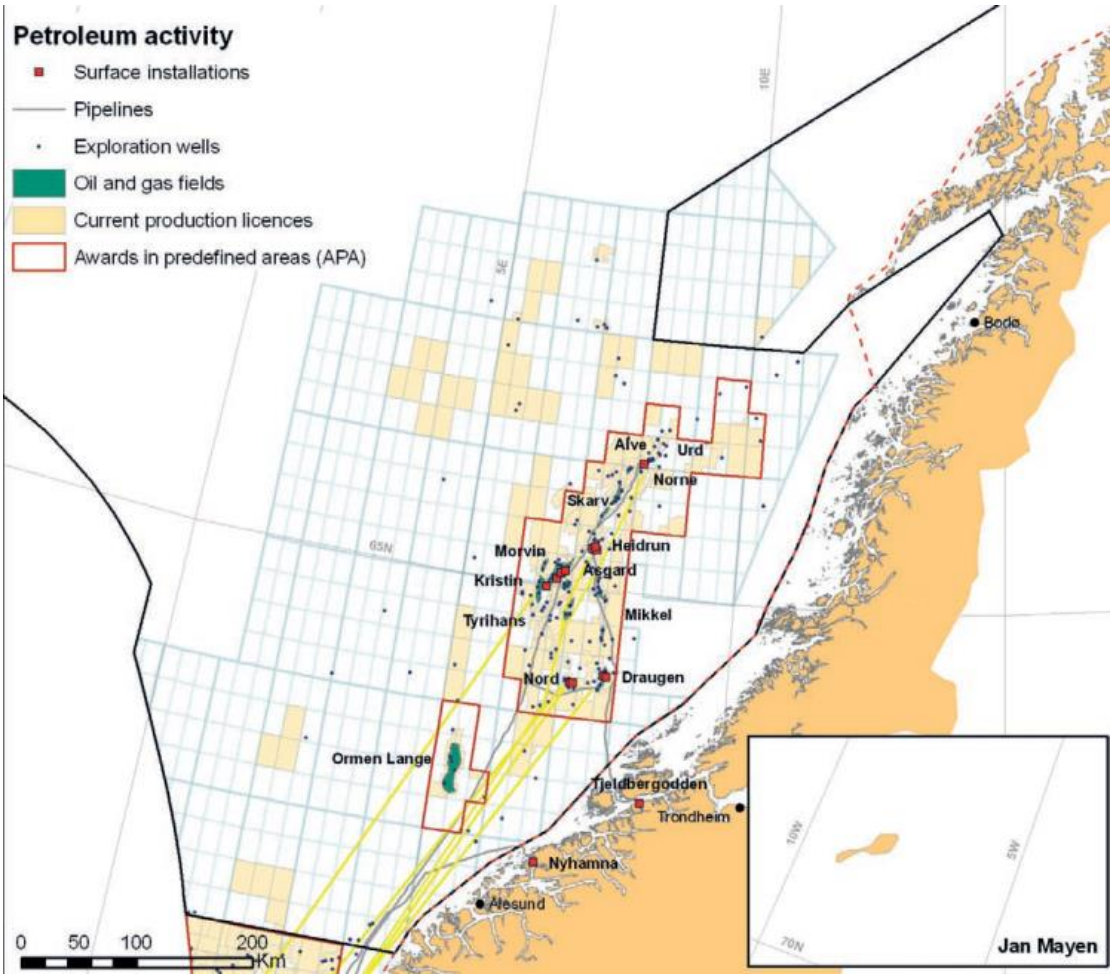

Figure 9 Overview of petroleum activities in the Norwegian Sea (Source: Norwegian Petroleum Directorate, http://www.npd.no/en/).

Nutrient and organic enrichment

Aquaculture production is increasing along the coasts and in fjords of the NwS. Several commercial fish farms are producing salmonids (salmon, trout) and shellfish. With aquaculture the increase in nutrients and enrichment can cause problems locally, but this does not impact the open ocean of the NwS.

Inputs from river run-offs are negligible.

Other pressures

Marine litter, noise, and introduced species are all pressures within the ecoregion, but their effects are considered to be of minor importance.

