



NORWEGIAN MINISTRY OF
THE ENVIRONMENT

Meld. St. 37 (2012–2013) Report to the Storting (white paper)

Integrated Management of the Marine Environment of the North Sea and Skagerrak (Management Plan)



Edvard Munch (1863–1944) and Kragerø

Edvard Munch painted *Winter on the Coast* in 1915, while living at Skrubben, a property in the beautiful seaside town of Kragerø in Southern Norway. After spending many years abroad, during which he gained an international reputation as an artist, he returned to Norway in 1909. His reacquaintance with Norway's natural landscapes resulted in a new feeling for harmony and classical composition, which manifested itself in a large number of landscapes depicted with bold, vital brushstrokes in a new, monumental style. Munch was particularly fascinated by the quality of the winter light, and many of his paintings depict Kragerø in the snow. The town's inhabitants also provided a rich source of subjects.

Munch is one of the greatest of the modernists. His style reflects his close association with symbolism and he was also an early exponent of expressionism, one of the most important movements in art in the first half of the 20th century. 2013 marked the celebration of the 150th anniversary of Munch's birth.



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Integrated Management of the Marine Environment of the North Sea and Skagerrak (Management Plan)

Meld. St. 37 (2012–2013) Report to the Storting (white paper)

*Recommendation of 26 April 2013 from the Ministry of the Environment,
approved in the Council of State the same day.
(White paper from the Stoltenberg II Government)*

1 Summary

The Government's goal is for Norway to be a pioneer in developing an integrated, ecosystem-based management regime for marine areas. The Government will therefore continue to use the system of management plans for sea areas. An overall framework for petroleum activities will be established in the management plan for each sea area.

Purpose of the management plan

The purpose of this management plan is to provide a framework for the sustainable use of natural resources and ecosystem services derived from the North Sea and Skagerrak and at the same time maintain the structure, functioning, productivity and diversity of the area's ecosystems. The management plan is thus a tool for both facilitating value creation and maintaining the high environmental value of the area.

Intensively used and economically important

The North Sea–Skagerrak area is Norway's most intensively used sea area and one of the most heavily trafficked in the world. Norwegian society

derives major assets from its use. The bulk of Norway's oil and gas production and thus value creation by the industry takes place in the North Sea. In addition, the North Sea is biologically productive. There are major fisheries in the area, which is fished by both coastal and deep-sea fishing vessels. Moreover, the Skagerrak is particularly important for small-scale fisheries, and is also the sea area of Norway that is most heavily used for outdoor recreation. The high level of activity combined with a number of potentially conflicting interests places considerable demands on the management regime.

Concern about the state of the environment

Since the 1970s, much has been done to improve the environmental status in the North Sea and Skagerrak, and particularly to reduce the pollution load. Nevertheless, the state of the environment still gives cause for concern and is unsatisfactory in many ways. These waters are naturally rich and productive, but the different types of pressures on the environment entail considerable management challenges. Concentrations of hazardous substances are higher in the North Sea

and Skagerrak than in Norway's other sea areas, and the concentration of marine litter is higher than anywhere else in the Northeast Atlantic. Water quality is good in the coastal current, but eutrophication and sediment deposition may affect water quality in near-coastal waters and fjords. Moreover, a number of seabird populations have declined and certain fish stocks are in poor condition. Climate change and ocean acidification are creating new challenges that will require a long-term approach to management of the North Sea and Skagerrak. This means that we need to take steps to improve environmental status and ecosystem resilience, and strengthen the basis for continued value creation through use and harvesting of the North Sea and Skagerrak.

International responsibility and national action

The North Sea and Skagerrak are shared between eight countries. Due to the direction of the ocean currents and prevailing winds, pollution from other countries is carried into Norwegian waters. Cooperation with the other North Sea countries and the combined efforts of all these countries are therefore of crucial importance for achieving good environmental status.

Management plans in place for all Norway's sea areas

With the publication of this management plan for the Norwegian part of the North Sea and Skagerrak, the Government has established management plans as the basis for integrated ecosystem-based management of all Norwegian sea areas. The other management plans have been published as the white papers *Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands* (Report No. 8 (2005–2006) to the Storting) and *Integrated Management of the Marine Environment of the Norwegian Sea* (Report No. 37 (2008–2009) to the Storting). The first update has been published as the white paper *First update of the Integrated Management Plan for the Marine Environment of the Barents Sea–Lofoten Area*, Meld. St. 10 (2010–2011).

The management plans clarify the overall framework and encourage closer coordination and clear priorities for management of Norway's sea areas. They increase predictability and facilitate coexistence between industries that are based on the use of these sea areas and their natural resources. The management plans are also intended to be instrumental in ensuring that busi-

ness interests, local, regional and central authorities, environmental organisations and other interest groups all have a common understanding of the goals for the management of the area in question. The Government will continue and further develop the system of management plans, and make it more effective.

The present management plan and the measures described in it apply primarily to the open sea in the Norwegian part of the North Sea and Skagerrak, i.e. the areas outside the baseline, in Norway's territorial waters and exclusive economic zone northwards to latitude 62 °N (off the Stad peninsula).

Basis for the management plan

Work on this management plan was organised along the same lines as for previous management plans. It was coordinated by an interministerial Steering Committee including all the relevant ministries and headed by the Ministry of the Environment. An important feature of the management plan system is that relevant subordinate agencies and key research institutions cooperate in drawing up the scientific basis for the plans. The scientific basis for the North Sea–Skagerrak management plan was prepared by an Expert Group headed by the Climate and Pollution Agency and including representatives of the Directorate for Nature Management, the Directorate of Fisheries, the Institute of Marine Research, the Coastal Administration, the National Institute of Nutrition and Seafood Research, the Norwegian Institute for Air Research, the Norwegian Institute for Nature Research, the Norwegian Institute for Water Research, the Norwegian Water Resources and Energy Directorate, the Petroleum Directorate, the Petroleum Safety Authority Norway, the Maritime Directorate and the Norwegian Radiation Protection Authority. Two advisory groups for the management plans, the Advisory Group on Monitoring (headed by the Institute of Marine Research), and the Forum on Environmental Risk Management (headed by the Norwegian Coastal Administration) have also been involved.

Participation by interested parties is also an important element of the management plan work, in the form of consultation on the background reports and consultative meetings during the process of developing the plan. After the Expert Group had delivered the scientific basis to the ministries, a conference was held in Haugesund in

May 2012 to give all interested parties an opportunity to discuss the reports.

The management plan is based on both existing and new knowledge about ecosystems, ecological goods and services and resources that are important as a basis for value creation in the management plan area, and about trends in environmental status, pressures and impacts on the environment, and environmental risk. Studies have also been carried out to assess commercial activities and social conditions and ecological goods and services.

Particularly valuable and vulnerable areas

Particularly valuable and vulnerable areas are those that on the basis of scientific assessments have been identified as being of great importance for biodiversity and for biological production in the entire North Sea-Skagerrak area. Areas may for example be identified as particularly valuable and vulnerable because they are important habitats or spawning grounds for fish, important habitats for seabirds, or contain coral reefs. Areas were selected using predefined criteria. The main criteria were that the area concerned was important for biodiversity or for biological production. The vulnerability of valuable areas to various environmental pressures has also been assessed on the basis of the species and habitats that occur naturally in each area and their productivity. The vulnerability of a habitat or species to different environmental pressures varies, and has been assessed on the basis of the likely impacts of different pressures on species or habitat development and survival. There may also be temporal and spatial variations in vulnerability. Thus the vulnerability of an area is considered to be an intrinsic property of the species and habitats to be found there, regardless of whether or not specific environmental pressures are actually acting on them.

The scientific basis for the management plan identifies 12 particularly valuable areas, eight along the coast and four in open sea areas in the North Sea. All of them are generally vulnerable, but their vulnerability varies depending on which pressures act in a particular area and at which times of year. In addition, the coastal zone has been identified as a generally valuable area.

Activities, value creation and management

The most important industries in the North Sea and Skagerrak today are fisheries, shipping,

petroleum activity and tourism. Other industries such as possible future developments in offshore energy, marine bioprospecting, and prospecting for minerals on the seabed are also discussed in this white paper. The importance of marine ecosystem services for value creation and Norwegian society is also discussed.

Fisheries and the seafood industry: Fisheries in the management plan area are conducted by Norwegian and foreign vessels, including EU vessels that have been allocated quotas in Norway's exclusive economic zone during negotiations on bilateral agreements. The share of the total catch value in Norwegian waters taken in the North Sea and Skagerrak is on average 25 %. The corresponding figure for catch quantity is on average 23 %.

Most aquaculture activity along the coastline bordering the management plan area is concentrated in the counties of Western Norway, along the North Sea coast. Fish farms in the counties of Sogn og Fjordane, Hordaland and Rogaland hold 31 % of all licences issued for salmon and trout farming in Norway. Aquaculture is not regulated in this management plan, but the industry is affected by environmental conditions in the North Sea and Skagerrak. In 2010, the aquaculture industry in Western Norway contributed NOK 13.7 billion to Norway's GDP, while the corresponding figure for Eastern Norway (counties along the Skagerrak coast) was NOK 2.7 billion.

Norway shares most of its fish resources with other countries, so that international cooperation on their management is essential. The EU is Norway's main partner in the North Sea and Skagerrak. Under the United Nations Convention on the Law of the Sea, Norway and the EU have an obligation to cooperate on the management of shared fish stocks in this sea area.

Shipping: The North Sea and Skagerrak are important shipping areas. There are several important transport routes, for example for vessels in transit along the Norwegian coast to northern waters, traffic to and from the Baltic Sea, and traffic between the major ports in Norway and other North Sea countries. The North Sea and Skagerrak are used by every vessel category and to transport all kinds of cargo.

There is a larger volume of shipping in the North Sea and Skagerrak than in other Norwegian sea areas, and it is more complex. The southern part of the management plan area is very heavily trafficked, and three-quarters of maritime transport in the North Sea take place outside Norway's exclusive economic zone.

The value added generated by shipping-related industries in the management plan area in 2009 is calculated at NOK 54.0 billion. This is 4.6 % of total value added generated in the management plan area, and somewhat higher than these industries' share of employment. International shipping is the largest shipping-related industry, and generated value added of more than NOK 42 billion (including spin-off effects).

New traffic separation schemes and recommended routes were introduced in the management plan area in July 2011 to route larger vessels (gross tonnage over 5000) and ships carrying dangerous or polluting goods much further away from the coast. The objective of these schemes is to reduce both the probability of accidents and the consequences of any oil spills in the event of accidents.

Petroleum activities: The North Sea was the starting point for Norway's petroleum industry, and much of the area was opened for exploration as early as 1965. Production started in 1971 on the Ekofisk field. The North Sea still has considerable petroleum potential and will generate substantial value added for many years to come.

The petroleum industry is by far the largest of the industries in the management plan area in terms of both value added and employment.

According to figures from 2010, a total of 68 fields are on stream on the Norwegian continental shelf, 55 of them in the North Sea. In the same year, the North Sea fields accounted for about two-thirds of production on the Norwegian shelf, or 153 million Sm³ oil equivalents. Ekofisk, Oseberg, Troll and Statfjord are large and important fields in the North Sea. In 2010, the first three of these accounted for 40 % of oil and gas production in the North Sea and 28 % of total production on the Norwegian shelf. The North Sea fields are mainly oil-producing.

The oil and gas industry is Norway's largest, measured in terms of value added, state revenues and export value. It currently generates about one fifth of Norway's total value added and a quarter of state revenues. Oil and gas account for half of the total value of Norway's exports. In 2009, value added from oil and gas extraction in the North Sea was about NOK 310 billion.

Travel and tourism and leisure activities: The sea and coast are very important areas for the travel and tourism industry and for leisure activities in Norway. The coastline bordering the management plan area is very attractive and heavily used by the local population. The coastal and marine environment is important for this sector in

a variety of ways: it provides enjoyment, opportunities to engage in a variety of activities and health benefits. In addition, the coastal and marine environment is an important basis for economic activity in the tourism and travel industry at both local and national levels.

In 2007, the tourism industry in the North Sea and Skagerrak counties provided NOK 25 billion in total value added, and employment for 58 000 people.

Offshore energy, marine bioprospecting and mineral extraction: Offshore renewable energy production includes offshore wind power, wave power, marine current power, tidal power and osmotic power. At present, offshore wind power is a marginal sector in Norwegian waters, but it has a very large potential. However, developments in the years ahead are uncertain, among other things because of the high costs.

Many marine organisms are likely to have properties that can be exploited and used in the manufacture of new products and processes in a number of industrial sectors. Marine bioprospecting therefore has a potential for value creation, and Norway is considered to be in a good position to make its mark internationally in this field.

At present, there is no mineral extraction from the seabed in the North Sea and Skagerrak or in other Norwegian sea areas. However, there has been little exploration of the seabed in the management plan area. Better mapping and the development of new technology may lead to value creation from seabed mineral deposits.

Ecosystem services: Ecosystem services are the benefits – goods and services – that people obtain from ecosystems. Opportunities for value creation and earnings in sectors such as fisheries, aquaculture and travel and tourism in future will depend on the state of the environment.

Ecosystem services from the oceans also include processes such as water purification and waste treatment, maintenance of ecosystem stability and climate regulation. Most ecosystem services are public goods. They are not traded in markets and therefore have no market price. Thus, the cost of damage to such services does not appear in company budgets or ordinary accounts, at any rate not in the short term. This increases the risk of their degradation, which can undermine the basis for future prosperity. One of the main purposes of the management plan is to coordinate different interests and weigh up their importance so as to ensure that ecosystem services that are not traded in markets are also man-

aged sustainably, so that their economic value and ecological importance are maintained.

Spatial management – challenges and coexistence between industries

The intensive use of the North Sea and Skagerrak puts considerable pressure on these waters, and it is important to maintain renewable resources and prevent damage to the marine environment.

A differentiated and sustainable spatial management regime must be based on knowledge of ecosystems and the impacts of different forms of use. Digital spatial management and mapping tools are extensively used in the management plan system to illustrate different types of use and protection of marine areas.

Cooperation between the countries around the North Sea and Skagerrak is crucial, both to address problems in these sea areas and to exchange experience of integrated marine management.

Acute pollution: risk and preparedness and response

Risk is defined as a combination of the probability of an event occurring as a result of human activity and the consequences of that event, taking uncertainties into account. Risk is not static, but changes over time along depending on the activities in an area and factors such as the implementation of measures, training, introduction of new technology and updating of legislation.

Environmental risk expresses the probability of a spill of oil or other environmentally hazardous substances combined with the scale of the expected environmental damage, taking uncertainties into account.

Shipping. An analysis of the probability of acute pollution from shipping in the management plan area shows that the predicted frequency of spills is higher near the coast, and highest along the coast of Western Norway, roughly between Stavanger and the Sognefjorden.

Preventive measures are very important for avoiding loss of human life and material assets, and for protecting society and the environment from pollution. Thus, emergency tugboat services, traffic surveillance and control, and traffic separation schemes are effective measures that substantially reduce the probability of acute pollution from shipping along the mainland coast.

Petroleum activity. Petroleum activity is higher in the North Sea than in other parts of the Norwegian continental shelf. However, collation of data

on acute pollution incidents involving the petroleum industry on the Norwegian continental shelf with various activity indicators shows that there is no direct linear relationship between activity level and the number or size of spills.

Cumulative environmental effects: environmental impacts and costs

The industries in and associated with the North Sea and Skagerrak can put pressure on ecosystems, and much has been done to reduce their impacts and the pressure on the environment. Nevertheless, there are still substantial environmental problems, related both to different types of pressures and to the state of individual species and habitat types. There is concern about the cumulative environmental effects of all the different pressures on the marine environment. In future, the impacts of climate change and ocean acidification may cause serious problems and increase ecosystem vulnerability. Current, planned and future commercial activity in the management plan area must take into account the environmental problems that have been identified and the cumulative effects on the area.

All ecosystem components in the North Sea and Skagerrak are affected by one or several human activities. This white paper presents analyses of different sectors that were drawn up as part of the management plan process. These analyses indicate that most pressures have only minor environmental impacts, although a few have major 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. In many of the cases where cause and effect are clearly understood, steps have been taken to reduce the impacts of a pressure. However, despite this there are still problems to be addressed.

The greatest cumulative effects are considered to be on certain fish stocks and seabird species. Threatened species and habitat types and populations that are declining are particularly vulnerable to any increase in cumulative effects. Habitat fragmentation and degradation is considered to be a serious threat to biodiversity today, in marine environments as elsewhere.

Although each source of disturbance or damage may put little pressure on the environment, their combined effects together with those of activities in other North Sea countries result in the cumulative effects and problems that have

been identified in the management plan area. The environmental impacts of any spills and other accidents are additional to those of normal activities and releases of pollutants. In the event of a large oil spill, seabirds and the shoreline are expected to be most seriously affected.

The impacts it is most difficult to do anything about are those of the rising concentrations of greenhouse gases in the atmosphere, which are resulting in global warming, a higher CO₂ content in seawater and ocean acidification. For many of the other pressures, it will be possible to take steps that result in good environmental status in the long term.

Goals for management of the North Sea and Skagerrak

In this white paper, the Government presents a set of goals for management of the North Sea and Skagerrak. They are intended to reflect relevant national and international goals for the environment and value creation. They are also based on the purpose of this management plan, and apply to all activities in the North Sea and Skagerrak management plan area.

Measures for the conservation and sustainable use of ecosystems

With the measures presented in this white paper, the Government intends to provide a framework for continued value creation from the North Sea and Skagerrak through the sustainable use of the natural resources and ecosystem services of the area, and at the same time contribute to improvement of the state of the environment and reduce the cumulative environmental effects on the ecosystems of the area.

Knowledge-based management

Management of the North Sea and Skagerrak must be based on the best available knowledge. The Government will therefore continue to build up knowledge about environmental conditions, value creation and commercial activities in the North Sea and Skagerrak in the period leading up to the first update of the management plan.

2 Introduction – integrated management of an intensively used sea area

2.1 A living sea

The North Sea–Skagerrak area is Norway’s most intensively used sea area, an engine of the Norwegian economy and a source of growth and prosperity. These are some of the most heavily trafficked waters in the world, with a large volume of shipping and considerable fisheries activity. The area is also important for local commercial activities and tourism along the coast. The North Sea is Norway’s largest petroleum province and suitable for the development of wind power. Access to the sea and opportunities to stay by the seaside and enjoy activities such as boating, swimming and fishing are important for a large proportion of the population, and form a basis for the tourist industry. And opportunities to enjoy the seaside are strongly dependent on a clean, rich and productive marine environment – a living sea means a living coast.

The state of the North Sea and Skagerrak environment used to be considerably poorer than it is today. For many years the sea was used as a refuse dump, and industrial waste water and domestic sewage were discharged untreated. For a long time, people acted as though the oceans could absorb anything that was dumped into them. Recently, however, binding cooperation in various international forums and between the eight North Sea countries has resulted in major improvements. Cooperation in the North Sea–Skagerrak area demonstrates how fruitful international environmental cooperation can be, and how targeted efforts can yield results. This cooperation has also produced a considerable body of knowledge about the North Sea and Skagerrak.

Nevertheless, the state of the environment in this area still gives cause for concern and is unsatisfactory in many ways. Concentrations of hazardous substances are higher in the North Sea and Skagerrak than in Norway’s other sea areas, and quantities of marine litter are higher than anywhere else in the Northeast Atlantic. Much of the pollution originates elsewhere. In addition, the state of certain fish stocks gives cause for con-

cern, and a number of seabird species are threatened. Climate change and ocean acidification will give rise to new management challenges, and a long-term approach will be required. This situation makes it necessary to improve environmental status and ecosystem resilience, and to strengthen the basis for continued value creation through use and harvesting of the area.

2.2 Purpose, roles and work process

The Government’s goal is for Norway to be a pioneer in developing an integrated, ecosystem-based management regime for marine areas. The Government will therefore continue to use the system of management plans for sea areas.

The purpose of this management plan is to provide a framework for the sustainable use of natural resources and ecosystem services derived from the North Sea and Skagerrak and at the same time maintain the structure, functioning, productivity and diversity of the area’s ecosystems. The management plan is thus a tool for both facilitating value creation and maintaining the environmental values of the sea area.

With the publication of this management plan, the Government has established integrated, ecosystem-based management plans covering all Norwegian sea areas. The other plans are for the Barents Sea–Lofoten area (Report No. 8 (2005–2006) to the Storting, updated in 2011 in Meld. St. 10 (2010–2011)), and the Norwegian Sea (Report No. 37 (2008–2009) to the Storting).

