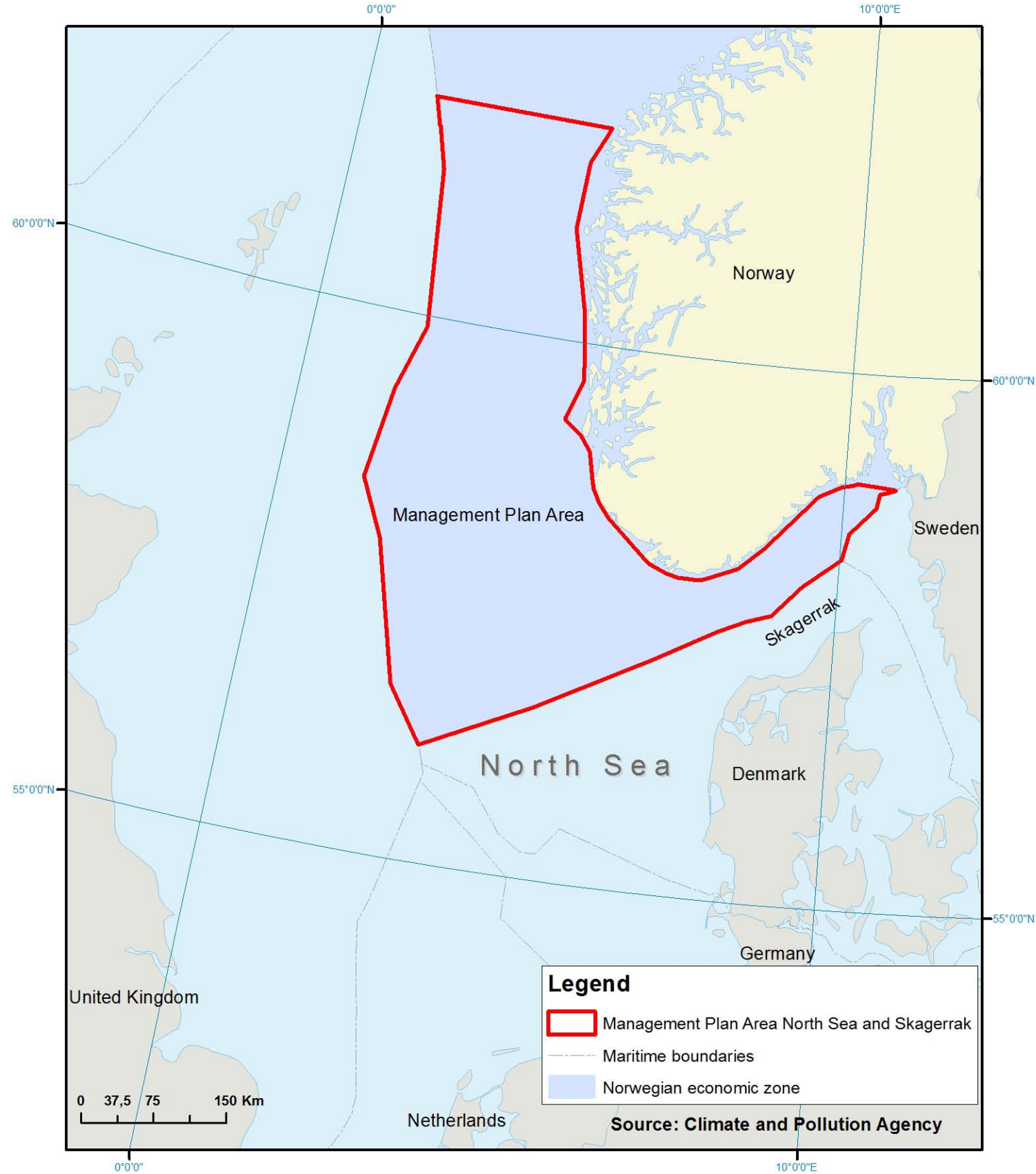
ENG

Scientific basis for an integrated management plan for

THE NORTH SEA AND SKAGERRAK

SUMMARY

CUMULATIVE ENVIRONMENTAL EFFECTS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Norway
Management Plan Area
Sweden
Skagerrak
North Sea
Denmark
Germany
United Kingdom
Netherlands
Legend
Management Plan Area North Sea and Skagerrak
Maritime boundaries
Norwegian economic zone
0 37,5 75 150 Km
Source: Climate and Pollution Agency

Summary

Work on the management plan for the Norwegian sector of the North Sea and Skagerrak

The Norwegian Government expects to present a white paper on the management of the Norwegian sector of the North Sea and Skagerrak (management plan) in 2013. The management plan is intended to provide an overall framework for both existing and new activities in these areas and to facilitate the coexistence of industries and activities that affect the marine environment.