State of the ecosystem

Habitats (substratum)

The substrates within the coastal NwS have been mapped by the MAREANO project. This mapping is confined mostly to the Norwegian continental shelf and slope. The majority of the shelf consists of fine muds and sandy muds, with coarser sediments on the shelf slope (Figure 10). MAREANO has located several vulnerable habitat locations, including coral and sponge communities. There is little information from the deep-water areas.

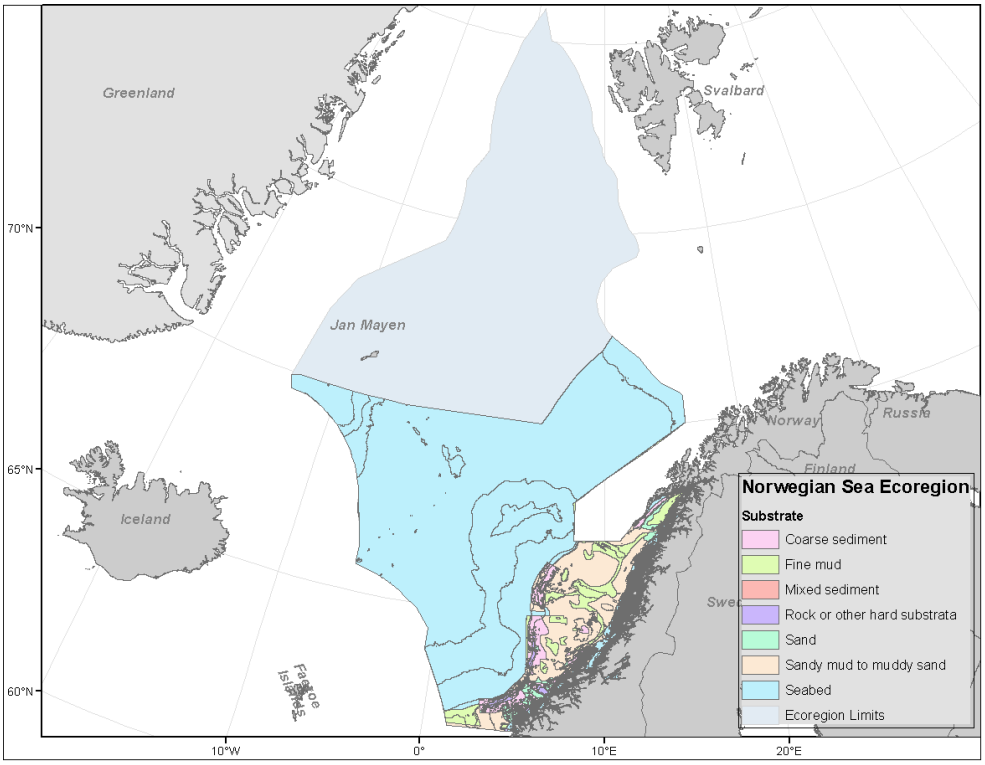

Figure 10 Major substrates in the Norwegian Sea ecoregion (compiled by EMODNET seabed habitats; www.emodnet-seabedhabitats.eu).

Productivity (phytoplankton)

Biomass varies between years, but no trends have yet been detected.

Plankton

The high-latitude ecosystem of the Norwegian Sea consists of areas with different physical regimes, and the length of productive season and intensity of biological production varies among these areas. In the east–west direction the Norwegian Sea can be divided into Norwegian coastal, Atlantic, and Arctic habitats, which is reflected in the zooplankton species composition. One of the most important zooplankton groups in the Norwegian Sea is the genus *Calanus,* both in numbers and biomass. In the Norwegian coastal and Atlantic habitats *C. finmarchicus* dominates the zooplankton biomass in spring and summer, and *C. helgolandicus* is also found in southern and eastern parts of these habitats. In the Arctic habitat *C. hyperboreus* is important. Of other species, the krill *Thysanoessa inermis*, *T. longicaudata*, and *Meganyctiphanes norvegica* are widespread, the latter especially in the warmer Atlantic and coastal habitats. The amphipod *Themisto libellula* is abundant in the Arctic, and *T. abyssorum* in the Atlantic habitats. The seasonal pulse of zooplankton production starts in southern and eastern parts of the Norwegian Sea, with a time delay towards the colder areas in the western and northern parts.