The management plans are intended to promote integrated, ecosystem-based management of Norwegian sea areas. They clarify the overall framework and encourage closer coordination and clear management priorities. They increase predictability and facilitate coexistence between industries that are based on the use of these sea areas and their natural resources. The management plans are also intended to be instrumental in ensuring that business interests, local, regional and central authorities, environmental organisa-

tions and other interest groups all have a common understanding of the goals for the management of the area in question. The Government will continue and further develop the system of management plans, and make it more effective.

The Ministry of the Environment is responsible for ensuring coherence in environmental policy, and is therefore responsible for heading and coordinating work on the management plans. However, a key feature of the management plan system is that all relevant authorities play an important part in developing the plans.

Work process

Work on this management plan was organised along the same lines as for previous management plans. It was coordinated by an interministerial Steering Committee including all the relevant ministries and headed by the Ministry of the Environment. An important feature of the management plan system is that relevant subordinate agencies and key research institutions cooperate in drawing up the scientific basis for the plans.

The relevant agencies may vary to some extent between sea areas. The scientific basis for the North Sea–Skagerrak management plan was prepared by an Expert Group headed by the Climate and Pollution Agency and including representatives of the Directorate for Nature Management, the Directorate of Fisheries, the Institute of Marine Research, the Coastal Administration, the National Institute of Nutrition and Seafood Research, the Norwegian Institute for Air Research, the Norwegian Institute for Nature Research, the Norwegian Institute for Water Research, the Norwegian Water Resources and Energy Directorate, the Petroleum Directorate, the Petroleum Safety Authority Norway, the Maritime Directorate and the Norwegian Radiation Protection Authority. Two advisory groups for the management plans, the Advisory Group on Monitoring (headed by the Institute of Marine Research), and the Forum on Environmental Risk Management (headed by the Norwegian Coastal Administration) have also been involved.

A scientific basis was compiled for the white paper, and includes topics such as biodiversity,

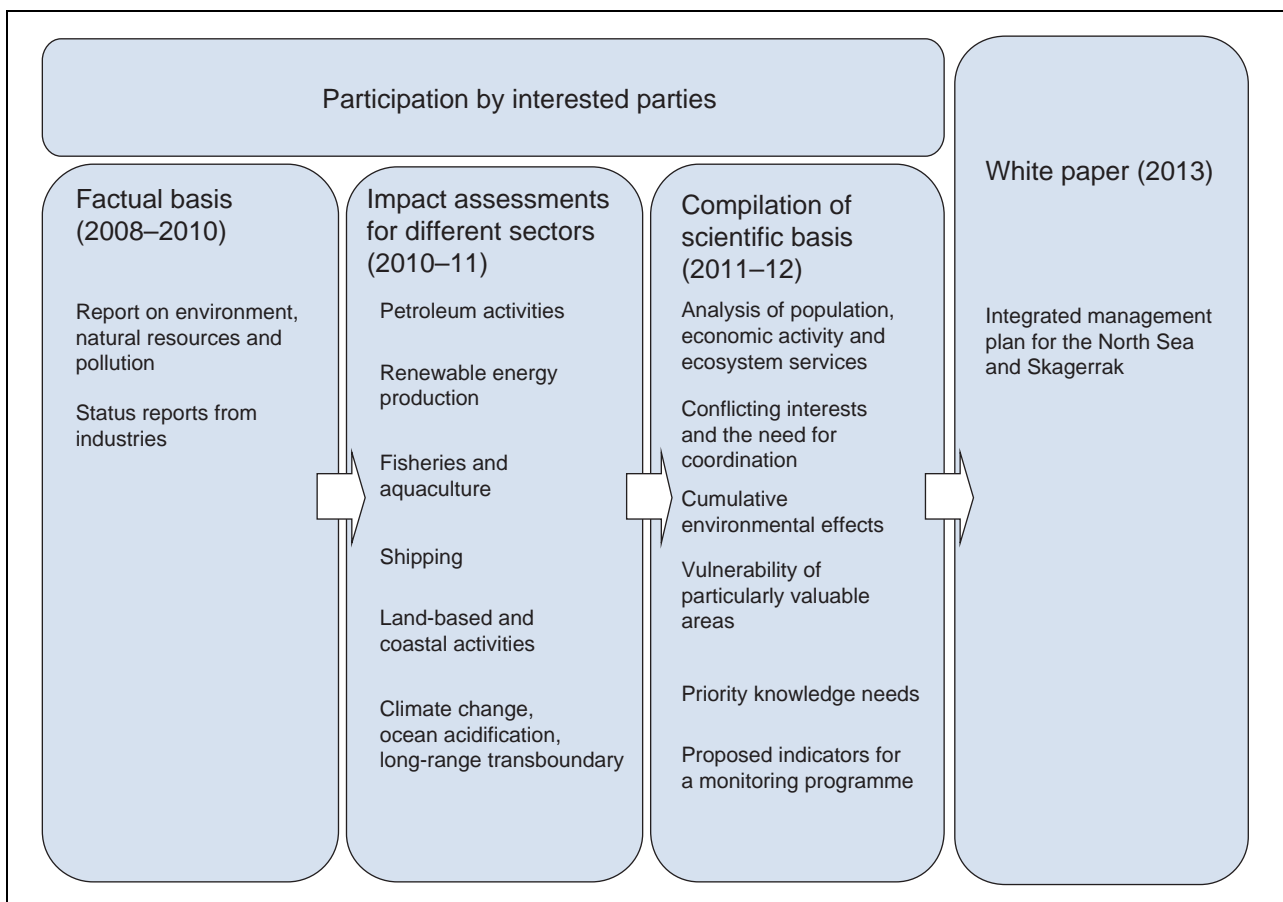


Figure 2.1 Stages in the preparation of the North Sea–Skagerrak management plan.

Source: Ministry of the Environment

pressures and impacts, and human activity. Chapters 3–7 describe the knowledge base, in line with the knowledge requirements of Norwegian legislation such as the Nature Diversity Act and the Marine Resources Act. Chapter 3 describes the state of the environment in the management plan area. Chapter 7 describes and assesses the cumulative environmental effects on the ecosystems of the area. This approach is in accordance with the requirement to assess cumulative environmental effects and apply the precautionary principle, as set out in the Nature Diversity Act.

In preparing the North Sea–Skagerrak management plan, economic considerations have been given more emphasis than in earlier management plans. This approach will be further developed in future updates of all the management plans.

Now that management plans have been drawn up for all Norwegian sea areas, the Government will take steps to simplify the way the work is organised and make updating the plans more effective.

The relevant sectoral authorities have the main responsibility for implementing the measures set out in the management plans under the legislation they administer, for example the Marine Resources Act and the Act relating to ports and navigable waters (Ministry of Fisheries and Coastal Affairs), the Petroleum Activities Act (Ministry of Petroleum and Energy and Ministry of Labour), the Offshore Energy Act (Ministry of Petroleum and Energy), the Maritime Safety Act (Ministry of Trade and Industry and Ministry of the Environment), and the Pollution Control Act and Nature Diversity Act (Ministry of the Environment).

Consultation

Participation by interested parties is also an important element of the management plan work. The Expert Group has ensured participation in the work on the scientific basis through consultation on the background reports and consultative meetings during the process of developing the plan. After the Expert Group had delivered the scientific basis to the ministries in May 2012, a conference was held in Haugesund on 22 May to give all interested parties an opportunity to discuss the reports. After the conference, interested parties were also invited to provide written input. The responses of the various parties made an important contribution to the preparation of this white paper, and are all available on the website of the Ministry of the Environment.

2.3 The management plan area

The area covered by the scientific basis for the management plan comprises the entire North Sea and Skagerrak, including waters along the coast and areas under the jurisdiction of other countries. The actual management plan and the measures described in it apply primarily to the open sea in the Norwegian part of the North Sea and Skagerrak, i.e. the areas outside the baseline, in Norway's territorial waters and exclusive economic zone northwards to latitude 62 °N (off the Stad peninsula). The management plan does not cover areas within the geographical scope of the Planning and Building Act or the Water Management Regulations, with the exception of an overlap in the area from the baseline to one nautical mile outside the baseline. This means that the management plan does not determine the framework for activities in the coastal zone, such as fish farming. Environmental pressures from land-based and coastal activities are therefore categorised as external pressures in the management plan.

2.4 Management plans in an international context

Norway's management plan work has put the country at the forefront of efforts to develop an

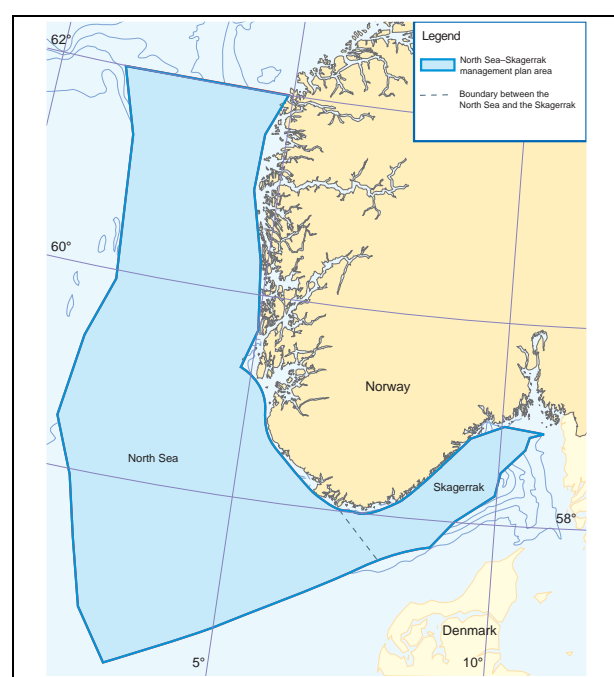


Figure 2.2 The North Sea and Skagerrak management plan area

Source: Norwegian Mapping Authority

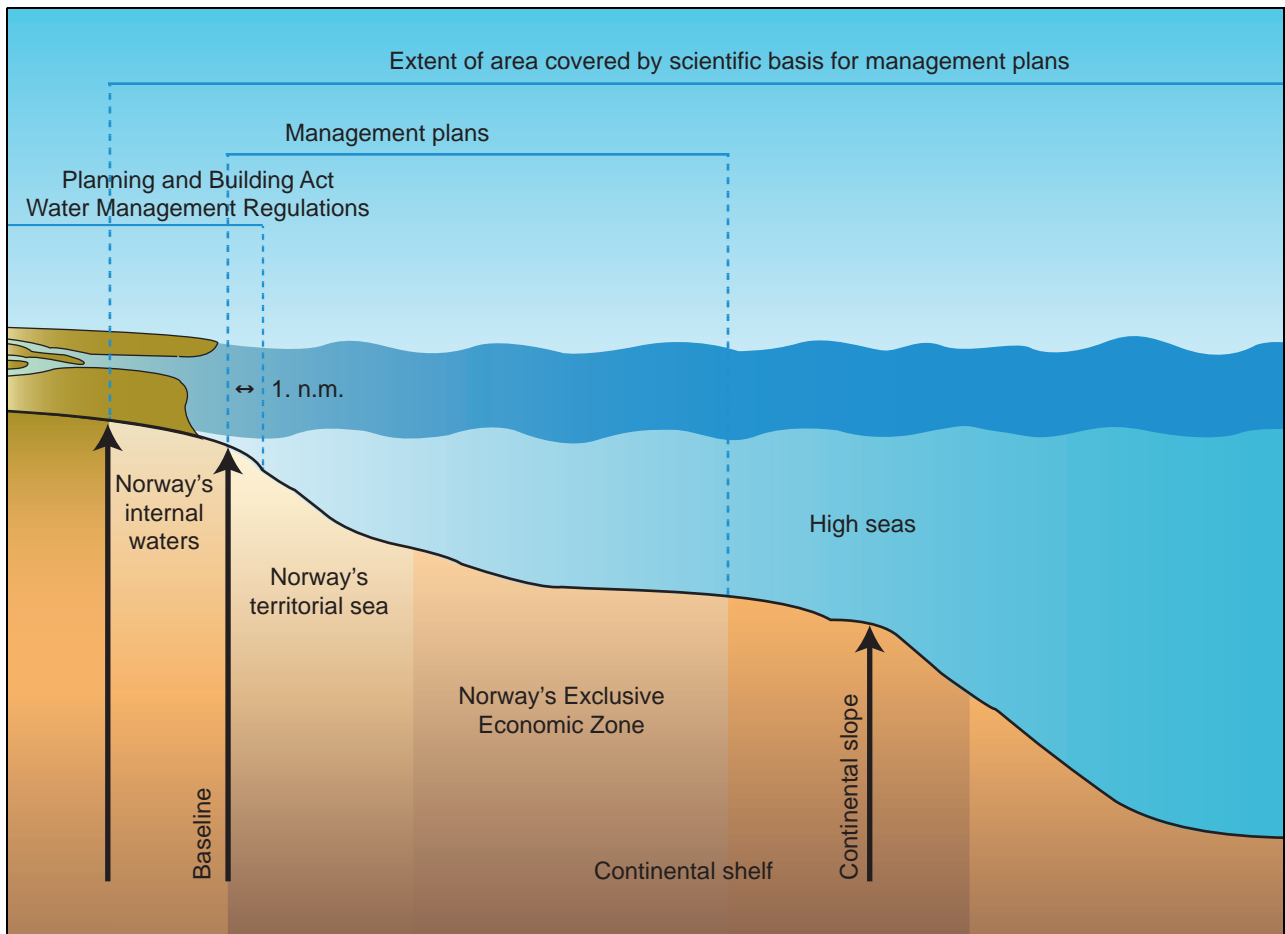


Figure 2.3 Geographical scope of Norway's management plans, the Planning and Building Act and the Water Management Regulations.

Source: Adapted from OSPAR QSR 2010

integrated ecosystem-based management regime. Coastal states have a clear duty under the UN Convention on the Law of the Sea to protect the marine environment. This is bound up with the extensive rights coastal states have under the Convention to utilise living marine resources and other resources on the continental shelf under their jurisdiction.

Under the Convention on the Law of the Sea, countries also have a duty to cooperate at regional and global level to protect and preserve the marine environment. In the 1980s and 1990s, international cooperation on the marine environment focused largely on reducing the worsening pollution of the seas. Through the regional Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention) and its predecessors (the 1972 Oslo Convention and the 1974 Paris Convention), and the North Sea Conventions (1984–2006), specific obligations were adopted that have led to a considerable improvement in pollution levels, particularly in

the North Sea–Skagerrak area. Together with the other Nordic countries, Norway was a driving force in this work (see Box 2.1).

Within OSPAR, the main focus has now shifted from traditional pollution issues to the need to maintain species and marine biodiversity. The Convention on Biological Diversity (CBD) is the most important global cooperation forum in this field. A target has been adopted under the Convention that by 2020, 10 % of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, will be conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into wider seascapes. A major effort is now underway within the framework of the Convention to collect information on ecologically or biologically important marine areas. In cooperation with the North East Atlantic Fisheries Commission (NEAFC), OSPAR has initiated work to identify such areas, mainly in interna-

Box 2.1 The North Sea and Skagerrak – an international sea area

The North Sea and Skagerrak are strongly influenced by human activity. About 160 million people live in the catchment area, and all eight countries surrounding the sea area – Norway, Sweden, Denmark, Germany, the Netherlands, Belgium, France and the UK – must cooperate to ensure an effective joint management system.

Parts of the North Sea were suffering from eutrophication and pollution as early as the 1800s, as a result of growing sewage discharges, runoff from agriculture and emissions from an expanding industrial sector. Between the mid-1800s and the 1960s, all the North Sea countries gradually introduced national legislation to combat pollution and by the late 1960s, it had become obvious that the North Sea countries also needed to agree on joint management of the North Sea and Skagerrak. The *Torrey Canyon* disaster was particularly important in triggering the political will to agree on binding joint rules. A few years later, the *Stella Maris* incident gave further momentum to the process of putting in place binding international agreements.

The *Torrey Canyon* was a Liberia-registered supertanker that was carrying a huge cargo of crude oil when it ran aground off the coast of Cornwall in south-western England in 1967. The oil spill from the wreck caused serious damage along both the English and the French coastlines, and clean-up operations required joint action by the British and French authorities. The accident triggered international action: at global level by the International Maritime Organization (IMO), which adopted the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), and at regional level through the negotiation of the Bonn Agreement (Agreement for Cooperation in dealing with Pollution of the North Sea by Oil and Other Harmful Substances).

The Dutch ship *Stella Maris* sailed from Rotterdam in 1971 to dump chemical waste at sea, but was prevented by local protests and strong pressure from the countries near the proposed dumping sites (the first plan was to dump the waste near the Norwegian coast, then between Iceland and Ireland). In the end, the ship returned to port and the Netherlands finally had to dispose of the waste on land. This incident speeded up the adoption of the 1972 Oslo Convention or the Prevention of Marine Pollution by Dumping from Ships and Aircraft, in which the Norwegian authorities played a leading role. The London Convention on dumping at sea, a global convention based on the same criteria as the Oslo Convention, was also adopted in 1972.

The new willingness to take joint action in the North-East Atlantic region also resulted in growing awareness of the harmful inputs of nutrients and

other pollutants from land, and to the adoption of the Paris Convention for the Prevention of Marine Pollution from Land-Based Sources in 1974. The Oslo and Paris Conventions set up a joint secretariat in London, and were merged into one convention, the Convention for the Protection of the Marine Environment of the North-East Atlantic (still known as the OSPAR Convention), in 1992.

The series of North Sea Conferences held between 1984 and 2006 were another expression of the willingness to cooperate and understanding of the need to do so. These high-level political meeting places provided an opportunity to discuss all pressures on the North Sea – pollution, fisheries, oil and gas activities, and shipping – from an overall perspective. The North Sea countries adopted joint declarations with ambitious goals, for example to halt dumping of waste from ships and reduce inputs of nutrients and hazardous substances. These goals have also had a strong influence on developments within the OSPAR cooperation and the EU, where the political goals have been translated into more legally binding rules. After the North Sea Conference on shipping and fisheries in Gothenburg in 2006, it was decided to continue the work within the framework of relevant conventions and organisations (OSPAR, NEAFC and IMO) and through active cooperation between these forums.

Since the adoption of the Oslo and Paris Conventions in the early 1970s, the oil and gas industry in the North Sea has expanded greatly. The 1992 OSPAR Convention therefore included a separate annex regulating pollution from offshore sources. In 1995, it emerged that the British authorities were planning to permit dumping of the Brent Spar, a disused oil storage buoy, in the North Sea. This caused political controversy at the North Sea Conference in Esbjerg in the same year. Brent Spar was finally towed to Norway (Erfjord in Rogaland), where it was decommissioned and the materials were re-used in new port facilities being built just outside Stavanger. The case sparked much political discussion between the North Sea countries. At the first ministerial meeting under the OSPAR Convention in 1998, rules on the disposal of disused offshore installations were adopted. They state that disused offshore installations must as a general rule be removed, but that exceptions may be made on specific conditions and after consultation with the other parties involved, for example for concrete installations. At the same ministerial meeting, a new annex to the OSPAR Convention on the protection of marine biodiversity was adopted. Using this as a basis, OSPAR has in recent years made its mark both globally and regionally through successful cooperation on the protection of marine areas, species and habitats.

Box 2.2 Marine protected areas and OSPAR

The parties to the OSPAR Convention have been working together for a number of years to establish a network of marine protected areas (MPAs). Until 2010, the network consisted of areas within the parties' national jurisdiction. These were protected in different ways under national legislation and nominated as components of the network. At OSPAR's ministerial meeting in Bergen in 2010, it was decided to establish six MPAs in areas beyond national jurisdiction. The network now consists of more than 280 MPAs in areas within and beyond the parties' national jurisdiction.

The ongoing work of identifying areas of the North-East Atlantic that may be ecologically or biologically valuable will provide an important basis for continued joint efforts to establish more MPAs.

OSPAR does not adopt measures targeting fisheries or shipping, and active cooperation with NEAFC and IMO is therefore essential for effective management of MPAs in areas beyond national jurisdiction. As early as 2009, NEAFC had closed several areas beyond national jurisdiction to bottom fishing to prevent damage, and

these overlap extensively with the OSPAR MPAs in areas beyond national jurisdiction. Studies are also being carried out within OSPAR on pressures and impacts from shipping in the MPAs as a basis for possible protective measures in cooperation with IMO.

Another joint initiative has therefore been taken to develop a collective arrangement involving OSPAR, NEAFC, IMO and the International Seabed Authority regarding principles for the management of areas beyond national jurisdiction that have been given some form of protection. Examples of such protection include OSPAR MPAs in areas beyond national jurisdiction and NEAFC's closures of areas beyond national jurisdiction to bottom fishing, and any future steps by IMO and the Seabed Authority. This cooperation model is important and is arousing considerable international interest, for example in connection with the UN's discussions on conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction in the context of the law of the sea. Norway is working actively to gain international acceptance of this form of cooperation.

tional waters in the North-East Atlantic, with a view to presenting proposals to the Conference of the Parties to the CBD in 2014.