The present report is one of six that have been compiled as part of the scientific basis for the management plan. The six reports provide an overview of existing knowledge about the environment and the natural resources, as well as on the commercial activities and other socioeconomic factors in the North Sea and Skagerrak.

Report on cumulative environmental effects

This report presents a compilation of knowledge about the state of the environment and human activity in the Norwegian part of the North Sea and Skagerrak. The report gives an overview of pressures and impacts on the environment from normal activity and in the event of accidents. This is used to assess the cumulative environmental effects, which factors have most impact and where the impacts are greatest, and to indicate which problems are expected to be most serious in the future.

The report is intended to provide relevant information that can be used in the management of the marine area in the future. It also provides input for the identification of environmental targets and management measures for the North Sea and Skagerrak.

There are a number of pollution problems and considerable pressures on biodiversity in the North Sea and Skagerrak. In the time ahead, climate change and ocean acidification are expected to intensify and have increasing impacts.

The North Sea and Skagerrak is more strongly influenced by human activities than the Norwegian Sea and Barents Sea. The North Sea and Skagerrak waters are some of the most heavily trafficked in the world. Large volumes of oil and gas are extracted from the seabed, and there are intensive fisheries. In addition, the Greater North Sea is surrounded by densely populated and highly industrialised countries. Most activities in and associated with the North Sea and Skagerrak affect the environment in some way or another. A number of responses and measures have been implemented to reduce pressures on the environment and resulting impacts, but despite this, the cumulative environmental effects on the area are causing concern. In future, new pressures will emerge, and we do not have a full overview of what their impacts will be.

State of the environment in the North Sea and Skagerrak

There are substantial environmental problems in the North Sea and Skagerrak, related both to different types of pressures and to the state of individual ecosystem components.

Climate change and ocean acidification

- Climate change and ocean acidification are new threats, and so far we know little about their impacts. However, they are expected to result in large-scale changes in marine ecosystems. In the past 10–20 years, the rising sea temperature has resulted in considerable changes in the quantity and species composition of zooplankton in the North Sea, and in particular a substantial decline in the amount of the copepod *Calanus finmarchicus*.

Hazardous substances

- There are still considerable inputs of hazardous substances and radioactive substances to the management plan area. For certain substances, inputs from different sources have been calculated, and in these cases the largest inputs are from long-range transport by ocean currents and the atmosphere. Inputs from national sources are also important, but the impacts are often more local. The highest levels of hazardous substances have been measured near the coast in the Skagerrak and Norwegian Trench.
- New hazardous substances are regularly detected in the North Sea, but little is known about their short- and long-term effects.
- The properties of hazardous substances make them a threat to the environment. These substances are toxic, persistent and bioaccumulative (build up along food chains). Climate change and ocean acidification in the future may affect the availability, uptake and toxicity of hazardous substances.
- Many hazardous substances have the most serious impacts on species at the top of food chains because of bioaccumulation. Concentrations of hazardous substances in porpoises in the North Sea and Skagerrak are high enough to disrupt reproduction and adversely affect foetal development. Hazardous substances have also been shown to affect the survival and reproduction in seabirds.
- Levels of hazardous substances in seafood from the North Sea and Skagerrak are generally low, but are somewhat higher than in the Norwegian Sea and the Barents Sea–Lofoten area. In some species, levels of hazardous substances are very close to or exceed the maximum levels for human consumption. Levels of dioxins and dioxin-like PCBs in cod liver (but not cod fillet) are cause for concern as regards seafood safety, and levels of mercury in tusk fillet are high in parts of the management plan area.
- Registration of seabirds washed ashore in Jærstrendene protected landscape (Rogaland) show that in some years a high proportion of the birds are oil-contaminated, but there are wide variations from year to year. Small oil spills can be an important pressure on seabirds.