Zooplankton biomass has shown considerable fluctuations over the period 1995-2016 (Figure 11). The plankton index was relatively high from 1995 to 2002, decreased steadily from 2003 to 2006 and has since remained at relatively low levels.

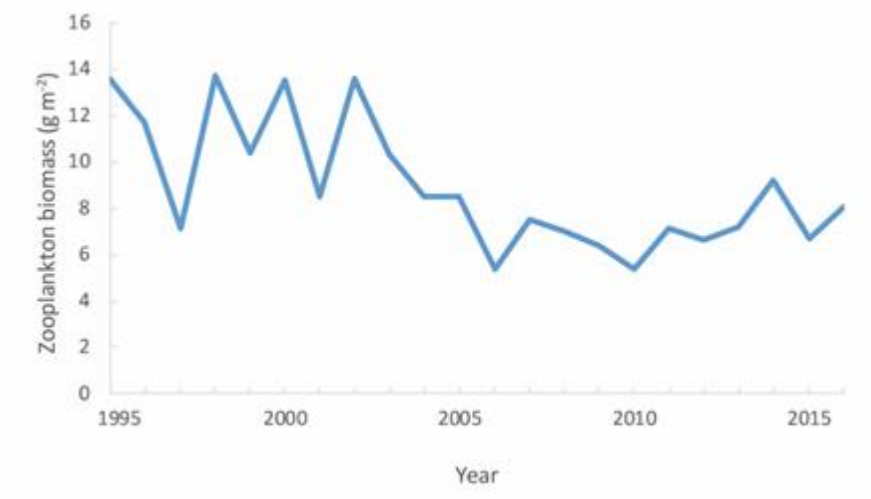

Figure 11 Indices of zooplankton dry weight (g m^{-2}) sampled in May in and near the Norwegian Sea, from 1995 to 2016. For details see ICES (2016a).

Fish

The major trends in fish distribution and abundance in the NwS during the last ten years have been the expansion and increase in the mackerel stock since 2007 and the decline in the NSS herring stock after 2009.

The mackerel stock was at a stable low level at the beginning of the 1990s. It started to increase in the mid-2000s and is currently at its maximum recorded level (Figure 12). A westward and northward expansion of its summer feeding grounds outside of NwS also started in the mid-2000s; whether this was a consequence of increasing stock, higher sea temperature in those areas, or less feeding opportunities in NwS remains to be answered.

The NSS herring has been declining since 2009 and is now considered to be at the precautionary level biomass of 5 million tonnes. The herring are getting older and a new strong cohort is needed to sustain the breeding stock.

The blue whiting stock, which prefers the slope areas of the Norwegian Sea and adjacent waters for feeding both as juveniles and adults, was at its maximum recorded level in the mid-2000s. A decrease followed until around 2011, when the stock size started to increase again as strong year classes entered the stock.

The beaked redfish stock has recovered from the low level it sustained some years ago, while the current golden redfish stock size is record low.

The stock size of saithe is increasing, with saithe mainly found along and off the coast in the NwS.