Norway's management plans are policy instruments. They take a long-term approach to the protection of marine ecosystems, and are therefore a key tool for meeting Norway's obligation under international law to protect the marine environment of its seas. They are also flexible; the regular updates allow for changes to earlier decisions within their overall framework, on the basis of new and updated information. This means that in addition to protecting ecosystems, the plans also provide for Norway to make use of its right and duty under international law to make sustainable use of the resources in its sea areas.

To achieve good environmental status in its sea areas, Norway is dependent on other countries taking steps to protect the environment and manage their resources sustainably. It is clearly in Norway's interests for the other North Sea countries to meet their commitments. In 2008, the EU adopted the Marine Strategy Framework Directive, with the aim of achieving good environmen-

tal status in all European marine waters by 2020. To this end, each member state is to develop a marine strategy for its waters. These will include the establishment of environmental targets, indicators, monitoring programmes and programmes of measures. In other words, the directive sets out much the same approach and the same methods as Norway's integrated management plans. However, the Government has found that the directive is not EEA-relevant, and Norway is therefore not bound by its provisions.

The Norwegian environmental authorities have entered into cooperation with Sweden and Denmark to ensure scientific coordination of the management of adjacent areas under their jurisdiction in the North Sea and Skagerrak. The OSPAR framework provides a basis for establishing similar cooperation with the other North Sea countries. It is important to continue developing the management plans so that Norway can continue to be at the forefront of developments and maintain its legitimacy and influence as a driving force in international efforts, especially as regards the North Sea and Skagerrak.

3 State of the environment – status and trends

The environmental status of the North Sea and Skagerrak has been improved over the past few decades, but still gives cause for concern and is unsatisfactory in many ways. These waters are naturally rich and productive, but there are various types of pressure on the environment, which entail considerable management challenges.

This management plan area differs from the Norwegian Sea and the Barents Sea–Lofoten area in being much more strongly influenced by human activity.

Climate change and ocean acidification are expected to result in major ecosystem changes, and may intensify the impacts of other pressures. Rising temperatures have already resulted in changes in the species composition and distribution of zooplankton. These may affect food supplies for fish, seabirds and marine mammals and thus have impacts on their populations. Higher sea temperatures have also allowed new fish species from further south to expand into the management plan area.

Releases of pollutants from point sources have been reduced, but there are still considerable inputs of hazardous substances, mainly from sources outside the management plan area. Moreover, concentrations of marine litter in the North Sea are among the highest recorded in the North-east Atlantic.

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. The levels of certain substances in some species are cause for concern.

Fishing pressure on a number of stocks in the North Sea was previously too high. Together with natural fluctuations and climate change, this has reduced some spawning stocks to critical levels, and there is a risk that other stocks are not being harvested sustainably. The impacts of bottom trawling can be seen in many areas of the seabed. Along the edge of the Norwegian Trench, where the same area may be bottom trawled up to 20 times a year, the composition of the benthic fauna has been altered.

A number of seabird populations are declining, including the common gull, black-legged kittiwake, common tern, Atlantic puffin and common guillemot. Pressures on seabirds include climate change, changes in food supplies, and human activity. However, great cormorant numbers have increased along the Skagerrak coast.

Water quality is good in the coastal current, but eutrophication and sediment deposition may affect water quality in some areas along the coast and in fjords.

This chapter gives an account of the environmental status of ecosystems in the management plan area, including the pollution situation and the status of species and habitats. It also describes the particularly valuable areas that were identified in the scientific basis for the management plan, and which are particularly important for biodiversity and biological production. Environmental pressures and impacts from various sectors and the cumulative environmental effects on ecosystems are discussed in Chapters 6 and 7.

3.1 The physical/chemical environment and climate change

3.1.1 Oceanographic conditions

The North Sea–Skagerrak management plan area covers an area of 142 100 km², and is thus considerably smaller than the other two management plan areas, the Norwegian Sea (1.17 million km²) and the Barents Sea–Lofoten area (961 000 km²). The management plan area is bounded by other countries' territorial waters and economic zones.

The North Sea is generally shallow, reaching the greatest depths (somewhat more than 100 metres) in the northerly parts of the basin. The Norwegian Trench separates Norwegian coastal waters from the shallower parts of the North Sea further west and south. The coastal side of the Norwegian Trench slopes steeply to the deepest water just off the Norwegian coast, while the offshore side rises more gently to the North Sea Plateau west and south of the Trench. The Norwegian Trench reaches its greatest depth of more

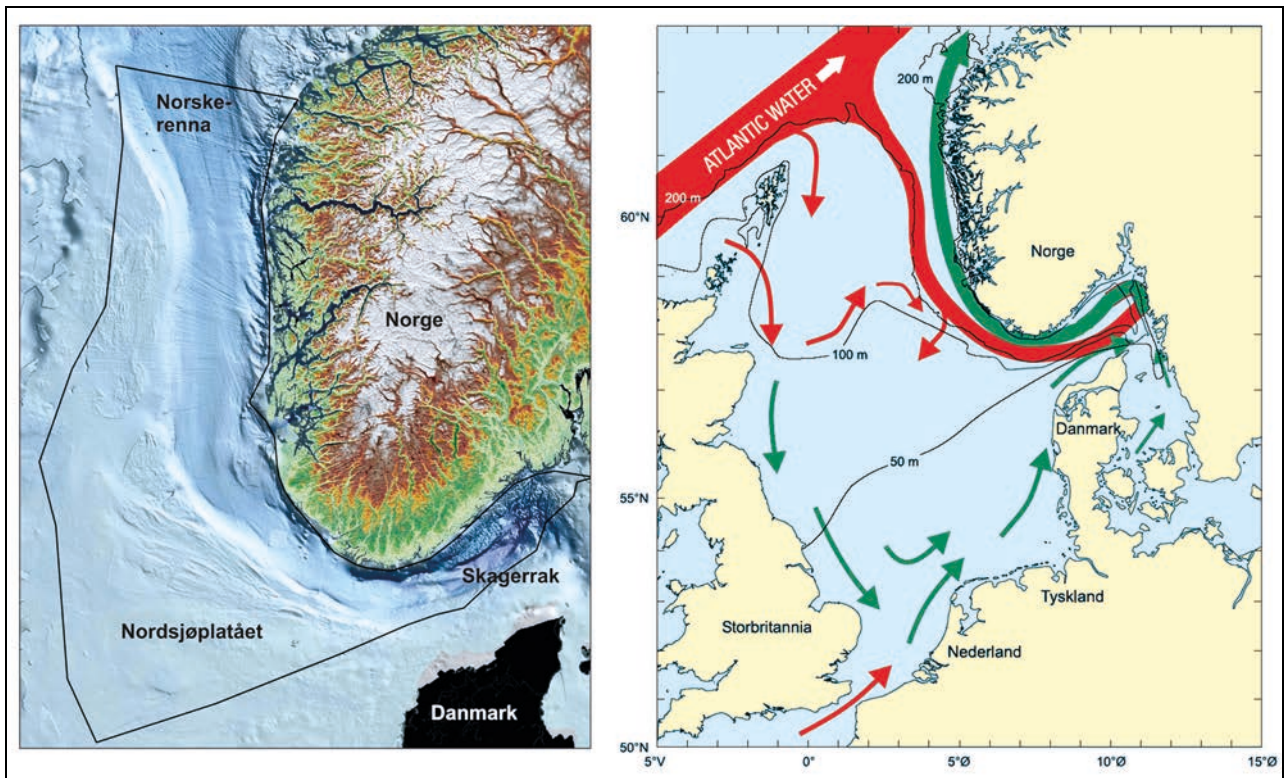


Figure 3.1 a) The bottom topography of the management plan area. b) The most important features of circulation patterns and water depths in the North Sea and Skagerrak. Red arrows: Atlantic water. Green arrows: Coastal water.

Source: a) Geological Survey of Norway and Norwegian Mapping Authority, b) Institute of Marine Research.

than 700 m in the Skagerrak south of Arendal. A shallower area off the Jæren area of Norway near Stavanger separates the deeper Skagerrak stretch of the Trench from the northern part.

Water circulation in the management plan area is strongly influenced by the topography. More saline, nutrient-rich Atlantic water flows in from the north and into the Skagerrak along the western slope of the Norwegian Trench. Together with water from the northern North Sea, it sinks to form the deep water. At the surface, outflowing, low-salinity Baltic Sea water mixes with water from the southern part of the North Sea. Together with runoff from land, this forms a wedge-shaped surface current off the coast, which flows southwestwards past Lindesnes (the southernmost point of Norway) and continues northwards along the coast. This current system is called the Norwegian coastal current. It shows seasonal variations in velocity, extent and depth. In summer, the coastal water may spread far across the North Sea Plateau, whereas in winter it is concentrated in a relatively narrow wedge-shaped band off the Norwegian coast. The quantity of water in the coastal current also varies, but the average transport off Western Norway is of

the order of 1 million m³ per second. The water masses of the North Sea are strongly influenced by wind. For example, strong northerly winds in the Jæren area near Stavanger and further east push surface water away from the coast, causing upwelling of colder nutrient-rich water to the surface, where the nutrients act as fertiliser for phytoplankton growth. The patterns of water circulation in the Skagerrak bring nutrient-rich deep water to the surface in the central parts of the Skagerrak, which is one important reason for the high level of biological production here.

The Skagerrak coast has relatively warm summers and cold winters, and freshwater inputs have most influence in this part of the management plan area. Most of the freshwater originates in the Baltic Sea, but Norway's largest rivers also drain into the Skagerrak, and carry large volumes of freshwater.

The coastline from Lindesnes northwards to the boundary of the management plan area at the Stad peninsula includes some of Norway's largest and deepest fjords. Some stretches of coastline are sheltered by hundreds of islands and skerries, whereas others, for example the Jæren area near Stavanger, are exposed to the open sea. Annual

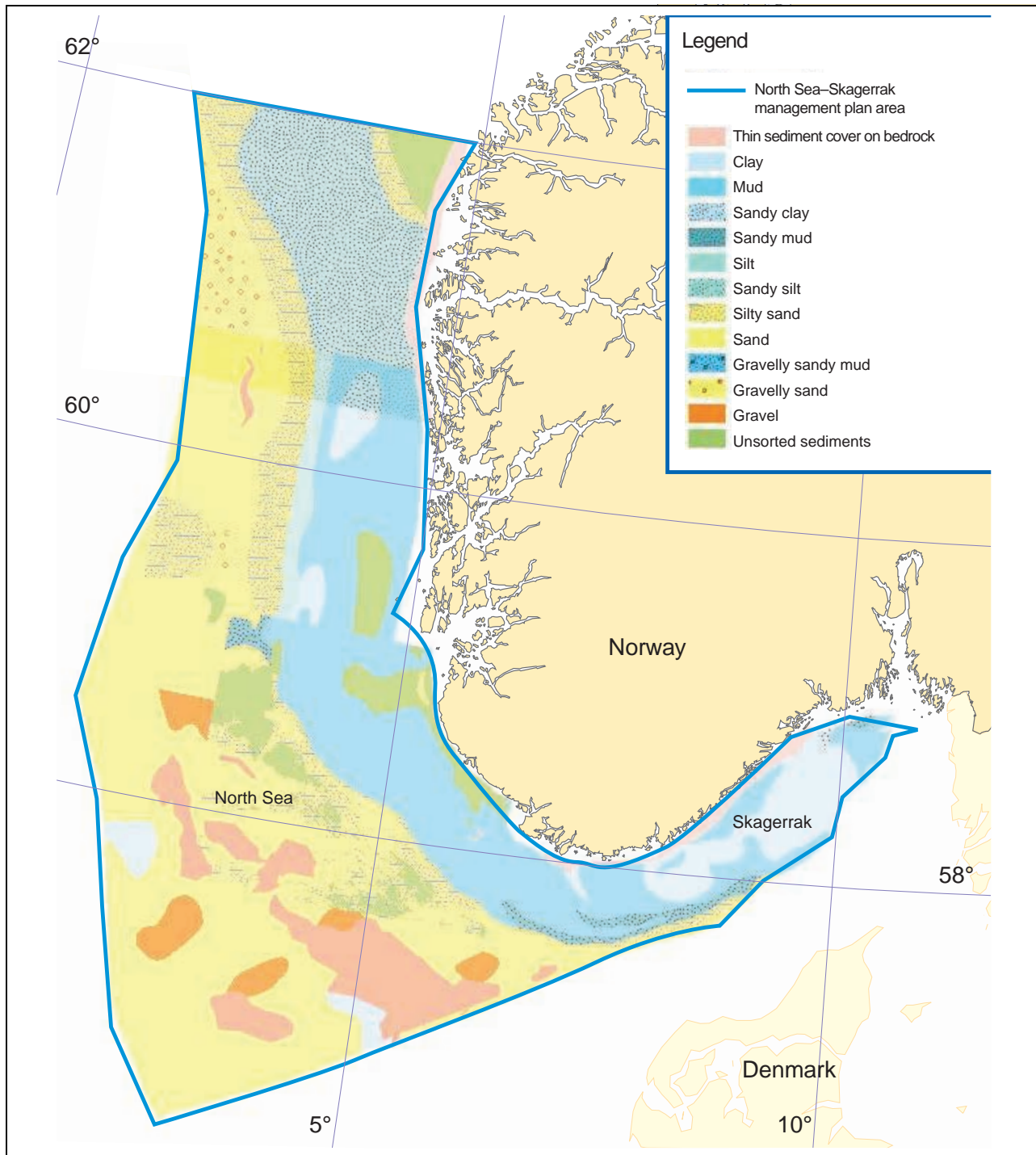


Figure 3.2 Sediment types in the management plan area.

Source: Norwegian Mapping Authority and Geological Survey of Norway.

temperature variations are smaller than along the Skagerrak coast, but the tidal range is greater and increases northwards. There are locally large inputs of freshwater in some fjords, but the coastal current itself is less influenced by freshwater than it is along the Skagerrak coast, and is not as strongly affected by long-range transport of nutrients. The general picture is that land-based activi-

ties, waste water discharges and industrial pollution put less pressure on this area than on the Skagerrak.

3.1.2 Sediments and landforms

Marine sediments are formed when unconsolidated material such as gravel, sand, mud and clay

is deposited on the seabed. The Norwegian Trench is the most important sedimentation area in the North Sea. Particularly in the Skagerrak and south of Lindesnes, large quantities of fine material (mud) transported with the currents from the southern parts of the North Sea are deposited, together with some material from the coastal zone. There is less sedimentation in the northern part of the Norwegian Trench. In shallower water over the slope between the Trench and the North Sea Plateau, the bottom sediments become gradually coarser, and in the transitional zone between the Trench and the Plateau they can be categorised as muddy sand. The upper part of the slope clearly shows the influence of stronger bottom currents, but also has deposits of fine sand transported from the Plateau.

Sandy sediments dominate the North Sea Plateau south of the Viking Bank (60°45'N). North of the Viking Bank, the bottom topography is more varied, with moraine ridges and hollows. The sediments are also more varied here, ranging from mud via sand to gravel, with boulders and bedrock appearing locally.

3.1.3 Natural conditions in the North Sea and Skagerrak

The composition and thickness of the bottom sediments have a considerable influence on the distribution of marine habitat types and benthic communities. Different soft bottom benthic communities consisting of crustaceans, molluscs, echinoderms and polychaetes are found, depending on the type of bottom substrate (sand, clay, etc). Certain sandy-bottom areas are important habitats and spawning grounds for sandeels. In some areas, moraine or hard clay deposits are exposed on the seabed, or covered by a layer of gravel and/or sand.

The topography along the coast is varied and complex, with a wide variety of subsea habitat types. There are sheltered fjords, islands and skerries, stretches of exposed coastline, and variations between deep and shallow water and between areas with strong currents and those with little current. Substrates can be divided into two main types: hard bottom, such as bedrock and boulders, and soft bottom, such as sand and mud. Coastal waters have a rich flora and fauna, including both sessile and free-swimming organisms, which vary in size from microscopic plankton to seals and whales. Many organisms are stationary, and spend their entire life cycle in coastal waters. Others have their spawning, nursery or feeding

grounds along the coast but spend long periods far out to sea. Macroalgae function as the trees, bushes and flowers of coastal waters, and are important nursery habitats for many organisms. There are three main groups of macroalgae: green, red and brown algae. The brown algae include the species commonly known as wracks and kelps. Macroalgae provide food and shelter for small organisms that are vulnerable as prey for larger species. The microscopic algae, phytoplankton, drift in the water column and make an even greater contribution to biological production along the coast. The phytoplankton is a vital source of food for zooplankton and other animals every spring and summer. In recent years, there has been growing awareness of the need to maintain species and habitats and a healthy coastal environment, and to avoid overharvesting resources and reduce pollution.

3.1.4 Climate change and ocean acidification

Climate change and ocean acidification may result in large-scale changes in marine ecosystems. The capacity of seawater to absorb heat and carbon dioxide (CO₂) is important for the role of the oceans in regulating greenhouse gases. The oceans have now absorbed so much heat that the rise in the average temperature at the surface and somewhat further down the water column is beginning to have marked effects. And the capacity of the oceans to absorb CO₂ is not unlimited either. In recent decades, the rising sea temperature has resulted in considerable changes in the quantity and species composition of zooplankton in the North Sea, and in particular in a substantial decline in the amount of the copepod *Calanus finmarchicus*.

Climate change may have impacts on marine ecosystems at a number of different levels, and may affect them in various different ways at the same time. It may have direct or indirect impacts on individual species or on trophic levels, and it is also possible that major ecosystems will be pushed past tipping points, so that they shift suddenly to a new state.

Carbon dioxide concentrations both in the atmosphere and in the oceans have risen due to anthropogenic greenhouse gas emissions. CO₂ reacts with water to form carbonic acid, making the seawater more acidic (lowering the pH). As a result, the average pH of ocean surface water is now about 0.1 pH units lower than the pre-industrial level. Calculations for the southern part of the North Sea indicate a drop of 0.35 pH units in the

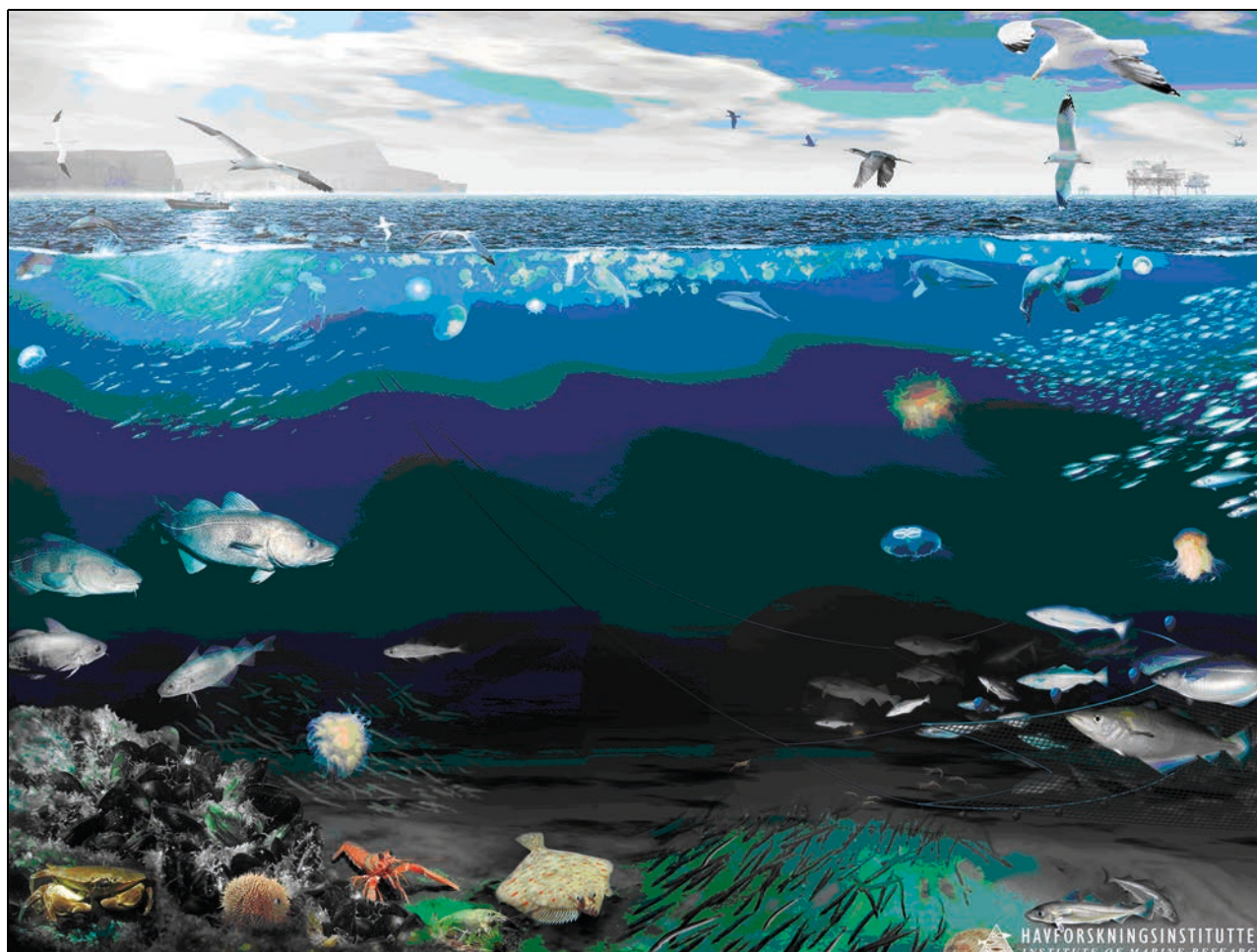


Figure 3.3 The pelagic and benthic ecosystems of the North Sea.