Marine litter in the management plan area

- Concentrations of marine litter in the North Sea are among the highest recorded in the Northeast Atlantic. Birds and other animals can be injured if they ingest marine litter or come into contact with it in other ways, but there are still considerable gaps in our knowledge.

Underwater noise

- There is growing concern about overall levels of noise pollution in the management plan area, but we know too little about the impacts of underwater noise.

State of habitat types, ecosystems and food chains

- Organisms that require very specific conditions on the seabed for part or all of their life cycle are vulnerable to changes in benthic conditions, local current patterns and sedimentation. Sandeel habitat and fish spawning grounds are examples of areas with very specific bottom conditions that have been identified as particularly valuable.
- Sandeels use both the seabed and the water column, feed on plankton and are in turn prey for other fish, seabird and marine mammals. They are thus a key species in the ecosystem, in much the same way as capelin are in the Barents Sea. A decline in sandeel stocks could have considerable impacts on much of the food web and the ecosystem.
- Changes in the major fish stocks will have repercussions on other parts of the ecosystem as a result of changes in grazing pressure on plankton and benthic fauna and in the availability of food for porpoises, seals and seabirds.
- Survival rates of many alien species in the North Sea and Skagerrak are increasing with the rising sea temperature. The number of species expanding their distribution northwards into the area is also expected to increase. At the same time, some species that are already present in the management plan area may shift their distribution further northwards to colder water.
- The coastal zone is affected by activities both on land and at sea and by climate change. Production is often high in coastal waters, and they are important nursery areas and habitats for many species. Changes in the coastal zone, such as the decline of sugar kelp along the coast of the southern half of Norway, can have a considerable impact on large parts of the coastal ecosystems, and subsequently on fish and seabirds associated with open waters further from shore.

State of fish stocks

- Spawning stocks of some of the major fish stocks are below precautionary levels (saithe and sandeels in some parts of the North Sea), in some cases as a result of overfishing. Cod is below the critical reference point, while stocks of Norway pout, North Sea herring, mackerel, blue whiting and plaice are above the precautionary level.
- Some species that used to be relatively common in the North Sea have disappeared or declined. European eel, blue skate and spiny dogfish are classified as critically endangered on the Norwegian Red List. Populations of most cartilaginous fish are low, and several other species are threatened or near-threatened.

State of seabird populations

- A number of breeding populations of seabirds in the management plan area have declined considerably. This is particularly the case for pelagic species (those that feed on fish and crustaceans out at sea), such as black-legged kittiwake, common guillemot and Atlantic puffin. Coastal species such as common eider, European shag and black guillemot have also declined. The situation for overwintering populations is unclear, but the figures show wide variations in numbers and species composition on the open sea.
- Species such as black guillemot, black-legged kittiwake, velvet scoter, common scoter, white-billed diver, black-throated diver, razorbill, black-headed gull, common gull and northern fulmar are all red-listed in Norway.

Vulnerable areas in the North Sea and Skagerrak

- The particularly valuable areas in the North Sea and Skagerrak are important for biological production and biodiversity, and as habitats for species or species groups. Species and habitats in these areas are considered to be vulnerable to certain types of environmental pressures. Several of the particularly valuable areas are important habitats or spawning grounds and are vulnerable to pressure from fisheries pressure. Most of them are vulnerable to oil pollution, mainly because they are important areas for seabirds or spawning grounds for fish.

Human activity – pressures and impacts

Biological pressures

- Harvesting fish stocks affects both their size and their age distribution. In some cases, it can also reduce age at sexual maturity. The impact of the current (2011) level of fisheries activity is assessed as moderate for saithe, North Sea herring, cod, sandeel and mackerel, and minor for plaice, blue whiting and Norway pout. The shrimp stock in the Norwegian Trench/Skagerrak has declined, and current fisheries activity is assessed as having a minor to moderate impact.
- Harvesting primarily affects the target species, but may also have impacts on other fish species, seabirds and marine mammals that are taken as bycatches. Seabirds can be substantially affected by changes in food supplies due to harvesting of their prey species.
- The introduction of alien species could potentially have major impacts at the ecosystem level. The problems are mainly related to shipping and the movement of species with ballast water and fouling on ships' hulls. The Ballast Water Convention is expected to improve the situation when it enters into force, by reducing the risk of introduction of alien species. Aquaculture can also result in the spread of alien species.