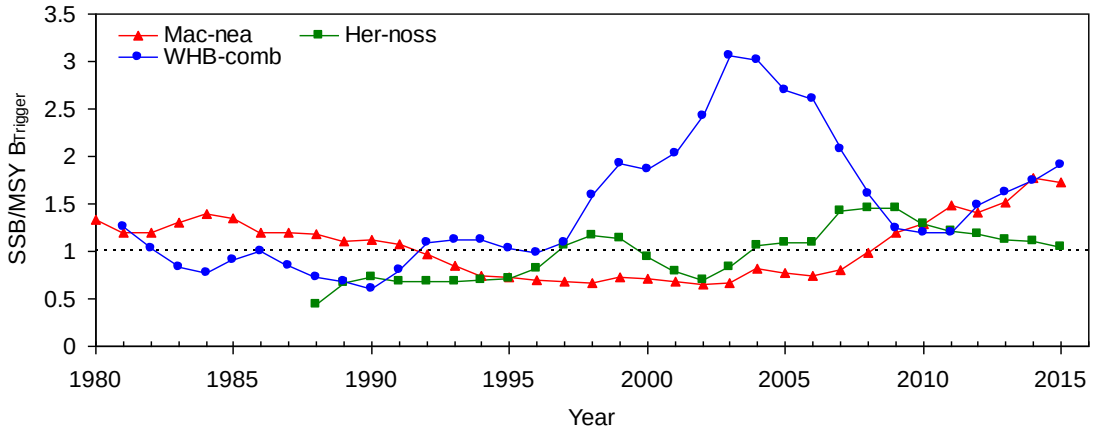

Figure 12 Biomass (SSB to B_{MSY} trigger ratio) for Northeast Atlantic mackerel (Mac-nea), Norwegian spring-spawning herring (Her-noss), and blue whiting (WHB-comb), based on ICES 2016 assessments.

Seabirds

The total number of seabirds breeding in the Norwegian parts of the Norwegian Sea was recently estimated at 1 270 000 pairs, of which 870 000 pairs of 20 species were breeding along the mainland coast and 400 000 pairs of 15 species were on Jan Mayen. Most populations have decreased steeply over the last decade (mean trend −5.8% $year^{-1}$ in 2005–2015), and many have decreased almost constantly since monitoring started three to five decades ago (see e.g. Figure 13). No single factor explains all these trends; however, long-term breeding failures for species feeding in pelagic waters such as Atlantic puffin *Fratercula arctica*, black-legged kittiwake *Rissa* tridactyla, common guillemot *Uria aalge*, and Northern fulmar *Fulmarus glacialis* indicate that much of the problem along the mainland coast is related to drastic changes in the availability of 0-group fish (especially herring), and also linked to variations in ocean climate.