Source: Institute of Marine Research.

period up to 2100. In future, ocean acidification may have far-reaching impacts on ecosystems in the management plan area (see Chapter 7.3.8).

The hydrography of the North Sea is complex, since there are several different water masses of different temperature and salinity. Because of this, pH varies widely from one geographical area to another and also varies with water depth. In the deeper water layers, degradation of organic material gives rise to a higher content of CO₂ and thus lower pH. There are also large natural fluctuations in pH during the year as a result of processes such as seasonal algal growth and decomposition of organic material. Long time series of measurements over many years are therefore needed to identify long-term trends in pH levels. There are no long time series for the management plan area, but measurements made in the Kattegat since 1993 show a decline in pH in surface water. This indicates that ocean acidification is already taking place. In 2010, monitoring of ocean acidification was started in Norwegian waters, including the eastern part of the Skagerrak.

3.2 Pollution affects all parts of ecosystems

Pollution problems in the North Sea and Skagerrak have changed character in recent decades. Previously, the main task was to reduce pollution from point sources, some of which were large, and especially from land-based industry. Releases from these sources have been substantially reduced, and diffuse releases from sources on land, such as runoff from agricultural areas and other surface waters, together with inputs with air and ocean currents, now make a relatively larger contribution to the total pollution load in the management plan area.

The North Sea cooperation and work within OSPAR to achieve objectives for the marine environment have resulted in substantial reductions in inputs and environmental levels of oil, nutrients and heavy metals. Inputs of many other hazardous substances have also been reduced. Despite this, pollutants are still entering the North Sea and Skagerrak through long-range transport. These

Box 3.1 *Calanus finmarchicus* and rising sea temperature

Rising sea temperatures have resulted in major changes in the quantity and species composition of zooplankton in the North Sea, and a particularly large decline in the amount of the copepod *Calanus finmarchicus*. This is a key zooplankton species in central and northern parts of the North Sea, where it is an important food species for several types of fish and for the larval stages of the most important prey species for seabirds.

The quantity of *C. finmarchicus* in the North Sea has declined greatly in the past 10–20 years, and has dropped by 70 % since the 1960s. At the same time, *Calanus helgolandicus*, a closely related species that prefers warmer waters, has been increasing in numbers, and its distribution has expanded all the way to the Norwegian Sea. This species spawns later in the year and is less nutritious for fish and seabirds than *C. finmarchicus*.

Changes in species composition, size distribution and production cycles of zooplankton have effects on animals at higher trophic levels in the food web. For example, *C. finmarchicus* spawns early in spring, and quantities of its early larval stages reach a maximum when the larvae of spring-spawning fish species have hatched. Fish larvae are dependent on finding the right kind of food at the right time if they are to survive. A decline in *C. finmarchicus* and an

increase in plankton species that spawn later in the season, such as *C. helgolandicus*, may result in a mismatch between spring-spawning fish and their prey, and thus have a direct impact on recruitment to stocks of these fish species.

Both *C. finmarchicus* and *C. helgolandicus* are near the edge of their distribution areas in the North Sea. They are therefore particularly sensitive to temperature change, and can be used as indicators of climate change.



Figure 3.4 The copepod *C. finmarchicus*

Source: Institute of Marine Research

pollutants are substances that can be transported for long distances and that largely originate outside Norway's borders. In addition, diffuse sources within Norway add to the pollution load. Hazardous substances are present in marine organisms, including seabirds and marine mammals. All these factors mean that the pollution status of the management plan area is not satisfactory. Furthermore, in addition to its impacts on marine species, pollution may have negative consequences for commercial activities that are based on marine resources and a clean environment, such as fisheries, aquaculture and tourism.

3.2.1 Hazardous substances

Hazardous substances are substances or groups of substances that are toxic, persistent and liable to bioaccumulate, and other substances or groups of substances that give rise to an equivalent level of concern. The latter include substances that do

not meet all three criteria but have other properties that give rise to an equivalent level of concern, such as endocrine disruptors.

In the case of the most persistent hazardous substances, the slow rate of degradation means that it takes a long time before emissions reductions lead to a reduction of environmental levels of the substances. In other cases, the main problem is that such large quantities of hazardous substances are used and released that environmental levels continue to increase even though the substances are less persistent.

Pollution levels in the management plan area vary between substances, geographical areas and sample media (water, fauna, algae, sediment). Substances that are bioaccumulative have the most serious impacts on species at higher trophic levels such as seals and seabirds. The pollution load in some of these species is so high that it can cause damage to the nervous system and disrupt reproduction.

Calculations show that long-range transport of pollutants with air and ocean currents is the most important source of hazardous substances in the Norwegian part of the North Sea and Skagerrak. Since these waters are downstream of pollution sources, the currents carry polluted water masses from other areas into the management plan area. The Norwegian part of the North Sea and Skagerrak is therefore influenced by activities and inputs from other countries. Hazardous substances are spread with the ocean currents, and the levels measured in the open sea are therefore relatively low. The exception is sedimentation areas in the Norwegian Trench, where elevated levels of polycyclic aromatic hydrocarbons (PAHs) have been measured. Modelling results indicate that levels of hazardous substances in seawater are highest near the coast of the Skagerrak, in eastern parts of the Skagerrak and in the southern part of the North Sea. This is explained by inputs from rivers and the coastal zone in other countries around the North Sea.

Little is known about the fate of hazardous substances once they reach the coastal current and the open sea, but given what is known about their properties and their presence in the water masses, there is reason to believe that these substances may have adverse impacts on the state of the environment in the management plan area.

3.2.2 Hazardous substances in seafood and seafood safety

Hazardous substances can pose a risk to health if they are consumed in seafood. 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. The content of certain substances in a few species is high enough to give cause for concern. Levels of dioxins and dioxin-like PCBs (polychlorinated biphenyls) in the liver of a relatively high proportion of the cod in the management plan area exceed the maximum levels permitted in fish liver. Levels of non-dioxin-like PCBs in cod liver also exceed the maximum permitted levels in a substantial proportion of cod from the North Sea and Skagerrak. Levels appear to be higher in the Skagerrak than in the North Sea.

If levels of dioxins and PCBs in cod liver exceed the maximum limits, the products may not be marketed for human consumption. To protect the most vulnerable groups in the population, the Norwegian Food Safety Authority has issued a

general warning that children, women of child-bearing age and pregnant women should not eat fish liver. Levels of dioxins and dioxin-like PCBs in cod liver from fjords and harbour areas are very high, and considerably higher than in cod from the open sea. The Food Safety Authority has therefore issued general advisories to the whole population against the consumption of liver from fish caught by private individuals inside the baseline. In addition to this, advisories on the consumption of fish and shellfish are in force today for 16 harbours and fjords in the North Sea–Skagerrak area. They are related to the presence of lead, cadmium, mercury, dioxins and furans, PCBs and PAHs.

Levels of mercury in tusk fillets from the Skagerrak have also been found to be just below the maximum permitted level. Mercury levels in tusk fillet from the North Sea were lower than in the Skagerrak and well below the maximum permitted level, but higher than the levels found in the Norwegian Sea and Barents Sea.

Animals and people often exhibit different levels of tolerance to hazardous substances, and their exposure to these substances also differs. Different systems have therefore been put in place to protect people and the fauna against the possible adverse impacts of hazardous substances (see Box 3.2).

3.2.3 Radioactive substances

Levels of radioactivity in the North Sea and Skagerrak are generally low, but higher than in Norway's other sea areas. Inputs from the Chernobyl accident in 1986 are still an important source of radioactive pollution in Norway's coastal and sea areas. Caesium 137 mainly enters the management plan area with contaminated water from the Baltic Sea, and the highest concentrations are therefore found in the Skagerrak (see Figure 3.6). There have been sporadic analyses of radioactive isotopes of radium and thorium in bottom sediments and the water column around selected petroleum installations, and elevated levels have been observed at certain sites.

3.2.4 Eutrophication and sediment deposition

Large inputs of nutrients to coastal and fjord areas result in eutrophication, which leads to excessive production of organic material. Decomposition of organic matter can lead to poorer oxygenation conditions in deep water. Dead organic matter

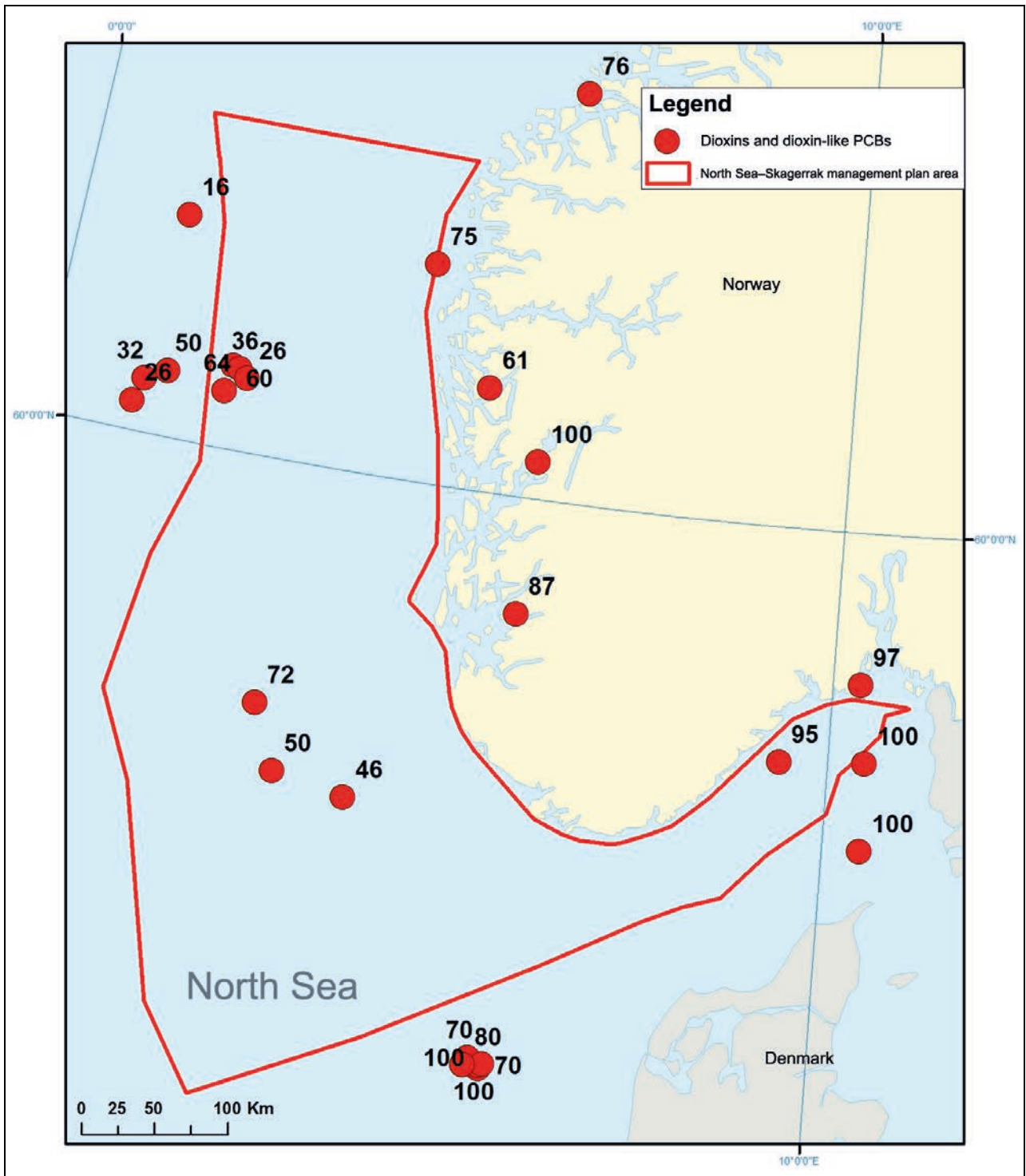


Figure 3.5 Percentage of cod found to contain concentrations of total dioxins and dioxin-like PCBs in the liver exceeding the statutory maximum level for human consumption set by the EU and Norway.

Source: National Institute of Nutrition and Seafood Research.

sinks to the bottom, and together with particulate matter in runoff from land this can result in sediment deposition on the seabed in sheltered areas. Eutrophication and sediment deposition as a result of inputs of nutrients and organic matter primarily lead to problems in coastal waters and

fjords. In 2007, an overall evaluation of eutrophication status along Norway's Skagerrak coast was carried out in accordance with OSPAR's Common Procedure and classification system, based on data from 2001–05. This identified the inner coastal waters (roughly the fjords and waters

Box 3.2 Differences between maximum permitted concentrations of hazardous substances in seafood and according to environmental quality standards

The concentration of a hazardous substance in an organism may be below the maximum permitted level for seafood, but higher than the level set in the environmental quality standard for biota.

The maximum permitted levels of contamination in seafood are intended to protect people. They set out the maximum permitted amounts of particular hazardous substances in seafood that is marketed for human consumption. The maximum levels are set in EU legislation and have with few exceptions also been made applicable in Norway. They are intended to prevent products containing levels of contaminants that could have negative effects on health from reaching consumers.

The environmental authorities (the Climate and Pollution Agency) also use a classification system, which is intended to protect the environment. The limits in this system were established to indicate environmental quality status in fjords

and coastal waters, but are now being revised to adapt them to the EU's Water Framework Directive. The revised classification system takes the most vulnerable elements of the ecosystem as a starting point, and sets maximum limits for concentrations of pollutants on the basis of the levels that have been shown to have environmental impacts. These thresholds are called Environmental Quality Standards (EQS). Both the EU and Norway are working on the determination of further EQS for different groups of organisms.

Thus, the levels of hazardous substances measured in an organism may be so high that there is a risk of environmental impacts, while at the same time the organism may be safe for people to eat. For example, levels of mercury in cod fillet are in many cases higher than the EQS set under the Water Management Regulations, but at the same time below the seafood safety limit.

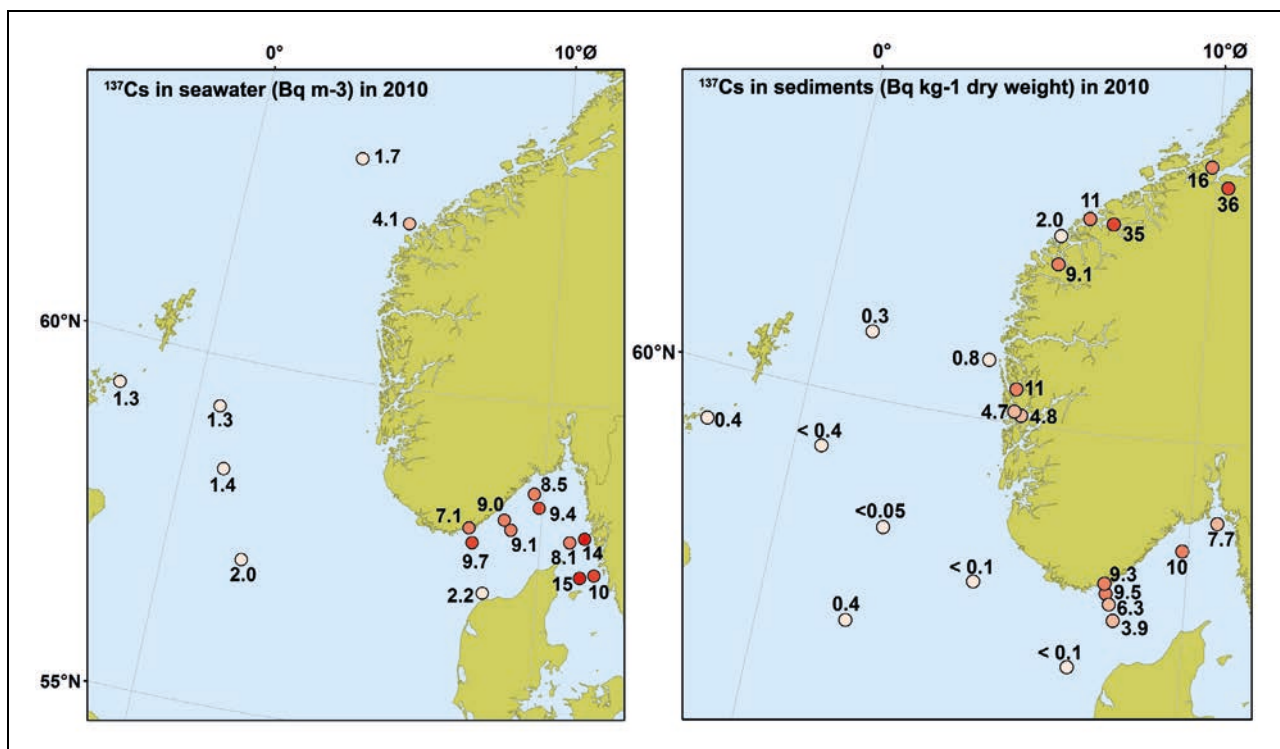


Figure 3.6 Levels of caesium 137 in sediments and seawater from the North Sea and Skagerrak in 2010

Source: Norwegian Radiation Protection Authority

inside the coastal islands and skerries) along this entire stretch of coastline as being a Problem Area with respect to eutrophication. Knowledge of environmental status along the coast of Western Norway is inadequate, but new calculations indicate that discharges of nutrients and organic matter are not having impacts at regional level. However, studies have revealed local effects. The eutrophication status of the outer zone of coastal waters and the open sea is considered to be good.

Local and regional changes in coastal waters and fjords may alter conditions in important nursery areas for fish and other marine animals that spend part of their life cycle in or near the management plan area. Rising sea temperatures combined with inputs of nutrients and sediment deposition are probable explanations for the loss of sugar kelp from much of the inner coastal waters of the Skagerrak (see Chapter 3.3.3).

3.2.5 Marine litter – a global environmental problem

Large quantities of litter enter the world's oceans every year, and are transported with ocean cur-

rents over great distances and across national borders. Plastic, glass, rubber and other long-lived materials can persist in the environment for many years. There are many different sources of marine litter, and their environmental impacts vary.

OSPAR has carried out beach litter surveys to assess the litter problem in the Northeast Atlantic. In general, high levels of beach litter were registered, although there were variations from one year to another. Concentrations of marine litter in the North Sea area are among the highest recorded in the Northeast Atlantic.

Plastics account for only 10 % of the annual quantity of waste generated worldwide, but because of their properties and slow rate of degradation, they make up the largest proportion of the accumulated litter in the sea. This is also the case in Norwegian waters (Figure 3.7). Plastics are gradually fragmented into smaller and smaller pieces, and finally form extremely persistent microplastics. It has been shown that microplastics may be present in high concentrations in seawater.

So far, only one pilot study of microplastics has been carried out in Norway, in which samples



Figure 3.7 The ten marine litter items most frequently found during the annual beach clean-up day in 2012

Source: Hold Norge rent (Keep Norway Clean). Photo: Oslofjordens friluftsråd.

were taken at stations between Arendal and Hirtshals in Denmark. Low concentrations were found in the open sea, but the possibility that this is a more serious problem closer to the coast and in enclosed fjords cannot be excluded.

Much of our knowledge about marine litter comes from beach litter surveys, studies of the contents of seabird stomachs and video recordings of pipelines on the seabed. Even though marine litter has been an obvious problem for a long time, our knowledge of its environmental impacts is very limited. In 2011, the Directorate for Nature Management established a network of seven localities for monitoring beach litter. Two of these localities are close to the management plan area (Kviljo in the Listastrendene area and Akerøya in Ytre Hvaler national park, Outer Oslofjord). Monitoring at these localities forms part of the international cooperation on marine litter, and the data are reported to OSPAR. Data series from these localities and similar monitoring programmes in other countries will provide information on the scale and sources of marine litter in the management plan area.