Pressure on habitats

- Pressure on habitats, including the seabed, may have impacts on recruitment, growth and food supplies for various species. We expect awareness and knowledge about this type of pressure in the North Sea and Skagerrak to increase in the future. It will be particularly important to monitor activities and pressures in areas that are important for biodiversity and biological production, including the particularly valuable areas that have been identified.

- Benthic organisms larger than 5 cm, including sponges, sea pens and corals, are vulnerable to bottom trawling. In the parts of the North Sea and Skagerrak that are trawled an estimated 10 to 20 times a year, it is therefore reasonable to assume that these elements of the benthic community have disappeared. Since little is known about the distribution of these species in the management plan area, it is not possible to quantify the impacts of bottom trawling. However, the impact in areas that are trawled frequently is assessed as moderate to major. For the management plan area as a whole, bottom trawling is considered to have only a minor impact.
- The construction of subsea installations is assessed as having minor impacts on the management plan area, although it should be noted that particularly valuable areas of the seabed, such as sandeel habitat and fish spawning grounds, are vulnerable to changes in conditions on the seabed.

Inputs of hazardous substances, radioactive substances and oil

- Inputs of hazardous substances, radioactive substances and oil to the management plan area affect all parts of the ecosystem. The impacts of long-range transboundary pollution and pollution from land-based and coastal activities are assessed as moderate for seabirds, marine mammals and fish. The impacts of operational discharges from maritime transport and the oil and gas industry are assessed as minor, but there is uncertainty about the long-term effects.
- Knowledge about the synergistic effects of hazardous substances is limited. There is concern both about the combined effects of these substances, and about their effects in combination with other human pressures (multi-stressor effects).
- Over the next 20 years, it is likely that inputs of already regulated substances will decline, but inputs of some unregulated and new substances will rise until there is a management response and steps are taken to regulate them.
- We have limited knowledge about the effects on marine organisms of long-term exposure to low concentrations of hazardous substances and combinations of such substances. Knowledge about how such substances accumulate along food chains is also inadequate.

Accidents

- All human activities carry a certain risk of accidents. An oil spill may be the result of an accident in the offshore oil and gas industry (blowout, incident during production, pipeline leak, etc) or at an onshore facility, or of a shipping accident.
- Although large spills rarely occur, acute pollution can have major environmental impacts. Oil spills can have serious effects on seabirds, and can also affect marine mammals, early stages of fish life cycles and shoreline habitats.
- The level of environmental risk depends on the probability of an accident that may result in acute pollution and the possible environmental impacts of such an accident. It also depends on what preventive measures are taken, the preparedness and response system, how close a spill is to land, and the presence of important species and habitats in the vicinity (for example seabird concentrations or spawning grounds for fish). At present, we lack a methodology for comparing levels of accident risk and environmental risk across sectors.
- Oil spills that have major impacts on certain species will continue to be a possibility, especially in connection with activities in or near vulnerable areas and along the coast. However, there is a great deal of uncertainty about future trends in environmental risk, mainly because our knowledge about the future distribution, state and vulnerability of

species and habitats is limited. Changes in the areas where there are commercial activities will also influence the level of environmental risk.

- The impacts of a nuclear accident on the ecosystem will depend on the type of scenario, size of the release, nuclide composition and physical conditions such as ocean currents, weather and wind direction. For example, some scenarios would have impacts on organisms in the upper layers of the water column, whereas in other cases the benthos and benthic communities would be more vulnerable. The scenarios described in the report would result in levels of radioactivity in fish and seafood products above the limit values for human consumption.

Inputs of nutrients and organic matter

- Eutrophication and sediment deposition as a result of inputs of nutrients and organic matter are primarily a problem in coastal waters and fjords. Discharges of nutrients and organic matter, in combination with climate change, hazardous substances and other factors, add to the pressure on coastal ecosystems. Local changes in coastal waters and fjords may alter conditions in important nursery areas for fish and other animals. This may have indirect effects on seabirds because of changes in the availability of food supplies. The impacts of inputs of nutrients and organic matter are assessed as moderate. Climate change may result in greater runoff from land, adding another element of uncertainty.

Marine litter

- Marine litter, whether floating on the surface or on the seabed, is a complex issue. Various sectors, including land-based and coastal activities, are responsible for marine litter in the management plan area, and currents also transports litter from other countries' sea areas. Much of the litter consists of materials that are very persistent in the environment. In general, we have only limited knowledge of the scale and sources of marine litter. This makes it difficult to assess the environmental impacts of litter from individual sectors, but overall, marine litter is considered to be a growing problem. Two monitoring stations have recently been established in the North Sea and Skagerrak, and these will provide information on the quantities and sources of litter on Norwegian beaches.