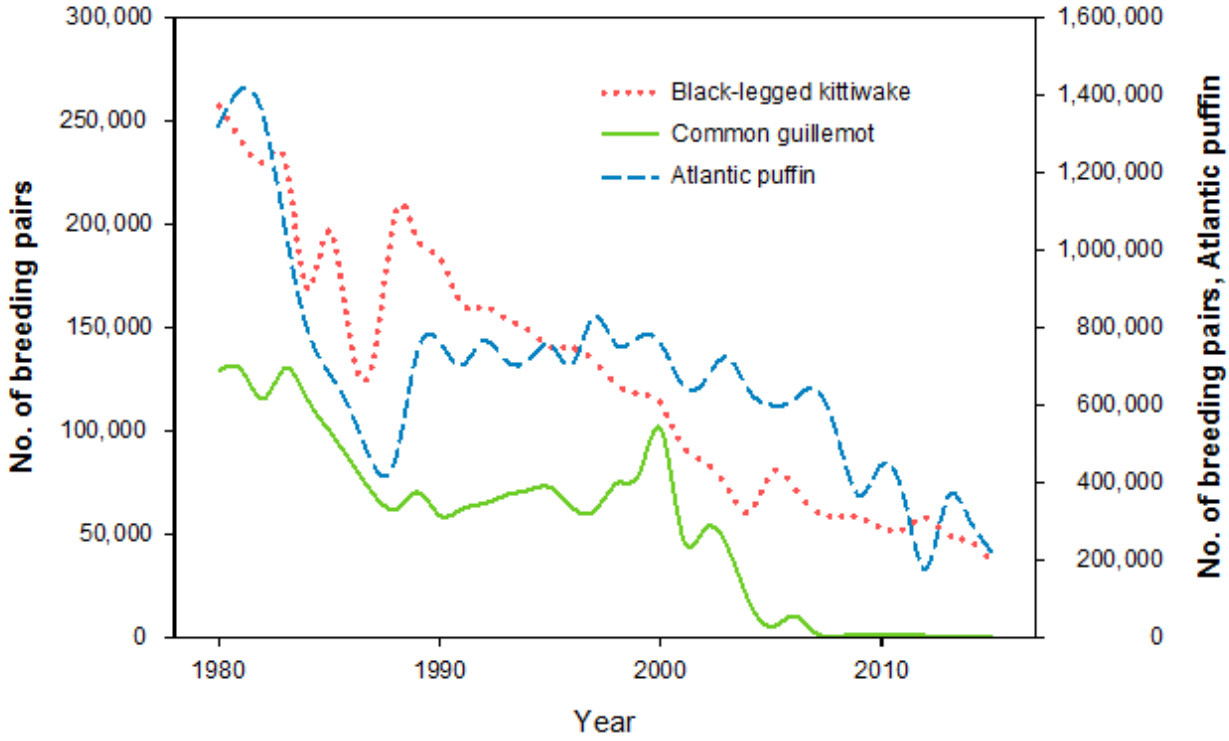

Figure 13 Development in the breeding populations of black-legged kittiwake, common guillemot, and Atlantic puffin in the Norwegian part of the Norwegian Sea in the period 1980–2013.

Marine mammals

Two species of seals are present year-round in coastal waters, harbour seal Phoca vitulina and grey seal Halichoerus grypus, with a further five pinniped species as infrequent visitors.

The abundance of harbour seals in central Norway has decreased since the late 1990s, mainly from hunting, but abundance is now increasing. Surveys of grey seals have shown a 50–60% reduction in pup production between 2007–2008 and 2014–2015 in mid-Norway, probably as a result of increased bycatches in gillnet fisheries for monkfish *Lophius piscatorius* and cod.

Twelve cetacean species are commonly observed in Norwegian waters, either on a year-round basis or as seasonal visitors in the productive summer season. The numbers of minke whales in the northeast Atlantic (including the Norwegian Sea) are stable overall (2007–2013). However, a general displacement of minke whales and other baleen whales towards the northeast implies a shift from the Norwegian Sea to the Barents Sea.

Non-indigenous species

No species are found in the Norwegian Sea are considered invasive, but the comb jelly *Mnemiopsis leidyi* is occasionally registered in zooplankton samples (most recent record in 2014), usually in warmer periods.

Threatened and declining species and habitats

Table 1 Threatened and declining species in the Norwegian Sea, according to OSPAR.

SCIENTIFIC NAME	COMMON NAME
INVERTEBRATES	
Nucella lapillus	Dog whelk
SEABIRDS	
Larus fuscus fuscus	Lesser black-backed gull
Pagophila eburnea	Ivory gull
Rissa tridactyla	Black-legged kittiwake
Uria lomvia	Thick-billed murre (or Brünnich's guillemot)
FISH	
Anguilla anguilla	European eel
Cetorhinus maximus	Basking shark
Dipturus batis	Common skate
Lamna nasus	Porbeagle
Petromyzon marinus	Sea lamprey
Salmo salar	Salmon
Squalus acanthias	[Northeast Atlantic] spurdog
MARINE MAMMALS	
Balaenoptera musculus	Blue whale
Eubalaena glacialis	Northern right whale
Phocoena phocoena	Harbour porpoise

Table 2 Threatened and declining habitats in the Norwegian Sea, according to OSPAR.

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

Sources and acknowledgments

The content for the ICES regional ecosystem overviews is based on information and knowledge generated by the following ICES processes: Workshop on Benchmarking Integrated Ecosystem Assessment (WKBEMIA) 2012, ACOM/SCICOM Workshop on Ecosystem Overviews (WKECOVER) 2013, Workshop to draft advice on Ecosystem Overviews (WKDECOVER) 2013, and the Advice Drafting Group to finalize draft Ecosystem Overviews (ADGECO) 2017, which provided the theoretical framework and final layout of the documents. ICES Working Group on the Integrated Assessments of the Norwegian Sea (WGINOR) contributed to the main sections of this overview including information from several ICES working groups, report of the Norwegian Environment Agency (2014), and the Norwegian management plan as reported by the Norwegian Ministry of the Environment (2009). The following working groups directly contributed to draft the subsections on the state of the ecosystem components: Working Group on Zooplankton Ecology (WGZE), Working Group on Marine Mammal Ecology (WGMME), Working Group on Introductions and Transfers of Marine Organisms (WGITMO), and the Joint Working Group on Seabirds (JWGBIRD). References have been removed from the text for clarity and can be found below.