3.3 Specific ecosystem components

3.3.1 Phytoplankton and zooplankton

Phytoplankton

Phytoplankton are microscopic, single-celled organisms that drift in the water column. Like other plants, they need light and nutrients to grow, in other words to divide and form new cells. At our latitudes, there is only enough light for plant growth in the upper 50 metres of the water column. In spring, runoff of freshwater (which is lighter than the saline seawater) increases, and the temperature of the surface water rises. This results in the formation of a relatively stable surface layer that is ideal for phytoplankton growth. Large algal blooms colour the sea surface, the colour depending on which species is involved. The spring algal bloom is dominated by diatoms, which require silicate as a nutrient in addition to nitrate and phosphate. Large algal blooms can be clearly visible, and may for example make the water in popular bathing areas appear discoloured and almost opaque. But all the organisms that feed on this first trophic level of marine food chains benefit from large algal blooms. Inputs of nutrients increase phytoplankton production and can result in negative impacts such as oxygen depletion in deeper water layers as surplus quanti-

ties of phytoplankton sink to the seabed where the dead cells are broken down, consuming oxygen in the process. The inner parts of fjords with shallow sills are particularly vulnerable because turnover of the bottom water is slow.

Zooplankton

In the past 25 years, considerable changes have been observed in the quantity and species composition of zooplankton in the North Sea. As a result of the rising sea temperature, warm-water species have expanded their distribution more than 1000 km northwards over the past 50 years, while there has been a reduction in the quantity of cold-water species. One clear example of the changes is the 70 % decline in the biomass of the copepod *Calanus finmarchicus* in the North Sea since the 1960s. The biomass of the related species *C. helgolandicus* has increased in the same period (see Box 3.1).

Changes in the species composition, size distribution and production cycles of the zooplankton have implications for higher trophic levels in the food web.

Because about 70 % of the water masses of the North Sea flow into the Skagerrak and then back out of the North Sea as part of the Norwegian coastal current, monitoring in the Skagerrak can give a good picture of conditions in the North Sea and how they are changing. Since 1994, the Institute of Marine Research has taken samples of zooplankton along the Skagerrak coast as part of the Climate and Pollution Agency's coastal monitoring programme. The results show a steep decline (80 %) in the biomass of small plankton species since 2003. The zooplankton community consists of a wide range of different species, and copepods of the genus *Pseudocalanus* are considered to be the most important species in the food chain in the North Sea after the *Calanus* species. However, these species are so small (1.0–1.5 mm) that the total biomass of *Pseudocalanus* is smaller than that of *Calanus*.

3.3.2 The seabed and benthic fauna

There is a rich benthic flora and fauna in the North Sea, Skagerrak and adjoining coastal areas. The distribution of benthic animals depends on the sediment type and water depth.

The species composition of the benthic fauna shows a split between more southerly assemblages, dominated by free-swimming organisms such as starfish and crustaceans, and more north-

Box 3.3 The 1988 algal bloom

Some phytoplankton species are toxic and can occur in such high concentrations that they cause widespread mortality of fish and benthic animals. This happened on an unusually large scale in summer 1988, when a massive bloom of the unicellular alga *Chrysochromulina polylepis* (*Prymnesium polylepis*) resulted in high fish mortality along the Norwegian coast. The bloom started in the Kattegat, and the algae were carried in the coastal current towards Western Norway. Other algae and a wide range of marine animals were killed or harmed in an area stretching from the west coast of Sweden to Bømlo, between Stavanger and Bergen. Salmon farmers suffered major losses, but mortality was also recorded in wild fish and benthic animals.

Although the main trigger of this particular algal bloom has not been identified, a considerable nutrient imbalance between phosphate and nitrate was observed shortly before the bloom started. Moreover, there was little silicon in the water before the bloom began, which prevented a bloom of «harmless» diatoms. Together with extraordinary inputs of nutrients to the North Sea from the large rivers on the continent and inputs with the coastal current from the Baltic Sea, this may explain why there was such a large-scale bloom extending over such a large area.

After this «algal disaster», a number of steps were taken to reduce inputs of nutrients to the sea.

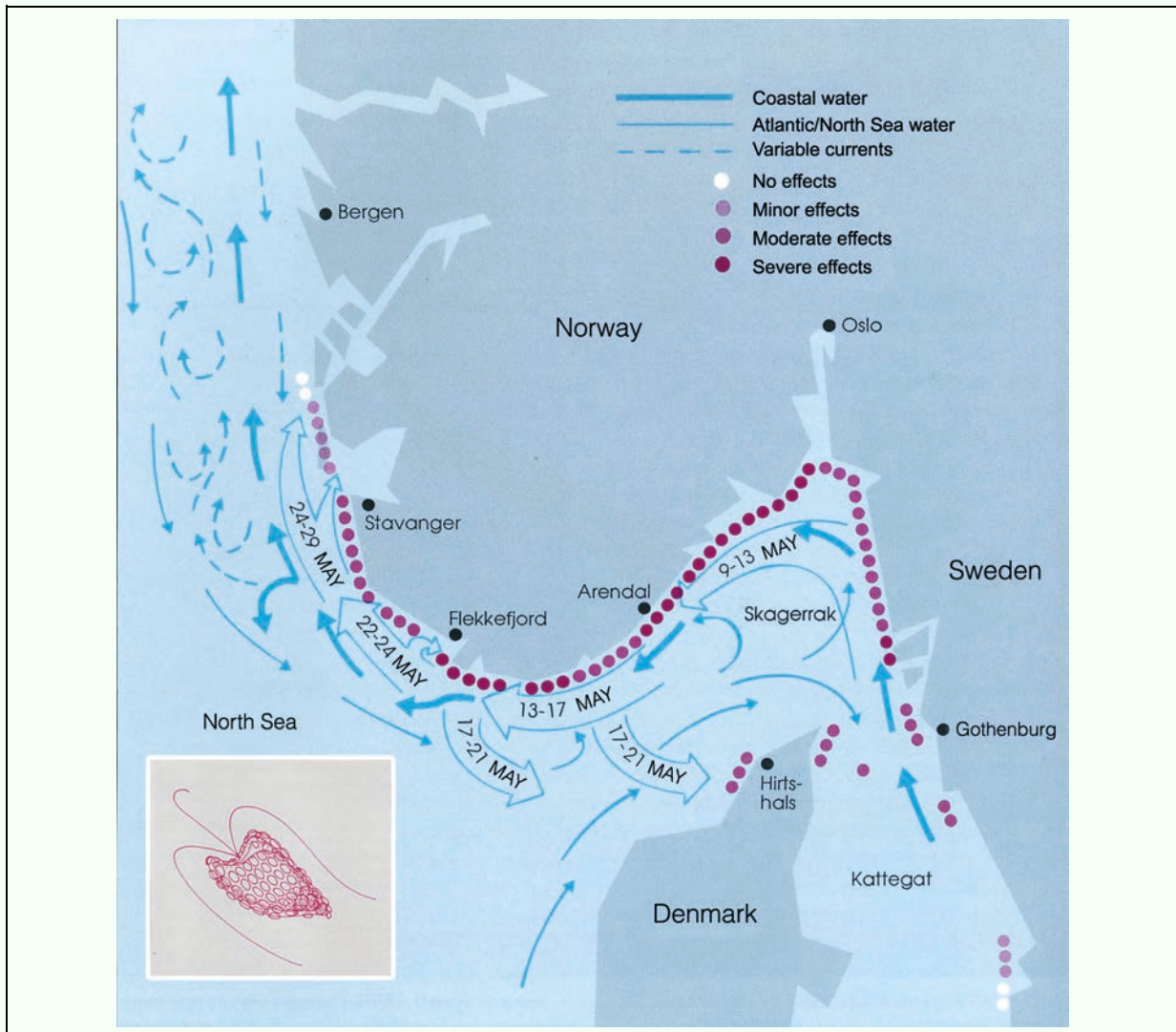


Figure 3.8 Extent and development of the algal bloom. The inset shows a single algal cell.

Source: Pedersen, Walday, Oug. Norwegian pollution monitoring programme. Report 475/91.

erly assemblages, where sessile organisms such as sea anemones and sponges tend to dominate. The boundary between the two types of assemblages follows the 50-metre depth line through the central part of the North Sea. The number of species is higher in the north than in the south, and the biomass is higher near the coast than further out to sea. Temperature variations and current conditions also influence species diversity and density, because most benthic species have larval stages that drift in the water column. The benthic fauna is important food for fish such as cod, haddock and flatfish, and benthic species feed on organic matter that sinks to the seabed.

We know a good deal about bottom types in the North Sea, but relatively little about the benthic and epibenthic fauna. This applies particularly to the largest species, such as sponges, sea pens and corals. These species protrude from the seabed and are therefore most sensitive to bottom trawling and other forms of physical disturbance. Coral reefs, gorgonian forests and sponge communities have been found in Ytre Hvaler national park and the adjacent Kosterhavet national park in Sweden. This reef complex, which stretches across the Norwegian–Swedish border, has also been identified as a particularly valuable area (see Chapter 3.4). The gorgonian forests in the area consist mainly of the sea fan *Primnoa resedaeformis*, but several other species of soft corals also occur. Coral habitats have also been found on the western slope of the Norwegian Trench in the Tampen area, towards the northern boundary of the management plan area, but the size of the reef complex is not known. No other coral habitats have been reported in the North Sea and Skagerrak. However, currents in both directions along the coast result in exchange between the water masses in the North Sea and those further north in the Norwegian Sea.

The fauna of the bottom sediments has been better studied, and there are long data series from the coastal and offshore monitoring programmes. However, there is a lack of information about the links between the structure of benthic communities and their ecological functions (cycling organic matter and nutrients, biological production).

Benthic communities are found in both hard bottom habitats (boulders, rock and gravel) and soft bottom habitats (clay and mud). Results from the coastal monitoring programme show that the state of both hard- and soft-bottom habitats in the outer zone of coastal waters in the Skagerrak and off the coast of Western Norway is generally good. The benthic communities in the eastern

part of the Skagerrak (outer Oslofjord) have been showing positive trends. This reflects the reduction in the nutrient content of water transported from areas such as the German Bight. Conditions within the coastal current vary greatly because of nutrient inputs from land. However, we know little about benthic communities in the management plan area other than those in coastal waters and around offshore installations. In areas that are repeatedly disturbed, for example near the slope of the Norwegian Trench, short-lived, opportunistic species will dominate at the expense of species that need more time to become established and reproduce.

Further south in the North Sea, it has been shown that slow-growing, sessile species such as molluscs have declined considerably, while free-swimming, fast-growing species, often crustaceans, are now dominant.

3.3.3 Kelp forests

Biodiversity and production are high in kelp forests, and they are often called the rainforest of the sea. The fauna is dominated by crustaceans and gastropods that move on and between the plants looking for food and shelter. Kelp forests are also important spawning, nursery and feeding areas for crustaceans, larvae and fish, and fish-eating seabirds often feed in these areas. Coastal cod spend the first winter of their life in these near-shore areas, and need the food and shelter they provide. The richness of kelp forests is illustrated by faunal densities in excess of 100 000 individuals per square metre. The invertebrate fauna plays an important role in nutrient cycles, since these animals live on the kelp and are in turn eaten by fish. Kelp forests also sequester large quantities of CO₂.

The outer part of the kelp forest zone is dominated by *Laminaria hyperborea*, which in hard-bottom habitats forms a belt in the depth range 1–20 metres. Individual plants, however, may grow down to a depth of more than 30 metres. In more sheltered coastal areas and fjords, kelp forests are often dominated by sugar kelp (*Saccharina latissima*). *L. hyperborea* is harvested commercially from Rogaland to Nord-Trøndelag. The state of these kelp forests and the impacts of kelp harvesting are monitored annually. The results indicate that the kelp communities in the outer part of the kelp forest zone are in good and stable condition. The regrowth of kelp after harvesting seems to be generally good from year to year, and the activity is considered to be sustainable.



Figure 3.9 Kelp forest.

Photo: Erling Svendsen

Early in the 2000s, it was observed that sugar kelp abundance had declined since the mid-1990s along the coast of the Skagerrak and further west along the southwestern coast of Norway. In the period 2005–08, a project was carried out to investigate the scale and causes of the decline. The conclusion was that sugar kelp had disappeared from much of the Skagerrak coast (80 % of the coastline had lost its kelp forests), and from 40 % of stretches of the coastline of Western Norway. Sugar kelp had been replaced by smaller filamentous algae growing on a silt-covered seabed where the kelp was unable to become attached and grow. In areas where kelp forests are lost, many benthic and pelagic animal species also disappear. Food supplies for larger fish and seabirds are reduced, and many species such as coastal cod and crustaceans lose shelter. Several factors are believed to be behind the decline of sugar kelp in the Skagerrak since the 1990s, including higher inputs of nutrients, sediment deposition and rising temperatures. This is probably the first clear example in Norway of how several environmental pressures can work together and cause a dramatic shift in the state of an ecosystem.

In the 2011 Norwegian Red List for Ecosystems and Habitat Types, sugar kelp forests are classified as endangered in the Skagerrak and vulnerable in the North Sea, and kelp forest habitats generally are classified as near threatened.

There are signs that the state of sugar kelp forests is improving along the coast of Western Norway and to some extent along the Skagerrak coast. However, it is too soon to conclude whether this is a lasting trend.

3.3.4 Fish stocks

The North Sea can be roughly divided into four areas, each with a characteristic ecological profile. The northern part, which is 100–200 metres deep, includes the most important fishing grounds for Norwegian fisheries. Species caught here include adult cod, saithe, herring, mackerel, horse mackerel, haddock and Norway pout. In the central parts of the North Sea, there are fishing grounds for sprat, whiting and haddock. The eastern part, at depths of 50–100 metres, is a nursery area for herring and cod. There are also important areas of sandeel and flatfish habitat.

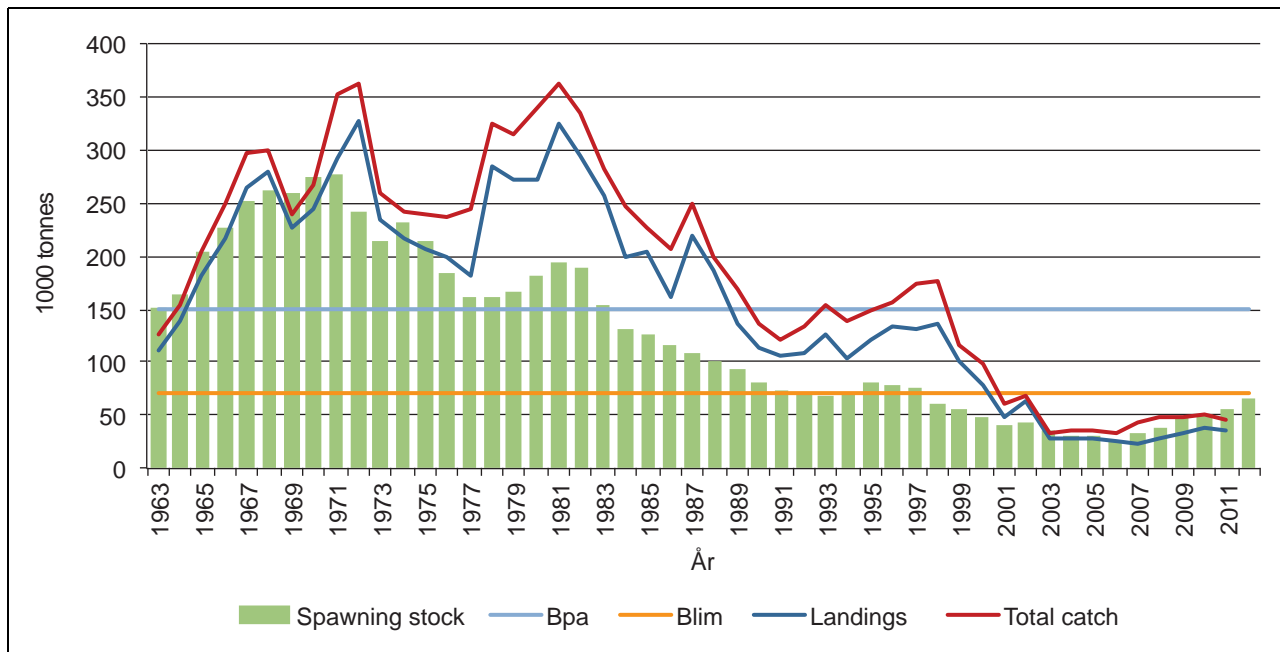


Figure 3.10 Changes in the spawning stock (1963–2012) and catches (1963–2011) of cod in the North Sea. Total catch = catches landed + discards. Blim: critical spawning stock reference point, Bpa: precautionary spawning stock reference point

Source: Institute of Marine Research

Fish stocks show wide natural fluctuations in size. Climate variability has particularly strong effects on shallow waters such as the North Sea, and this in turn influences migration and distribution patterns of fish stocks to varying degrees. Temperature changes can affect recruitment, individual growth and distribution patterns. The International Council for the Exploration of the Sea (ICES) issues updated advice for fish stocks every year. The most important species in the North Sea are saithe, mackerel, herring, sprat, blue whiting, Norway pout, sandeel, shrimps and cod. Sandeels, herring and sprat are important prey for marine mammals, other fish and seabirds, while Norway pout is an important part of the diet of other fish.

Cod

Cod in the North Sea are relatively stationary, and there are probably several spawning stocks. There are no clear boundaries between these, and spawning can take place throughout the North Sea. All North Sea cod is therefore managed as a single stock.

There has been heavy fishing pressure on North Sea cod for many years, and the spawning stock has been greatly reduced. Recruitment has been low, both because of the depleted spawning

stock and because of the rise in the temperature of the North Sea. The spawning stock was reduced from about 250 000 tonnes in 1970 to well below the critical level (70 000 tonnes) in 1999, and the decline continued after 2000. However, a plan for rebuilding the stock has now been evaluated and approved by ICES, and the total allowable catches (TACs) that are now being set are considered to be sustainable. The status of the stock has improved in recent years, and the spawning stock is expected to rise above the critical level in 2013 for the first time since the 1990s. Of the TAC for the EU and Norway, 17 % is allocated to Norway.

Saithe

After hatching, juvenile saithe live close to the coast, and move out into the North Sea when they are three or four years old.

During the 1970s and 1980s, the spawning stock was depleted, reaching a minimum level of 100 000 tonnes in 1991. Since then, fishing pressure has been lower. The spawning stock has increased, and has been above the precautionary level since 1997. It is estimated at 235 000 tonnes in 2013. The stock is classified as sustainably harvested and as having full reproductive capacity.

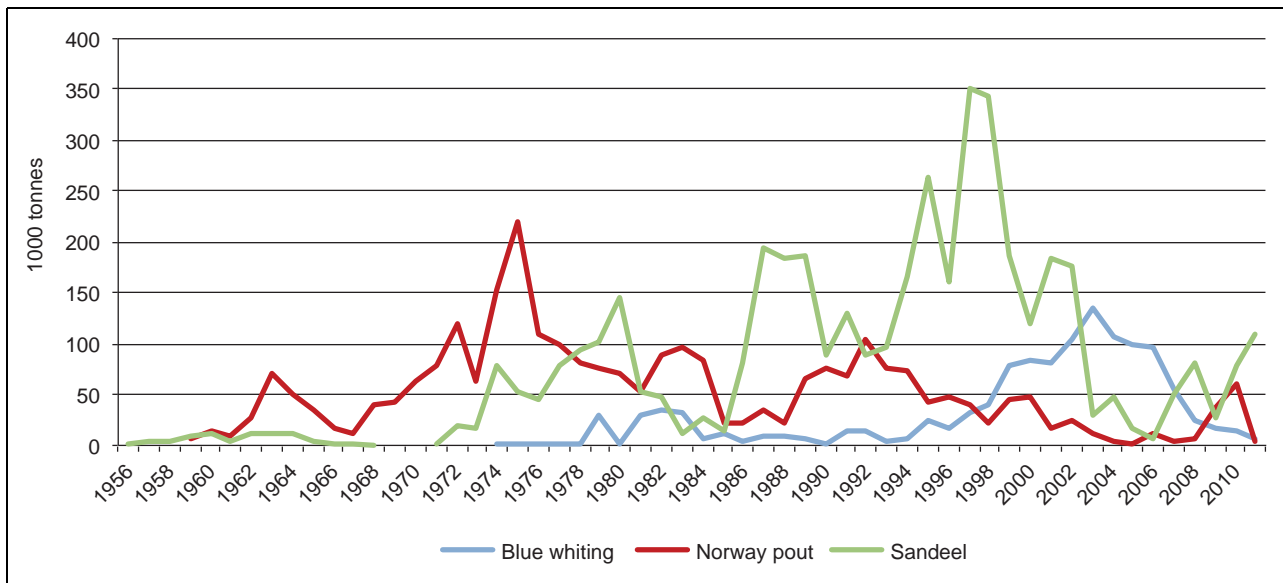


Figure 3.11 Norwegian industrial fisheries in the North Sea from the 1950s to the present. Fisheries for blue whiting, Norway pout and sandeels are generally called industrial fisheries because the catches are used for production of fish meal and oil.