Climate change and ocean acidification

- Climate change and ocean acidification as a result of global CO_2 emissions constitute a major long-term threat to the ecosystems of the North Sea and Skagerrak. Both of these processes may result in large-scale changes in marine ecosystems, and they may intensify the impacts of other pressures.

Cumulative environmental effects on individual ecosystem components

Plankton

Physical changes in the environment, for example as a result of climate change and ocean acidification, are expected to have marked effects on plankton. Changes in the species composition of the zooplankton (regime shifts) have been observed and have been linked to ongoing climate change. Ocean acidification will have particularly severe impacts on organisms that use calcium minerals to build shells and skeletons, and that may have difficulty in forming such structures in more acidic seawater. Such effects may result in large- scale changes in the ecosystem.

Other pressures are assessed as having only minor impacts on plankton, including species that are planktonic at certain stages of their life cycle (algae, early life stages of fish and benthic animals) and those that are planktonic throughout their life cycle (for example copepods, amphipods, isopods, the sea snail *Limacina helicina* and polychaetes). In general, there is a high degree of uncertainty associated with the impact assessments and clear cause-effect linkages are often lacking.

Benthic animals and communities

Our knowledge of habitat types and benthic communities in the North Sea is limited. Until we know more, it is difficult to make accurate assessments of cumulative environmental effects on benthic communities in the management plan area.

Until now, bottom trawling is the single activity that is considered to have had the greatest impacts on benthic communities. At present, these are assessed as moderate to major in areas that are trawled frequently. For the management plan area as a whole, the impacts are assessed as minor.

The impacts of other activities in the area are generally assessed as minor for the North Sea and Skagerrak as a whole. However, the negative impact of local activities should also be included when the cumulative environmental effects are assessed.

Ocean acidification and climate change will probably have major impacts on benthic communities towards the year 2100.

Fish

The current level of activity puts relatively high pressure on fish stocks. The impacts of current fisheries activities are assessed as moderate for stocks of saithe, North Sea herring, cod, sandeel and mackerel, and minor for plaice, Norway pout and blue whiting.

The impacts of long-range transboundary pollution and national inputs of pollutants from land-based and coastal activities on fish and seafood safety are assessed as up to moderate. In the period up to 2100, climate change and ocean acidification are expected to have major impacts.

The impacts on fish of operational discharges during petroleum activities in the management plan area are assessed as minor.