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

1. Exclusive Economic Zones. *Marineregions.org (VLIZ).*
2. Depth contours. *General Bathymetric Chart of the Oceans (GEBCO).*
3. Ecoregions. *International Council for the Exploration of the Sea (ICES).*
4. Ports. *Norwegian Institute of Marine Research (IMR).*
5. Cities. *World Cities (ESRI).*
6. Rivers. *WISE Large rivers and large lakes. European Environment Agency (EEA).*
7. ICES Areas. *International Council for the Exploration of the Sea (ICES).*
8. Catchment Area. *European Environment Agency (EEA). European Topic Centre on Inland, Coastal and Marine waters (ETC/ICM).*
9. Substrate maps. EU EMODNET seabed habitats; www.emodnet-seabedhabitats.eu.

Sources and references

Anker-Nilssen, T., Barrett, R. T., Lorentsen, S-H., Strøm, H., Bustnes, J. O., Christensen-Dalsgaard, S., et al. 2015. SEAPOP – De ti første årene. SEAPOP Nøkkeldokument 2005–2014. Norwegian Institute for Nature Research, Norwegian Polar Institute and Tromsø University Museum. 58 pp. ISBN: 978-82-426-27772-8.

Anker-Nilssen, T., Strøm, H., Barrett, R., Bustnes, J. O., Christensen-Dalsgaard, S., Descamps, S., *et al*. 2016. Key-site monitoring in Norway 2015, including Svalbard and Jan Mayen. SEAPOP Short Report, 1-2016. 14 pp.

Arneberg, P., Ottersen, G., Franzen, N. M., Frie, A. K., van der Meeren, G. I., Johannson, J., and Selvik, I. 2013. Forvaltningsplan Norskehavet – rapport fra overvåkingsgruppen 2013. Fisken og Havet, særnummer 1b-2013. 95 pp. (Report on state and trends of the Barents Sea – in Norwegian.)

Bagoien. E., Melle, W., and Kaartvedt, S. 2012. Seasonal development of mixed layer depths, nutrients, chlorophyll and *Calanus finmarchicus* in the Norwegian Sea – A basin-scale habitat comparison. Progress in Oceanography, 103: 58–79.

Bambulyak, A., and Frantzen, B. 2009. Oil transport from the Russian part of the Barent Region. Status per January 2009. The Norwegian Barents Secretariat and Akvaplan-niva. 97 pp.

Barret, R., Anker-Nilssen, T., Bustnes, J. O., Christensen-Dalsgaard, S., Descamps, S., Erikstad, K-E., *et al*. 2015. Key-site monitoring in Norway 2014, including Svalbard and Jan Mayen. SEAPOP Short Report, 1-2015. 99 pp.

Bjørge, A., Lydersen, C. L., Skern. Mauritzen, M., and Wiig, Ø. 2010. Marine mammals. Fisken og Havet, Special Edition, 2-2010. http://www.imr.no/filarkiv/2011/05/sjoens_pattedyr_web.pdf/en.

Broms, C., Melle, W., and Kaartvedt, S. 2009. Oceanic distribution and life cycle of Calanus species in the Norwegian Sea and adjacent waters. Deep Sea Research, 56: 1910–1921.

Buhl-Mortensen, L., Buhl-Mortensen, P., Dolan, M. F. J., Dannheim, J., Bellec, V., and Holte, B. 2012a. Habitat complexity and bottom fauna composition at different scales on the continental shelf and slope of northern Norway. Hydrobiologia, 685: 191–219.