Source: Institute of Marine Research

Blue whiting

The blue whiting is a small pelagic gadid that is found throughout the Northeast Atlantic and is one of the most numerous fish species in the mesopelagic zone. Blue whiting feed mainly on crustaceans such as krill and amphipods, and are themselves important prey for saithe, Greenland halibut and pilot whales. The stock was reduced from over 7 million tonnes in 2003 to 2.8 million tonnes in 2011. In 2012 it rose again to 3.8 million tonnes. In 2008, the coastal states agreed on a new management plan to ensure sustainable harvesting, and the spawning stock is expected to reach 5.1 million tonnes in 2013. According to ICES, the stock is being harvested sustainably.

Norway pout

This species is widely distributed in eastern parts of the North Atlantic, but is most abundant in the northern part of the North Sea, east of Shetland and along the western edge of the Norwegian Trench. The Norway pout is a small gadid that feeds mainly on krill and the copepod *Calanus finmarchicus*. Recruitment to the stock varies widely, and it is prey for a number of larger fish species and marine mammals. Because this is a short-lived species and important prey for a variety of other species, the stock size fluctuates relatively widely from year to year.

Sandeels

Sandeel is the name used for any of several species of the family Ammodytidae, but it is the lesser sandeel (*Ammodytes marinus*) that dominates catches. Sandeels live on sandy substrate, and are patchily distributed in the open sea and along the coast. They spend long periods burrowing in the sand. The sandeel stock in the North Sea probably consists of a number of distinct and geographically isolated components, and this must be taken into account in their management. Sandeels are important prey for other fish, marine mammals and seabirds, and thus play a key role in the ecosystem. The sandeel fishery was previously completely unregulated, and this led to intense fishing pressure and negative impacts on spawning stocks. The fishery is therefore now much more limited. Denmark and Norway dominate the sandeel fishery, which takes place on the Viking Bank and in central parts of the North Sea. Between 1990 and 2002, annual landings varied around an average of 815 000 tonnes, but have since been considerably lower. The decline was particularly steep in the Norwegian zone, where catches were 88–94 % lower in the period 2003–05 than in 1994–2002. In the EU zone, catches dropped by 44–74 % in the same period. It is only in recent years that quotas have been set for the sandeel fishery in the North Sea. In the Norwegian zone, a new area-based management model was introduced in 2010. Its main aim is to build up

and safeguard viable spawning stocks in all historically important sandeel areas (see Box 4.1), and the Institute of Marine Research is responsible for annual acoustic surveys of the distribution and quantity of sandeels. A strong 2009 year class and healthy individual weights resulted in a considerable increase in sandeel biomass and distribution in Norway's Exclusive Economic Zone from 2009 to 2010. However, there are also natural fluctuations in recruitment, and for the last two years this has been weak. The stock now consists largely of the 2009 year class and a proportion of older fish.

Shrimps

The shrimp *Pandalus borealis* prefers deep water, generally deeper than 70 metres, but can also be found at depths of as little as 15–20 metres. This is a cold-water species that is widely distributed on both sides of the North Atlantic. It is found from the Skagerrak and along the entire Norwegian coast to north of Svalbard. It prefers a clay or muddy substrate, where it feeds on small crustaceans and polychaetes, and also on detritus. At night, it migrates upwards through the water column to feed on zooplankton. Shrimps are important prey for many demersal fish species, especially cod.

There is a longer time series of Danish than of Norwegian catch rates, and they show that the shrimp stock declined from 2007 to 2010. Recruitment was lower in 2008–11 than in 2006 and 2007, suggesting that the stock will remain low. Recruitment increased in 2011 and 2012.

Shrimps are caught using single or pair trawls. A growing number of vessels are using trawls in which a sorting grid is mounted. Where sorting grids are not used, the harvest includes bycatches dominated by saithe and cod, and also containing various deep-water fish and sharks in the deeper parts of the Skagerrak and in the Norwegian Trench. There are regulatory measures relating to such bycatches, which may make up as much as 30 % of the total catch.

Mackerel

Mackerel are found from northwestern Africa to the Barents Sea. In the Northeast Atlantic, they are managed as a single stock with three spawning components. North Sea mackerel spawn in central parts of the North Sea and in the Skagerrak, western mackerel spawn west of Ireland, and southern mackerel spawn in Spanish and Portuguese waters. The North Sea spawning compo-

nent is the smallest of the three. It was severely depleted in the 1970s and has remained at a very low level ever since. Regulatory measures including closed areas now prevent fishing for North Sea mackerel. Mackerel are typical plankton feeders even as adults, but also feed on fish larvae and juvenile fish. After a long period of relative stability, the overall spawning stock biomass rose from 1.7 million tonnes in 2002 to 3 million tonnes in 2009.

The 2005 and 2006 year classes are the strongest in the whole time series, closely followed by the 2002 year class. The 2007 and 2008 year classes were also above average in size, but higher fishing mortality is increasing the risk that harvesting is not sustainable. Since 2010, there has been no international coastal state agreement on a TAC for mackerel, which is the explanation for the relatively high harvest. Iceland and the Faroe Islands have started to take significant catches in their own economic zones, and despite a number of negotiation rounds, it has not been possible to reach agreement on a TAC and how to share it. The mackerel stock as a whole is in very good condition, despite the fact that catches have been substantially higher than recommended by ICES for several years.

North Sea herring

The herring is a pelagic, schooling species. North Sea herring are found in the North Sea, Skagerrak and Kattegat. There are autumn-, winter- and spring-spawning herring in this area, but autumn-spawning North Sea herring dominate. Herring are plankton feeders and a key species in the ecosystem both as predators and as prey for other fish species, seabirds and marine mammals. Heavy fishing pressure and low recruitment over a number of years led to a collapse of the spawning stock, which reached a historical low in 1978. Stricter regulatory measures have helped the stock to recover. Although recruitment has not been good since 2001, the North Sea herring stock is still at full reproductive capacity.

Sprat

The sprat is a small schooling species of the herring family, with its main distribution area in central and southeastern parts of the North Sea. In the Skagerrak it is found mainly inshore and in Norwegian and Swedish fjords. The information available is not sufficient to evaluate the status of the sprat stock in the North Sea and Skagerrak.

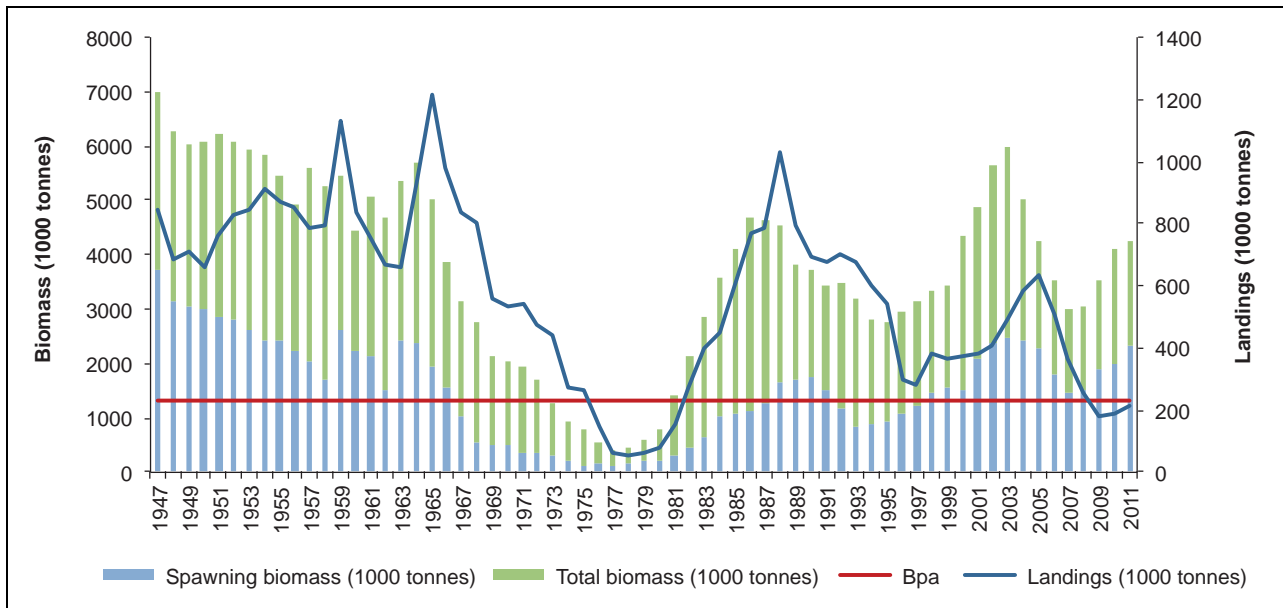


Figure 3.12 Changes in the spawning stock and catches of North Sea herring, 1947–2011. Bpa: precautionary spawning stock reference point.

Source: Institute of Marine Research

ICES has concluded that although the distribution of the stock is expanding, catches are remaining more or less constant. The current fishing pressure is therefore considered to be sustainable.

Spiny dogfish and bluefin tuna

There were previously relatively large fisheries for spiny dogfish and bluefin tuna in the North Sea. The spiny dogfish was the commonest shark species in the Northeast Atlantic, but the stock has declined substantially. However, there are no good estimates of stock size. The species is classified as critically endangered on the 2010 Norwegian Red List. The bluefin tuna stock, which spawns in the Mediterranean Sea, has also been severely depleted and no longer feeds in Norwegian waters. However, researchers believe that the stock is now increasing, and a number of bluefin tunas have been observed further north in the Atlantic Ocean in recent years. Several regulatory measures have been introduced in Norway to improve protection of these species, including a complete ban on fishing specifically for both species.

3.3.5 Marine mammals

Five species of marine mammals are numerically dominant in the North Sea: three whale species (common porpoise, minke whale and white-beaked dolphin) and two seal species (grey seal

and common seal). Minke whales make a feeding migration into the North Sea during the summer, while the other four species are all resident in the area. In addition, there is a small resident population of bottlenose dolphins on the east coast of Scotland. Other species of seals and whales also spend shorter periods of time in the North Sea.

There are no long time series on the abundance of whales in the North Sea. Two large-scale international surveys in 1994 and 2005 showed that the porpoise population was stable (about 1/3 million) during this period, but that there was a southerly shift in their distribution. The number of minke whales and white-beaked dolphins was also stable during this period. However, the number of minke whales that move into the North Sea in summer can vary from year to year.

Rather longer time series are available for seals, and show considerable changes over the past 50 years. Information on numbers of grey seals is based on counts of pups, while the whole population of common seals is counted at haul-out sites during the moult.

The grey seal population is found largely around the British Isles, and pup production has risen from about 5 000 in 1960 to almost 40 000 in 2010. By way of comparison, only about 45 pups a year are born along the Norwegian North Sea coast, but the number is rising. Since they were protected, grey seals have re-colonised areas where they used to breed in Danish, German and Dutch waters.

Common seals have increased in numbers in the second half of the 20th century, since the North Sea countries introduced protection measures. Common seals were protected in the southern half of Norway in 1973, but since then a regulated hunt has been opened in some areas. Two outbreaks of disease, in 1988 and 2002, caused considerable mortality along the mainland coast of Europe and in England, but the populations recovered quickly. Around 2010, the Norwegian North Sea populations numbered about 1 000 common seals in the North Sea part of the management plan area, and about 300 in the Skagerrak. The populations in Scotland and along the Norwegian coast from Rogaland and northwards were not much affected by these disease outbreaks. However, in the last few years the large Scottish populations have declined dramatically (by 50 % in Shetland and 68 % in Orkney). The reasons for this are not clear, but the decline is not believed to be linked to the earlier outbreaks of disease. The common seal population also appears to have shown a weak decline in Norway

in recent years. The species is classified as vulnerable on the 2010 Norwegian Red List.

The short-beaked common dolphin and striped dolphin are both very abundant in the Atlantic Ocean south of the British Isles. If climate change results in higher water temperatures in the North Sea, these species may become established in large numbers here. This could alter the competitive balance between these species and the traditional North Sea dolphin species.

3.3.6 Seabirds

The North Sea–Skagerrak area is used by many seabird populations. A large proportion of the seabirds found here breed in the southern half of Norway and northeastern parts of Britain. At the end of the breeding season, seabirds from these parts of Britain move offshore to the North Sea. The area also attracts large numbers of seabirds from the Norwegian Sea and the Barents Sea. Thus, the management plan area includes important migration routes and staging and wintering areas for a wide variety of seabird species. The

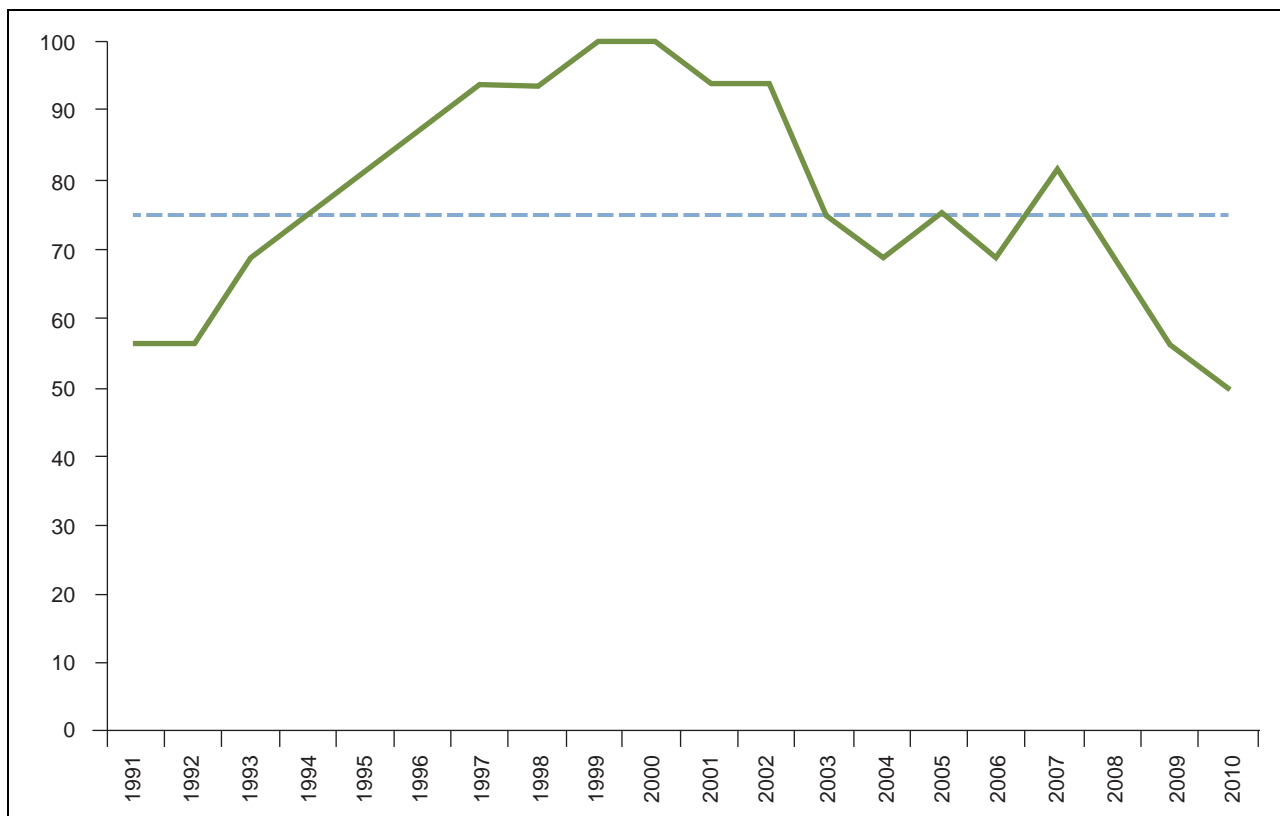


Figure 3.13 The proportion of 16 species in the North Sea that were within the target levels of abundance defined in OSPAR's ecological quality objective for seabird population trends in the period 1991–2010. The objective is not achieved in years when the proportion drops below 75 %. The vertical axis shows the percentage of the species that achieve target levels.

Source: OSPAR

breeding seabird populations in the Norwegian part of the North Sea and Skagerrak are estimated at 133 000 and 101 000 pairs respectively. This means that 12 % of all Norway's seabirds breed in the area, particularly coastal species (gulls, terns, cormorant and shag, and common eider). The breeding populations of common eider, common gull, lesser black-backed gull and herring gull are largest, followed by Atlantic puffin, great black-backed gull, common tern, Arctic tern and black-legged kittiwake.

There are many seabird colonies along the Norwegian North Sea and Skagerrak coast, but not large cliff-based colonies such as those found further north. Birds from the large colonies on Runde island in the southern part of the Norwegian Sea feed in the northern North Sea. Einevarden in Sogn og Fjordane is one of the few colonies south of Runde where auks, kittiwakes and northern fulmar breed. Norway has a special responsibility for some species that occur in the North Sea and Skagerrak because more than 25 % of the European population breeds in Norway. These include the common gull, lesser black-backed gull (subspecies *intermedius*) and herring gull.

Seabirds are an important component of coastal and marine ecosystems, partly because they are a highly visible top trophic level in long food chains. Population trends, survival and reproduction in seabirds are good indicators of the state of marine ecosystems.

Generally, the trend is that populations of pelagic seabirds (those that feed out at sea) in the North Sea and Skagerrak are declining. The same applies to many coastal species, but the picture is more varied for this group. Recently established species such as the northern gannet and cormorant (subspecies *sinensis*) are increasing, whereas the common gull, kittiwake, common tern, puffin and common guillemot are declining. The management plan area is changing, and this is reflected in seabird species composition. Eleven species of seabirds that occur in the management plan area are included on the Norwegian Red List, and six of them are considered to be threatened.

3.3.7 Threatened species

Red lists have become an important tool in national and international management of biodiversity. They are drawn up using the categories and criteria adopted by the International Union for Conservation of Nature (IUCN) as a basis. «Threatened species» is a generic term that cov-

Boks 3.4 The 2010 Norwegian Red List for species

The most important elements of the IUCN criteria are as follows:

- Population reduction. Used for species whose population has recently declined, or is expected to do so in the near future.
- Limited geographical range combined with severe fragmentation, continuing population decline or range, or extreme fluctuations.
- Small population size and decline and/or unfavourable population structure.
- Very small population or very restricted range.

Vertebrate species that occur in the management plan area and are listed in one of the «threatened» categories in the Norwegian Red List

Species name	Red list category
European eel	Critically endangered
Blue skate	Critically endangered
Spiny dogfish	Critically endangered
Basking shark	Endangered
Blue ling	Endangered
Golden redfish	Endangered
Porbeagle	Vulnerable
Common guillemot	Critically endangered
Black-legged kittiwake	Endangered
Razorbill	Vulnerable
Black guillemot	Vulnerable
Atlantic puffin	Vulnerable
Common tern	Vulnerable

ers three categories: critically endangered, endangered and vulnerable. A set of five criteria is used to determine the category in which a particular species should be placed, using information on geographical range and population size and trend.

The categories for Norway's red-listed fish and marine mammals have largely been determined on the basis of information on population reductions, and the information available on fish stocks is largely based on monitoring of stocks and of recruitment to commercial fish stocks. In con-

trast, our information on seaweeds, kelp and invertebrates consists mainly of registered finds and knowledge about the habitats they occur in and their extent. For these groups, red-list categories have therefore largely been assessed on the basis of this information. The main threats to most threatened and near-threatened marine species are disturbance of the seabed and habitats, eutrophication and harvesting.

The Red List is a dynamic tool that is regularly revised to incorporate new knowledge about the population status of different species. Marine species were included in the Norwegian Red List in 2006, and new assessments resulted in changes in 2010; some species were removed from the list, while others were moved from the category «data deficient» to one of the threatened categories.

In addition to the species listed in Box 3.4, some invertebrates have been classified as threatened. These include some molluscs (including the sand gaper and European flat oyster), five species of gastropods and a few small crustaceans, including the Atlantic ditch shrimp. Many invertebrates on the Red List are in the category «data deficient», because so little is known about their population status and trends.

The marine species that have been included on the Red List were assessed on the basis of the scientific knowledge available at the time. In many cases, only limited data was available for these species, often based on catch reports. Catch data have limitations because of variations over time in fishing effort and regulatory measures. A precautionary approach is taken when there is uncertainty about the population trend. The fisheries authorities take the need for extraordinary measures or monitoring into account in their annual budgets, and set priorities for measures targeting individual species on the basis of recent information on trends and changes in harvesting patterns, stock status and knowledge needs. Fishing specifically for most of the red-listed species is completely prohibited.