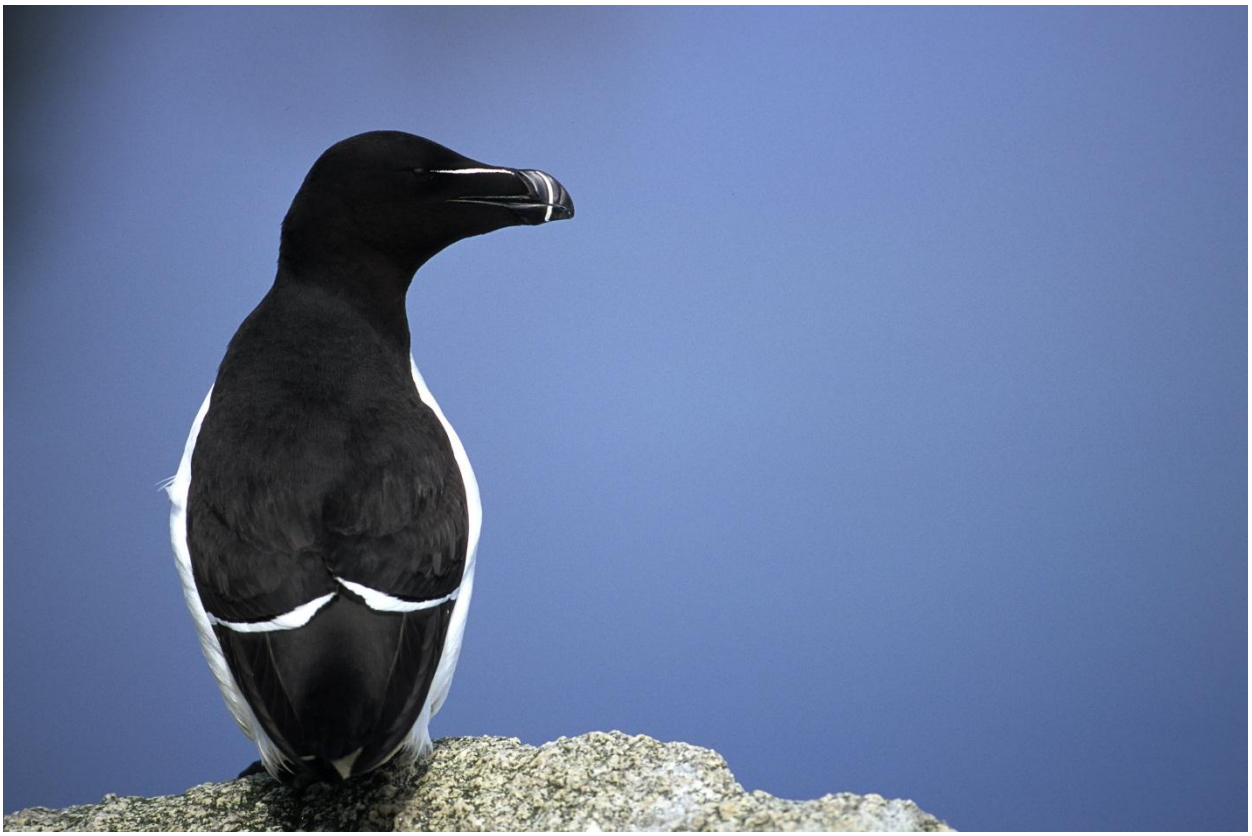
Seabirds

Both coastal and pelagic seabird populations are declining because of climate change and other effects of human activity that have resulted in changes in the availability of prey. This applies to both breeding and wintering populations.

There is a clear distinction between direct pressures on seabirds, such as acute pollution, hazardous substances and disturbance of breeding sites, and indirect pressures that result in changes in their food supplies. In the case of indirect pressures, there are complex interactions involving human activities that cause changes resulting in poorer conditions for seabirds.

As the temperature of seawater rises, organisms such as the copepod *Calanus finmarchicus*, herring and mackerel respond by altering their distribution patterns . The fisheries may also influence the species distribution and relative proportions of potential prey species. Seabird populations that have already been negatively affected by changes in food supplies are more vulnerable to direct pressures.

In seabirds at the top of food chains, particularly coastal species, high concentrations of hazardous substances may accumulate in body tissues. The impacts of long-range transboundary pollution and inputs from land-based and coastal activities on seabirds are therefore assessed as up to moderate.



The razorbill (Alca torda) is red-listed as a vulnerable species in Norway. Photo:Lars Løfaldli, Directorate for Nature Management

Marine mammals

Pressures known to affect marine mammals in the North Sea and Skagerrak are hazardous substances, marine litter, and noise from sonar and propellers.

Since they are top predators, marine mammals (especially seals and toothed whales) often have high tissue loads of hazardous substances. The impacts of long-range transboundary pollution and inputs from land-based and coastal activities on marine mammals are therefore assessed as up to moderate.

Porpoises are particularly vulnerable to gill nets, where they may be taken as a bycatch.

In general, there is relatively little monitoring or knowledge of the impacts of these pressures on marine mammals in the North Sea and Skagerrak.

The shoreline

Hazardous substances continue to be a major problem in many coastal and fjord areas. Climate change and rising concentrations of nutrients may directly affect seaweed communities.

Acute oil pollution has a high potential for impacts along the shoreline. However, the actual impacts of a spill depend on the oil type, the quantity of oil and the distance from land.

As a result of wind, current and geographical conditions, marine litter is more likely to accumulate in some localities along the coast than others. Other impacts along the shoreline are generally associated with other activities and pressures in areas nearer the coast.

Cumulative environmental effects on the North Sea and Skagerrak

All parts of the North Sea and Skagerrak are influenced by human activity, though to a varying degree. All trophic levels in the ecosystem are subject to one or more environmental pressures. Some pressures affect the entire management plan area and have impacts on all parts of the ecosystem. Others are directly associated with a specific group of organisms or a limited part of the management plan area.