Buhl-Mortensen, L., Bøe, R., Dolan, M. F. J., Buhl-Mortensen, P., Thorsnes, T., Elvenes, S., and Hodnesdal, H. 2012b. Banks, troughs and canyons on the continental margin off Lofoten, Vesterålen, and Troms, Norway. *In* Seafloor Geomorphology as Benthic Habitat: GeoHab Atlas of seafloor geomorphic features and benthic habitats. P. Harris and E. Baker (eds.). Ch. 51, pp 703–715. Elsevier Insights E-Book. http://dx.doi.org/10.1016/B978-0-12-385140-6.00051-7.

Durant, J. M., Anker-Nilssen, T., and Stenseth, N. C. 2003. Trophic interactions under climate fluctuations: the Atlantic puffin as an example. Proceedings of the Royal Society, London, Series B 270: 1461–1466.

Fauchald, P., Anker-Nilssen, T., Barrett, R. T., Bustnes, J. O., Bårdsen, B. J., Christensen-Dalsgaard, S., *et al*. 2015. The status and trends of seabirds breeding in Norway and Svalbard. NINA Report 1151. 84 pp.

Huse, G., Holst, J. C., Utne, K., Nøttestad, L., Melle, W., Slotte, A., *et al*. 2012. Effects of interactions between fish populations on ecosystem dynamics in the Norwegian Sea – results of the INFERNO project. Marine Biology Research, 8: 415–419. Doi: 10.1080/17451000.2011.653372.

ICES. 2008. Report of the *Ad hoc* group on the international redfish survey in the Norwegian Sea (AGRED). ICES CM 2008/ACOM:63. 48 pp.

ICES. 2012. Report of the Workshop on Benchmarking Integrated Ecosystem Assessments (WKBEMIA), 27–29 November 2012, ICES Headquarters, Copenhagen, Denmark. ICES CM 2012/SSGRSP:08. 28 pp.

ICES. 2013a. Report of the Working Group on the ICES ACOM/SCICOM Workshop on Ecosystem Overviews (WKECOVER), 7–11 January 2013, ICES Headquarters, Copenhagen, Denmark. ICES CM 2013/ACOM/SCICOM:01. 131 pp.

ICES. 2013b. Report of the ICES Workshop to draft Advice on Ecosystem Overviews (WKDECOVER), 4–7 November, ICES Headquarters, Copenhagen, Denmark. ICES CM 2013/ACOM/SCICOM:03. 11 pp.

ICES. 2013c. Interim Report of the Working Group on the Integrated Assessments for the Norwegian Sea (WGINOR). 19–23 August 2013, Bergen, Norway. ICES CM 2013/SSGRSP:07. 94 pp.

ICES. 2014a. Second Interim Report of the Working Group on Integrated Assessments of the Norwegian Sea (WGINOR), 18–22 August 2014, Torshavn, Faroe Islands. ICES CM 2014/SSGRSP:07. 25 pp.

ICES. 2014b. Report of the Working Group on Widely Distributed Stocks (WGWIDE), 26 August–1 September 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:15. 917 pp.

ICES. 2014c. Report of the Benchmark Workshop on Pelagic Stocks (WKPELA), 17–21 February 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:43. 344 pp.

ICES. 2015a. ICES glossary of principal pressures in ICES ecoregions. http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2016/2016/Pressure_Glossary_for_ecosystem_overviews.pdf.

ICES. 2015b. Report of the Arctic Fisheries Working Group (AFWG), 23–29 April 2015, Hamburg, Germany. ICES CM 2015/ACOM:05. 639 pp.

ICES. 2015c. Second Interim Report of the Working Group on the Integrated Assessments of the Barents Sea (WGIBAR), 1–4 June 2015, Kirkenes, Norway. ICES CM 2015/SSGIEA:04. 102 pp.

ICES. 2015d. Report of the Working Group on Widely Distributed Stocks (WGWIDE), 25–31 August 2015, Pasaia, Spain. ICES CM 2015/ACOM:15. 588 pp.

ICES. 2016. Final report of the Working Group on the Integrated Assessments of the Norwegian Sea (WGINOR), 7–11 December 2015, Reykjavik, Iceland. ICES CM 2015/SSGIEA:10. 149 pp.

ICES. 2017. Report of the OSPAR/HELCOM/ICES Working Group on Marine Birds (JWGBIRD), 10–14 October 2016, Thetford, UK. ICES CM 2016/ACOM:29. 120 pp.