3.3.8 Alien species

Alien species are species that have been intentionally or unintentionally introduced outside their natural past or present distribution by human agency.

Many of these species meet environmental conditions that are so different from those they

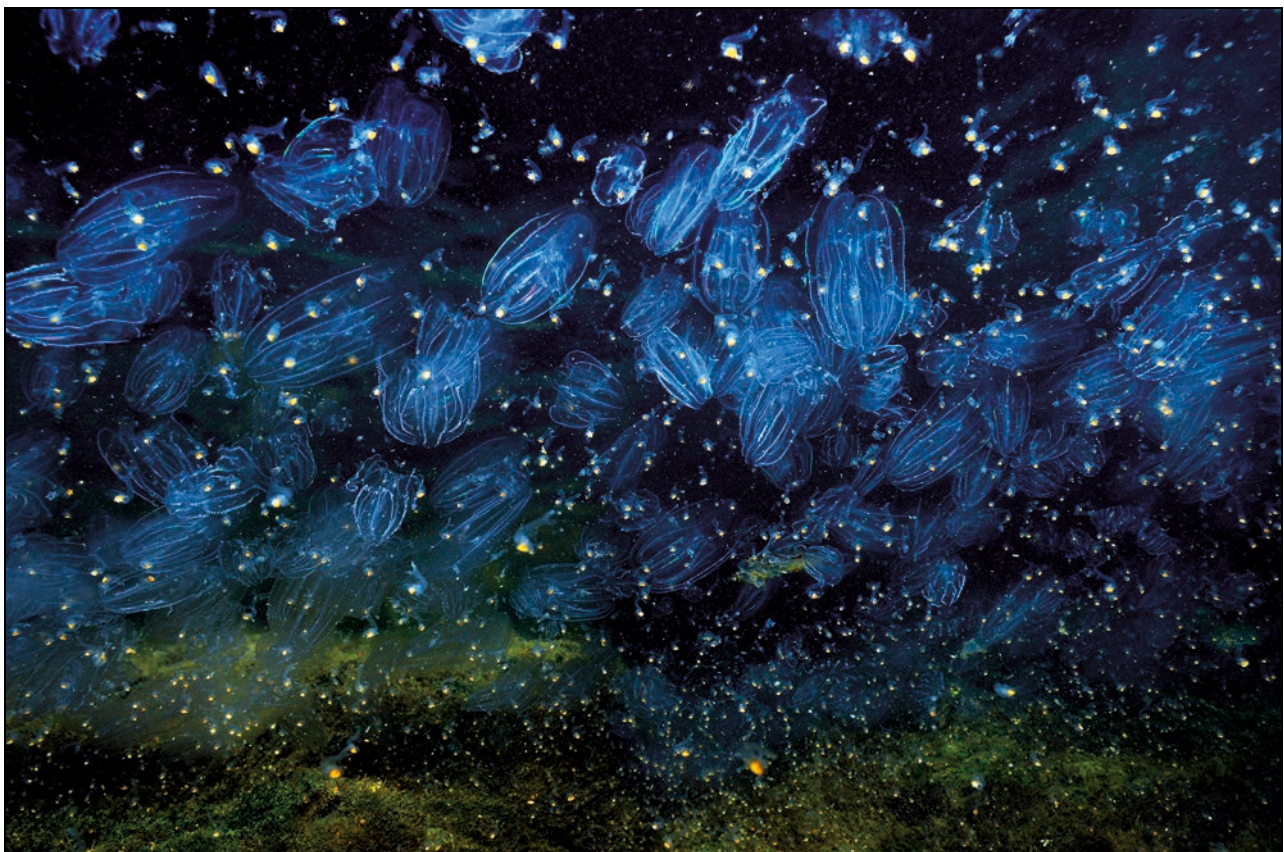


Figure 3.14 The comb jelly (*Mnemiopsis leidyi*)

Photo: Erling Svendsen

prefer that they are unable to survive. Others find conditions that allow them to grow and survive, and establish local populations. A few species find favourable environmental conditions and lack natural enemies (especially during the colonisation phase). Such species may after a time reach very high densities, displace native species and disrupt local ecosystems. They are known as invasive alien species.

The probability that a particular alien species will survive transport to a new area, and in addition turn out to be adapted to conditions in its new environment and be able to establish a reproducing population is low, but this does happen in a proportion of cases. The probability that new alien species will become established rises with invasion pressure, which is determined by the number of individuals arriving in an area and the frequency of introductions.

Alien species originally evolved in their native ecosystems in interaction with many other species that are not present in the new ecosystem. This makes it difficult to predict what impacts they will have. In the absence of such knowledge, alien species are often assumed to be invasive until otherwise demonstrated.

A number of alien species have become established in Norwegian waters. In the management plan area, most of them are benthic species found near the coast, such as Pacific oysters (*Crassostrea gigas*) and japweed (*Sargassum muticum*). The comb jelly *Mnemiopsis leidyi* (see Figure 3.14) is a pelagic species that has been observed at very high densities along Norway's North Sea coastline.

The Norwegian Biodiversity Information Centre has published official lists of alien species in Norway. The first was the *2007 Norwegian Black List*, and an updated version, *Alien species in Norway with the Norwegian Black List*, was published in 2012. Not all Norwegian sea areas are covered by systematic mapping and monitoring of alien species, but 10 permanent monitoring stations have been established along the coastline. Observations from these together with results from other monitoring programmes will give some indication of developments, but are unlikely to reveal new introductions at a very early stage. A number of the alien marine species that have become established in other parts of Europe are likely to be able to spread to Norway.

3.3.9 Nature Index for the North Sea and Skagerrak

The Norwegian Nature Index is intended to document the state of biodiversity and trends over time in major Norwegian ecosystems.

A set of indicators has been chosen to represent biodiversity in each of these ecosystems. Indicators may be species or indirect indicators that give information on the biodiversity potential of an area. In all, the Nature Index uses more than 300 indicators from nine major ecosystems.

Nature Index values have been calculated for seabed and pelagic ecosystems in the North Sea, the Skagerrak and coastal waters. The calculated values for the North Sea and Skagerrak fell steeply between 1950 and 1990. After this, the values for the North Sea levelled off or improved slightly from 1990 to 2010, whereas the decline continued for the pelagic ecosystem of the Skagerrak from 1990 to 2000, and it was only after this that a positive trend emerged.

Even if Nature Index values show a positive trend or no change in an ecosystem, there may be significant changes that are not revealed by the aggregated data.

The selection of indicators is based on expert assessments, monitoring data and modelling. At present, they do not give a complete picture, because there are few indicators for the marine ecosystems (seabed and pelagic) and the set of indicators is skewed. Both the number and the coverage of the indicators need to be improved for the North Sea and Skagerrak.

Information from the Nature Index must be supplemented with detailed information on trends for individual species and vulnerable areas. It has been difficult to collect adequate data for many of the ecosystems, and this adds to the uncertainty of the calculations.

The Nature Index reveals considerable gaps in our knowledge about a number of ecosystems and species groups. Marine species that are commercially exploited have been monitored and actively managed for many years, but more information is needed about benthic species and non-commercial fish species. It is particularly important to establish and maintain long time series. The gaps in our knowledge are greatest for the major ecosystem type «coastal waters». Coordination between the Advisory Group on the Monitoring of Sea Areas and the Nature Index needs to be improved as the index is further developed.

Box 3.5 Vulnerability

Vulnerability can be defined as a measure of how liable a species or habitat is to be negatively affected by external, often anthropogenic pressures.

Thus the vulnerability of an area is considered to be an intrinsic property of the species and habitats to be found there, regardless of whether or not specific environmental pressures are actually acting on them. An assessment of the vulnerability of an area is generally based on which species and habitats occur naturally in the area and their productivity. Factors such as seasonal variations, distribution patterns, age/stage of the life cycle, behaviour and biological characteristics are used to determine the vulnerability of a particular species. Vulnerability to environmental pressures is assessed on the basis of the likely impacts of different pressures on the development and survival of a species or population. Some species are particularly vulnerable at times of the year when most of the population is

concentrated in a limited area (for example fish during spawning and seabirds during the breeding season). The vulnerability of habitats depends on factors such as the substrate type (for example sand or rock), whether it contains sessile or motile species, and whether the habitat type is rare. Certain areas dominated by long-lived, habitat-forming species such as corals and sponges may be particularly vulnerable to certain environmental pressures because habitat formation is a very slow process. Areas where biological production is high may be particularly vulnerable at certain times of year (for example when eggs and larvae (the early stages of fish) are present). Cumulative environmental effects may increase vulnerability. Vulnerability can be measured at individual, population, community and ecosystem level. For management purposes, impacts at population, community and ecosystem level are most important.

3.4 Particularly valuable and vulnerable areas

Particularly valuable and vulnerable areas are those that on the basis of scientific assessments have been identified as being of great importance for biodiversity and for biological production in the entire North Sea-Skagerrak area. Areas may for example be identified as particularly valuable and vulnerable because they are important habitats or spawning grounds for fish, important habitats for seabirds, or contain coral reefs. Areas were selected using predefined criteria. The main criteria were that the area concerned was important for biodiversity or for biological production. In addition, a number of secondary criteria were evaluated, for example economic, social and cultural importance, and scientific value.

The vulnerability of valuable areas to various environmental pressures has also been assessed on the basis of the species and habitats that occur naturally in each area and their productivity. The vulnerability of a habitat or species to different environmental pressures varies, and has been assessed on the basis of the likely impacts of different pressures on species or habitat development and survival. There may also be temporal and spatial variations in vulnerability. The vulnera-

bility of an area is considered to be an intrinsic property of the species and habitats to be found there, regardless of whether or not specific environmental pressures are actually acting on them.

The designation of areas as particularly valuable and vulnerable does not have any direct effect in the form of restrictions on commercial activities, but indicates that these are areas where it is important to show special caution. To protect particularly valuable species and habitats, it is for example possible to use current legislation to make activities in such areas subject to special requirements. Such requirements may apply to the whole of a particularly valuable and vulnerable area or part of it, and must be considered on a case-by-case basis.

The scientific basis for the management plan identifies 12 particularly valuable areas on the basis of scientific assessments, eight along the coast and four in the open sea (in the North Sea). All 12 areas are generally vulnerable, but their vulnerability varies depending on which pressures act on them and at which times of year (see Box 3.5 on vulnerability). In addition, the coastal zone has been identified as a generally valuable area.

A brief description of each of the particularly valuable and vulnerable areas in the North Sea and Skagerrak is given below:

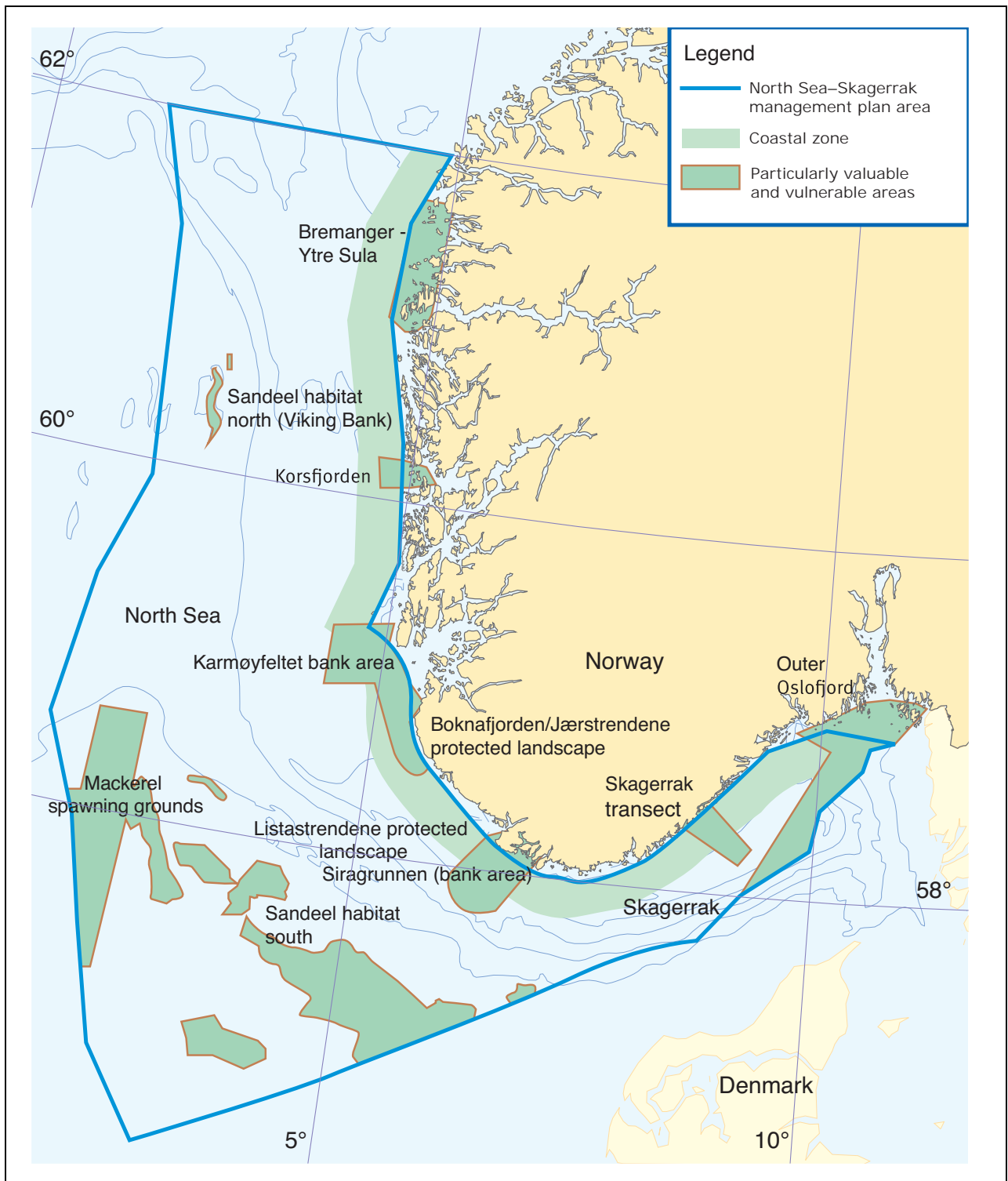


Figure 3.15 Particularly valuable and vulnerable areas in the North Sea and Skagerrak

Source: Directorate for Nature Management, Norwegian Mapping Authority.

1) Bremanger-Ytre Sula

This is an important breeding, moulting, passage and wintering area for seabirds, and an important whelping area for the common seal.

2) Korsfjorden

The qualities that are considered to make the area particularly valuable are its habitat, landscape and geological diversity, the kelp forests and rich bird life, and its cultural history. The area has particularly large stands of kelp forest (*Laminaria hyper-*

borea) and shell sand deposits. This is a varied coastal area that is representative of the islands and skerries along the coastline of Western Norway and shows considerable variation in underwater topography.

3) *Karmøyfeltet bank area*

Biological production is high in this area. Karmøyfeltet includes spawning grounds for Norwegian spring-spawning herring and retention areas for drifting fish eggs and larvae, which makes it attractive to predators such as seabirds and marine mammals. The area is important at ecosystem level because there are large concentrations of shrimps, a key species in the ecosystem.

4) *Outer Boknafjorden/Jærstrendene protected landscape*

This area has a number of distinctive features and includes large tracts of shallow water with sandy and rocky bottom. Strong wave action and currents result in a physically dynamic environment, with a specialised fauna that are able to live in such challenging conditions. The geological and ecological diversity of the area is high, ranging from open sea areas in the west via shallow kelp forest, beaches that are rich in drift seaweed and sand dune systems, to nutrient-rich lakes and mires in the east. The sand dune systems are of international value and thousands of waders congregate to rest and forage for food along the shoreline during migration. This is also a whelping ground for common seals and includes a number of protected areas.

5) *Listastrendene protected landscape*

This is an extremely important area for birds. It is also a type locality for sand dune landscape and supports an interesting sand dune flora. The area includes the oldest known end moraine in Norway. There are also raised beaches and vegetation characteristic of shingle beaches and nutrient-rich mires.

6) *Siragrunnen bank area*

The area provides good spawning conditions and food supplies for a number of fish species. It is a spawning ground for Norwegian spring-spawning herring and a retention area for pelagic fish eggs and larvae. This makes it attractive to predators such as seabirds and marine mammals. Siragrun-

nen is also one of the most important areas in the region for lobster.

7) *Skagerrak transect*

Habitat and landscape diversity are high in this area, and there are valuable geological features. It is also important because of its bird life and cultural history. The transect extends from the shoreline on the seaward side of the islands and skerries, between the northern point of Tromøya off Arendal and the land-locked bay Ruakerkilen near Fevik, and out to a depth of about 600 metres in the Norwegian Trench. The transect includes the intertidal zone, a terminal moraine (Raet), brackish-water areas at the mouth of the river Nidelva, the seaweed zone, eelgrass beds, soft-bottom areas, hard-bottom areas with kelp forests and corals, and an area that is closed to lobster trapping. The area is representative of the Skagerrak.

8) *Outer Oslofjord*

The outer Oslofjord includes Ormø–Færder protected landscape and Ytre Hvaler national park. Ormø–Færder protected landscape provides habitats for a number of rare and threatened plant and animal species, has a rich bird life and offers a range of opportunities for outdoor recreation. Ytre Hvaler national park is a breeding, passage and wintering area for seabirds, and has the world's largest recorded coral reef in inshore waters. Conditions in the area are very distinctive because of the influence of the Glomma (Norway's largest river), which flows into the sea here. There is also wide variation in underwater topography and seabed conditions.

9) *The Skagerrak*

This is a moulting and wintering area for seabirds, and a large proportion of Norway's common guillemot population is found here from late summer to winter. The common guillemot is now classified as critically endangered after a dramatic population decline in recent years.

10–11) *Sandeel habitat north (Viking Bank) and south*

The Viking Bank is a habitat and spawning ground for sandeels and a feeding area for whales that feed on sandeels. Sandeels are a key species in the North Sea ecosystem, and are stationary because they have a strong preference for a sea-

bed of coarse sand in which they can burrow. Sandeels are also an important commercial species.

Sandeel habitat south includes several other areas of habitat and spawning grounds for sandeels in the central parts of the North Sea.

12) Mackerel spawning grounds

This covers the most important spawning areas for mackerel, which is an ecologically and commercially important stock in the North Sea.

The coastal zone

In addition to the list above, the coastal zone out to 25 km from the baseline has been identified as a generally valuable area. The topography is varied and complex, with a high diversity of underwater habitat types and a rich flora and fauna. The area is important for seabirds, and is used by both seals and whales. The actual shoreline and beach habitats are also important. Species and habitats along the shoreline can be vulnerable to oil pollution, litter, bycatches, and expansion of recreational activities.

3.5 Important knowledge needs

An extensive knowledge base has been developed on the ecosystems and state of the environment in the North Sea and Skagerrak, and this is considered to be one of the most thoroughly investigated marine areas in the world. Nevertheless, there is still a need to improve knowledge about

pressures and impacts on ecosystems as a result of climate change, acidification and human activity. Mapping, monitoring and research will all be needed.

To make it possible to assess the probability and impacts of drastic changes in ecosystems (ecological regime shifts), more knowledge is needed about the resilience of ecosystems to climate change, ocean acidification and pollution. It is important to obtain more information about which species and benthic and other habitat types are vulnerable to change. We also need to know more about how climate change and ocean acidification may influence the pollution status of the management plan area in the future.

More and more new hazardous substances are being detected in the environment, but we know little about their impacts. It is essential to set up monitoring programmes and develop new methods to detect the potentially most dangerous pollutants. We need to know more about the effects of long-term exposure and the combined effects of exposure to mixtures of different pollutants, both new and old substances.

More data is needed on hazardous substances in the open sea, and there are few studies that provide information on pollution loads in marine organisms.

It is also important to develop technology and know-how that can be used to prevent or reduce anthropogenic pressures and impacts. Knowledge about ecosystem services that are not linked to a specific market or branch of industry is also needed, so that we can build up an overall picture of the importance of the management plan area for people and society.

4 Activities, value creation and management

Norway's large, rich sea areas and up-to-date sea-based activities have given us a leading position as a maritime nation. Few other nations are as dependent on the contribution of sea-based activities to value creation and prosperity. Petroleum, shipping and seafood are Norway's largest export industries, and there is considerable potential for future offshore renewable energy production. Travel and tourism in coastal areas, especially along the shores of the Skagerrak, also contribute substantially to economic value creation.