Few of the pressures have major impacts. Some are considered to have moderate impacts, but most of them only have minor impacts, particularly if the entire management plan area is considered as a single unit. The cumulative environmental effects are a result of the combination of and interactions between all these pressures and impacts, however small.

There is no general method for combining impacts across different geographical scales and as a result of different pressures. It is therefore difficult to assess the severity of the cumulative environmental effects on the ecosystem. Uncertainty and lack of knowledge about the population status of species, the range and ecological status of habitat types, and the impacts of environmental pressures also add to the uncertainty of assessments of environmental impacts.

Long-term measurement series show changes over time in the North Sea and Skagerrak. Some of the changes can be directly linked to human activity, while in other cases the causal relationships are much more complex.

A number of measures have already been implemented to reduce pressure on the North Sea and Skagerrak, but there are still problems. Measurements show that hazardous substances are present both in the environment and in marine organisms, and the population status and distribution of various species are being affected by human activity. In the time ahead, the impacts of climate change and ocean acidification are likely to intensify and increase the vulnerability of the ecosystem. The consequences of such changes are difficult to predict, but may be far-reaching.

Ecosystem-based marine management in Norway -- background information

Management plans for all Norwegian sea areas

The Norwegian Government is developing integrated marine management plans for all Norwegian sea areas. The first to be completed was the management plan for the Barents Sea–Lofoten area, which was presented in the white paper *Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands* in 2006. A management plan for the Norwegian Sea was finalised in 2009, and a first update of the management plan for the Barents Sea–Lofoten area was published in 2011. The Government will present a management plan for the North Sea and Skagerrak in 2013.

The management plans are large-scale spatial management tools, and cover the areas in Norway's Exclusive Economic Zone outside the baseline. Work on the management plans is coordinated by an interministerial Steering Committee. In addition, there is a management forum for each of the three sea areas, an Advisory Forum on Monitoring, and a Forum on Environmental Risk Management.

Towards an integrated management plan for the North Sea and Skagerrak

When the management plan for the Norwegian part of the North Sea and Skagerrak is presented in 2013, Norway will have an ecosystem-based management regime for all Norwegian sea areas.

An Expert Group headed by the Climate and Pollution Agency has been responsible for drawing up the scientific basis for the management plan. This was finalised in spring 2012, and includes a number of reports produced during a broad process involving various institutes and government agencies. Information has been compiled on environmental conditions (including the identification of particularly valuable and vulnerable areas), commercial activities in the sea area, and value creation and social conditions in order to provide a common factual basis for impact assessments. Impact assessments were carried out for fisheries, petroleum activities and maritime transport, which are the main activities that may affect the environment and natural resource base or have implications for other commercial activities in the area. The possible impacts of potential new industries such as offshore renewable energy were also assessed. In addition, external pressures such as long-range transboundary pollution, emissions from onshore activities, climate change and ocean acidification were reviewed. The risk of acute oil pollution has been reviewed, and proposals for indicators and environmental targets have been drawn up. The Expert Group has also proposed indicators for a monitoring programme and has described knowledge needs in the areas of mapping, monitoring and research.

TA 2928/2012

THE SCIENTIFIC BASIS FOR THE MANAGEMENT PLAN FOR THE NORTH SEA AND SKAGERRAK

The Norwegian Government plans to submit a white paper on the management of the Norwegian part of the North Sea and Skagerrak in 2013. This integrated management plan will be a framework for assigning priorities and balancing commercial and environmental interests in these sea areas.

An Expert group is coordinating the work on the scientific basis for the management plan. The group has built up a broad knowledge base on the environmental and economic consequences of current and future activities in the management plan area. Six reports have been compiled.

The members of the Expert group for the North Sea and Skagerrak represent the following institutions:

- Climate and Pollution Agency (head)
- Directorate for Nature Management
- Directorate of Fisheries
- Norwegian Coastal Administration
- Norwegian Water Resources and Energy Directorate
- Norwegian Petroleum Directorate
- Petroleum Safety Authority Norway
- Norwegian Maritime Directorate
- Norwegian Radiation Protection Authority
- Institute of Marine Research
- National Institute of Nutrition and Seafood Research
- Norwegian Institute for Air Research
- Norwegian Institute for Nature Research
- Norwegian Institute for Water Research

More information about the work can be found at: www.klif.no/northsea-management

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EXECUTIVE EDITOR