IMR. 2016. Havforskningsrapporten 2016. Fisken og Havet, Særnummer 1-2016. http://www.imr.no/filarkiv/2016/03/havforskningsrapporten_2016.pdf/nb-no.

Mehl, S., Aglen, Gjøsæter, H., Godiksen, J., Stabby, A., de Lange Wennecke, T., Wienerroither, R., and Amelkin, A. 2015. Fish investigations in the Barents Sea, winter 2015. IMR–PINRO report series 2-2015. 61 pp.

Melle, W., Ellertsen, B., and Skjoldal, H. R. 2004. Zooplankton: The link to higher trophical levels. *In* The Norwegian Sea ecosystem. H. R. Skjoldal (ed.) Tapir Academic Press, Trondheim, pp. 137–202.

Norwegian Environment Agency. 2014. Faglig grunnlag for oppdatering av forvaltningsplanen for Norskehavet. (Scientific background report for the revision of the management plan for the Norwegian Sea). Miljødirektoratet, Rapport M-140. 248 pp. (In Norwegian.)

Norwegian Ministry of the Environment. 2009. Integrated Management of the Marine Environment of the Norwegian Sea. Report No. 37 (2008–2009) to the Storting (white paper). 151 pp. https://www.regjeringen.no/contentassets/1b48042315f24b0182c3467f6f324d73/en-gb/pdfs/stm200820090037000en_pdfs.pdf.

Olsen, E., Aanes, S., Mehl, S., Holst, J. C., Aglen, A., and Gjøsæter, H. 2010. Cod, haddock, saithe, herring, and capelin in the Barents Sea and adjacent waters: a review of the biological value of the area. ICES Journal of Marine Science, 67: 87–101.

Planque, J., and Nedreaas, K. 2015. Uer – Snabeluer og vanlig uer i Norskehavet og Barentshavet. (The redfishes in the Norwegian Sea and the Barents Sea.) *In* Havforskningsrapporten 2015. Fisken og havet, særnr. 1–2015: 205–206. (In Norwegian with English legends.)

Polyakov, I. V., Beszczynska, A., Carmack, E. C., Dmitrenko, I. A., Fahrbach, E., Frolov, I. E., Gerdes, R., *et al*. 2005. One more step toward a warmer Arctic. Geophysical Research Letters, 32, L17605. doi:10.1029/2005GL023740.

Sandvik, H., Reiertsen, T. K., Erikstad, K. E., Anker-Nilssen, T., Barrett, R. T., Lorentsen, S-H., Systad, G. H., and Myksvoll, M. S. 2014. The decline of Norwegian kittiwake populations: modelling the role of ocean warming. Climate Research, 60: 91–102.

Sandvik, H., Barrett, R. T., Erikstad, K. E., Myksvoll, M. S., Vikebø, F., Yoccoz, N. G., *et al*. 2016. Modelled drift patterns of fish larvae link coastal morphology to seabird colony distribution. Nature Communications, 7: 11599. Doi: 10.1038/ncomms11599.

Skjoldal, H.R. (ed.) 2004. The Norwegian Sea Ecosystem. Tapir Academic Press, Trondheim 2004. 359 pp.

Sundby, S., Fossum, P., Sandvik, A., Vikebø, F. B., Aglen, A., Buhl-Mortensen, L., *et al*. 2013. KunnskapsInnhenting Barentshavet–Lofoten–Vesterålen (KILO). Status og videreutvikling av kunnskapsgrunnlaget for mengde, fordeling og transport av kommersielle fiskearter fra gytende fisk til egg, larver, yngel og ungfisk i nordnorske sokkelområder med vekt på Lofoten og Vesterålen. (Collection of knowledge from the region Barentsavet–Lofoten–Vesterålen. Development of insights in amounts, distributions and transportations of commercially important fish species from spawners to egg, larvae, juveniles and young fish in northern Norway shelf regions with emphasis on Lofoten and Vesterålen.) Fisken og Havet, 3-2013. 188 pp. (In Norwegian.)