In 2009, *petroleum activities in the management plan area* generated value added amounting to NOK 310 billion, and provided 18 000 person-years of direct employment and 110 000 person-years of indirect employment. Value added from *shipping* was NOK 38 billion, with 26 000 person-years of direct employment and 19 000 jobs in related industries. The figures for *travel and tourism* are from 2007: value added was around NOK 25 billion and total employment was around 58 000 person-years in the North Sea and Skagerrak counties. In 2010, value added from core activities in the seafood industry, in other words fishing, whaling and sealing, fish farming, fish processing and wholesale, was NOK 28 billion, with a production value of NOK 91.2 billion and 24 300 person-years of employment. Offshore renewable

energy production may be started in the management plan area in the future.

4.1 Fisheries and seafood

The North Sea and Skagerrak are surrounded by densely populated land areas, and living marine resources in these waters have been heavily exploited for generations. Harvesting has often been above sustainable levels, and earlier overfishing has resulted in a decline in catch sizes. One reason for this situation is that since the North Sea–Skagerrak area is surrounded by so many coastal states, it is under greater pressure than the Norwegian Sea and the Barents Sea–Lofoten area, and the management challenges are therefore more complex.

4.1.1 Activity

Fisheries in the North Sea part of the management plan area are conducted by both Norwegian and foreign vessels. Norwegian vessels participating in fisheries for the largest commercial fish stocks, particularly saithe, mackerel and herring, also include vessels registered in counties that do not border on the management plan area. EU vessels that have been allocated quotas in Norway's Exclusive Economic Zone during negotiations on bilateral agreements are also active in these waters.

Fisheries in the management plan area in the Skagerrak are conducted mainly by Norwegian, Danish and Swedish vessels. Most of the Norwegian vessels are from the counties bordering on the management plan area.

In the period 1990–2010, the share of the total *catch value* in Norwegian waters taken in the Norwegian part of the North Sea and Skagerrak varied from year to year, but was on average 25 %. The corresponding figure for catch quantity was on average 23 %, which shows that the return on catches in other Norwegian sea areas was somewhat smaller than in the North Sea and Skagerrak. The proportion of the total catch has shown a



Figure 4.1 Fishing vessel

Photo: Institute of Marine Research

declining trend in the last 10 years, primarily owing to the increase in catch quantities from the major stocks in the Barents Sea during this period.

The annual catch quantities in the North Sea declined in the period 2000–10, although the catch value increased by 34 %. Catch quantity

dropped by 16 %. In 2010 the catch quantity was 550 000 tonnes, and the annual average for the period 2000–10 was 578 000 tonnes. Pelagic species accounted for 86 % of total catch quantity and 74 % of total catch value in this period. There were very large variations in catches of blue whiting, herring, Norway pout and sandeel.

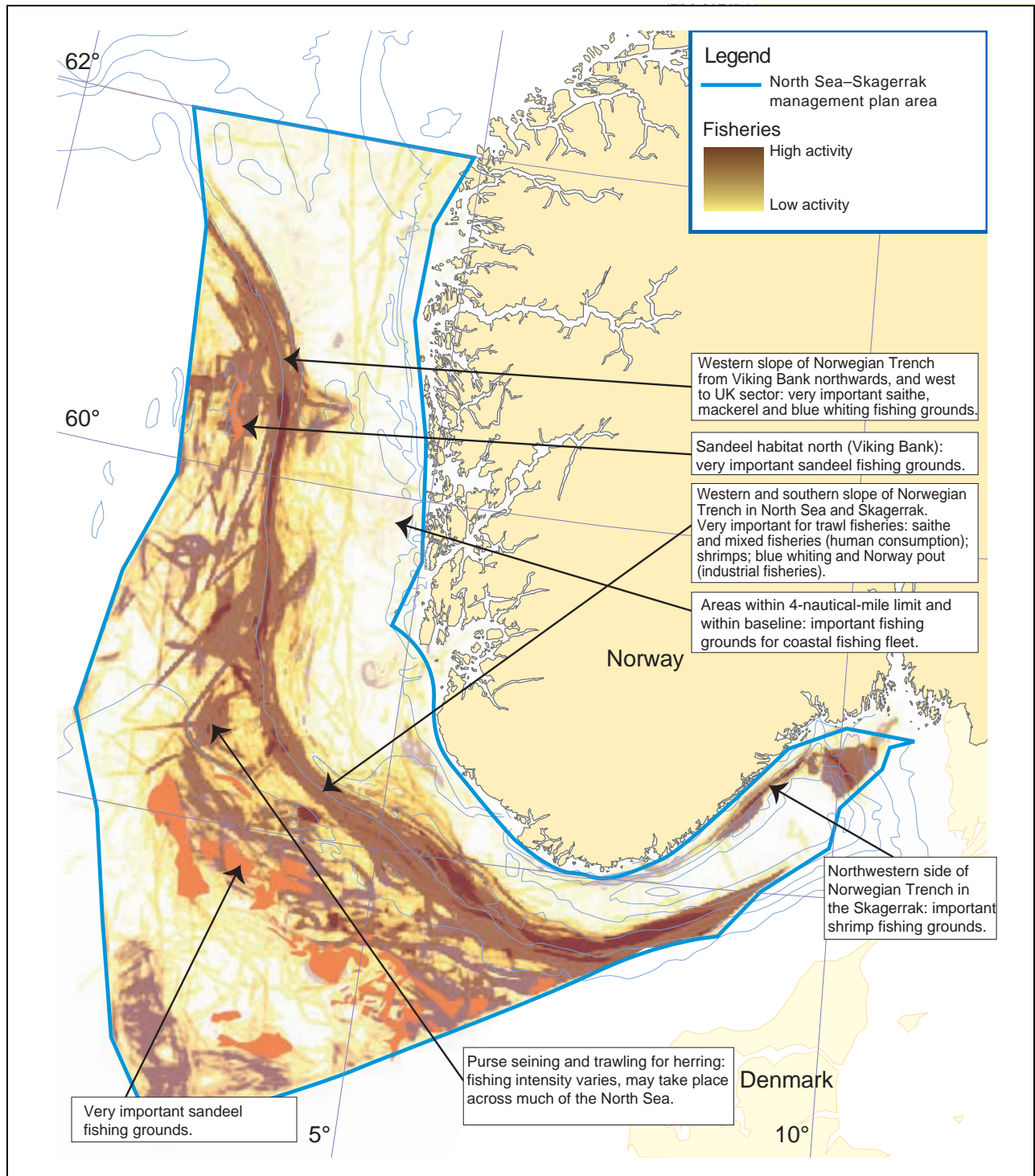


Figure 4.2 Important areas for fisheries in the North Sea and Skagerrak. Vessel activity (Norwegian and foreign vessels) in 2011.

Source: Directorate of Fisheries, Norwegian Mapping Authority

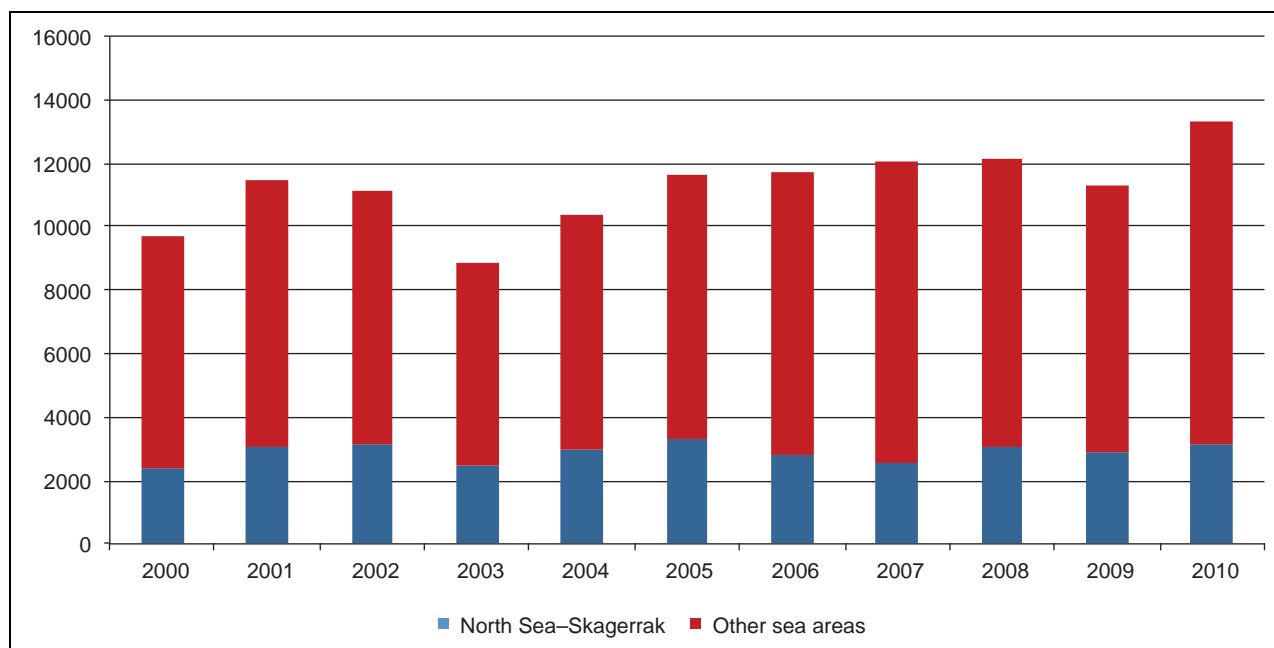


Figure 4.3 Value of fisheries in the North Sea and Skagerrak and other Norwegian sea areas, 2000–10. NOK million

Source: Statistics Norway

Annual catch quantities in the Skagerrak also declined, by 39 % from 2000 to 2010. However, the landed value of the catches rose by 14 %. In 2010 the total catch quantity was 12 000 tonnes, while the average catch quantity for the period 2000–10 was 15 000 tonnes. Pelagic species accounted for half the total quantity and crustaceans and molluscs for 65 % of the total value, much of which was salt-cooked shrimp.

It is difficult to predict very long-term trends in the various stocks and in total catch quantity, since these are influenced by pressure from human activities as well as natural fluctuations. Several fisheries in the North Sea and Skagerrak have suffered a negative trend, partly owing to overfishing. Total catches of cod have declined from 200 000–300 000 tonnes in the 1960s to 20 000–30 000 tonnes today. However, the negative trend for a number of stocks is being reversed owing to improved management, so that harvests in the management plan area may increase in the future.

There are three factors in particular that will determine developments in the fishing industry in the management plan area up to 2030:

- any changes in the EU Common Fisheries Policy;
- the effectiveness of the Norwegian fisheries industry, and the development of management strategies in cooperation with the EU;

- climate change and other pressures that have physiological effects on fish, and ecological interactions between fish stocks.

If developments in these three areas are positive, this will considerably strengthen the North Sea and Skagerrak as fishing grounds. Cooperation with the other coastal states will be essential for controlling the pressure from human activities on stocks that migrate between different countries' Exclusive Economic Zones and international waters.

Most aquaculture activity along the coastline bordering the management plan area is concentrated in the counties of Western Norway, along the North Sea coast. Fish farms in the counties of Sogn og Fjordane, Hordaland and Rogaland hold 31 % of all licences issued for salmon and trout farming in Norway. Aquaculture is not regulated in the present management plan, but the industry is affected by environmental conditions in the North Sea and Skagerrak.

4.1.2 Value creation and employment

The seafood industry is Norway's next largest export industry and the value added it generates has increased substantially in the last few years. Norwegian seafood products are continually winning new markets worldwide, and in spite of large fluctuations, there has been an overall rise in

prices. Rising international prosperity is being accompanied by a growing focus on health and nutrition, providing further opportunities for the Norwegian seafood industry. However, the emphasis on quality has also increased, which makes even greater demands on catch handling, product quality and the environmental status of the nursery areas of fish and crustaceans. Norway's future visions and goals for ensuring that its seafood industry is in the lead worldwide are described in a white paper on seafood (Meld. St. 22 (2012–2013) *Verdens fremste sjømatnasjon*, in Norwegian only).

For hundreds of years the fisheries industry has occupied a very important position both in Norway and in the other regions bordering on the North Sea and Skagerrak, and these waters are used by both the coastal and the ocean-going fishing fleets. Coastal fisheries off southern and eastern Norway, however, have become less profitable in the last few years because of negative trends in a number of populations such as cod, spiny dogfish and European eel. In response, restrictions have been introduced on fishing activities and on permitted target species. It is vital for the fisheries industry that environmental and fisheries management is successful in restoring the resource base to previous levels. This will also benefit other local activities and industries along the coast.

In 2009 Norwegian vessels caught around 0.5 million tonnes of fish and crustaceans in the North Sea and Skagerrak, with a catch value of almost NOK 2.5 billion. The total value of all catches in Norway that year was NOK 11.3 billion, so that catches from the North Sea and Skagerrak accounted for just over 20 % of total value in 2009.

In 2010, value added from the Norwegian seafood industry (including spin-off activities) totalled NOK 46.5 billion, employment was around 44 000 person-years and overall production value was NOK 137 billion. Core activities, in other words fishing, whaling and sealing, fish farming, fish processing and wholesale, generated NOK 28 billion in total value added, had a production value of NOK 91.2 billion and provided 24 300 person-years of employment. Every krone generated by core activities in the fisheries and aquaculture sector resulted in NOK 0.7 in value creation in other sectors (for example supply industries), and every person-year of employment resulted in 0.8 person-years in other sectors.

In 2010, the aquaculture industry in Western Norway generated value added of NOK 13.7 billion and employment of 13 294 person-years when

the spin-off effects in the region and the rest of the country are included. The corresponding figures for Eastern Norway were NOK 2.7 billion and 3 702 person-years.

The number of fishers and fishing vessels in the management plan area declined by more than 30 % from 2000 to 2010, and fewer than 2000 vessels are now registered. This is primarily the result of a deliberate restructuring and rationalisation of the fisheries with a view to adapting the manpower and catch capacity to the resource base and thus improving profitability. At the end of 2010, there were 2 260 full-time and 680 part-time fishers living in the counties bordering on the North Sea and Skagerrak. The proportion of part-time fishers was largest in the Skagerrak area.

According to figures from the Directorate of Fisheries, employment in the aquaculture industry in Sogn og Fjordane, Hordaland, Rogaland and Eastern Norway increased by 21 % from 2000 to 2010, from 1777 to 2153 person-years. In the fisheries and aquaculture sector as a whole, however, there has been a slight decline in employment.

4.1.3 Fisheries management

The overall framework

As a coastal state and steward of living marine resources, Norway has national and international commitments under international law. The following are among the most important international agreements to which Norway is a party:

- The 1982 Convention on the Law of the Sea of 1982 and the 1995 Agreement on implementation of the provisions of the Convention on the Law of the Sea (UNCLOS) relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (Fish Stocks Agreement);
- The 1992 UN Convention on Biological Diversity;
- The 1995 Code of Conduct for Responsible Fisheries from the Food and Agriculture Organization's (FAO).

It is a guiding principle that marine resources should be based on the precautionary approach in accordance with international agreements and guidelines, and using an ecosystem approach that takes into account both habitats and biodiversity. These commitments have been emphasised in Norway's *Marine Resources Act*.

The Marine Resources Act regulates all harvesting and other utilisation of wild living marine

resources and genetic material derived from them. Under the Act, the management authorities must evaluate which types of management measures are necessary to ensure sustainable management of these resources. This management principle does not impose requirements for how, when or how often the authorities should evaluate measures, but makes them responsible for evaluating at regular intervals whether there is a need for some form of regulation. According to this principle, surplus living marine resources may be harvested, but this must be done in a way that ensures that future generations can do the same.

The International Council for the Exploration of the Sea (ICES) promotes and coordinates marine research in the North Atlantic area and disseminates the results. On the basis of scientific assessments, the ICES Advisory Committee (ACOM) provides advice on proposed management strategies, and recommends total allowable catches (TACs) for the various fish stocks every year. The Norwegian Institute of Marine Research participates actively in ICES and provides data from scientific cruises and mapping data, and performs a significant amount of the research on which ICES advice is based.

ICES' recommendations on TACs are not politically binding, but there is a growing tendency in international fisheries management to set quotas in line with these recommendations. Another trend in the last 10 years is to adopt long-term management strategies and rules for harvesting important commercial stocks.

Norway and the EU – cooperation on management in the North Sea and Skagerrak

Norway shares most of its fish resources with other countries, so that international cooperation on their management is essential. The EU is Norway's main partner in the North Sea and Skagerrak. Under the United Nations Convention on the Law of the Sea, Norway and the EU have an obligation to cooperate on the management of shared fish stocks in this sea area.

In 1980 Norway and the EU concluded a bilateral agreement on fishing, which is implemented in the form of annual fisheries arrangements. The annual arrangements set out the agreed joint management measures, including long-term measures, and exchanges of quotas. They also include a wide range of provisions on technical measures and cooperation on control and enforcement.

TACs for joint stocks are shared on the basis of agreed allocation keys. Norway's share is at

present well under 50 % for most of the stocks apart from saithe, where we have 52 %. Thus Norway can only address management challenges through close, constructive cooperation with the EU.

Differences between the management models chosen by Norway and the EU can make cooperation challenging. The clearest example is the difference between Norwegian and EU discard policy. Norway has a ban on discards in Norwegian waters, and to back this up a number of measures have been implemented to avoid catches of fish that are likely to be discarded. The EU, on the other hand, has a discard requirement when a quota is exceeded or when the catch composition (size or species) is illegal. In addition there are differences between the technical measures required by Norway and the EU. Although in the last few years the parties have agreed on a number of measures to reduce discards, the widespread practice of discarding fish continues to be the most significant problem in the EU in the efforts to achieve sustainable management.

In 2011 the European Commission put forward a proposal for reform of its Common Fisheries Policy that included a ban on discards. The proposal has to be considered by the European Council and the European Parliament before being adopted, and Norway has expressed its willingness to support it. In November 2011 the fisheries ministers of Norway, Denmark and Sweden signed a joint statement on the introduction of a ban on discards of fish in the Skagerrak from 2013.

In spite of the considerable differences between the fisheries management regimes in Norway and the EU, the parties cooperate closely on other management issues, such as long-term management measures for joint fish stocks. The stock most urgently in need of rebuilding is North Sea cod.

Regulation of fisheries at national level

Once negotiations with other countries have been completed, it is clear how much of each stock Norway can harvest in the subsequent year, and the rules for the Norwegian fisheries can be adopted. The Directorate of Fisheries draws up proposals for quota regulations, which are discussed at an open consultative meeting at which a broad range of business associations and interest organisations are represented. On the basis of these processes, the Directorate sends draft regulations to the Ministry of Fisheries and Coastal Affairs,

Box 4.1 The Norwegian sandeel management model

Sandeels are widely distributed in large areas of the North Sea, and were previously treated as a single stock shared between Norway and the EU.

In response to overfishing of sandeel in certain areas in the Norwegian part of the North Sea, Norway has introduced a new management model for the species. The aim is to build up viable spawning stocks throughout the distribution area of sandeel in Norway's Exclusive Economic Zone. Following this model an area-based management plan with a limited open season has been developed. Closure of parts of the areas of sandeel habitat reduces the possibility of local overfishing.

The management plan for sandeel contains the following elements:

- *Background.* Sandeels are highly stationary and an important source of food for larger fish, marine mammals and seabirds. For the ecosystem as a whole, it is therefore vital that sandeel are found throughout their natural area of distribution. There are strong indications that recruitment is generally stronger and more even in areas where there is a viable spawning stock.
- *Management objective.* The objective of the new management model is to maintain viable local spawning stocks of sandeel throughout their range in the Norwegian zone. This will maintain the key role of sandeel in the ecosystem, and provide a basis for a high sustained yield by ensuring that sandeels can spread throughout their natural range.
- *Closure of areas.* Under the new model, sandeel habitat in the Norwegian zone has been divided into six areas, each of which has two subdivisions (marked a and b, see Figure 4.4). If the population in one area is estimated to exceed a predetermined level, one subdivision (either a or b) of the area is opened for fishing but not both. Subdivisions are opened and closed alternately from year to year.
- *Close season.* In order to take advantage of the rapid increase in sandeel biomass in spring (from the beginning of April), the fishery opens on 23 April and closes on 23 June, when older sandeels normally cease to emerge from the sand to feed. Closure prevents harvesting of juveniles, which often dominate the catches after this date.
- *Minimum size.* The measures to prevent harvesting of juveniles also include temporary closure of sandeel areas during the fishing sea-

son if the intermixture of undersized fish (length under 10 cm) exceeds 10 % by number. The closed area is reopened after seven days, but if the proportion of fish below the minimum size is still too large, it will be closed for another seven days.

- *Implementation of the management plan.* The Institute of Marine Research conducts acoustic surveys of sandeel abundance in April–May each year. On the basis of the surveys, the Institute advises on which of the six main areas should be opened to fisheries in the subsequent year and sets an overall quota for these areas. The figures may be adjusted in the light of data from the following year's surveys. Although a limited catch from the opened areas is permitted, closure of one subdivision in each area should ensure viable local spawning stocks.

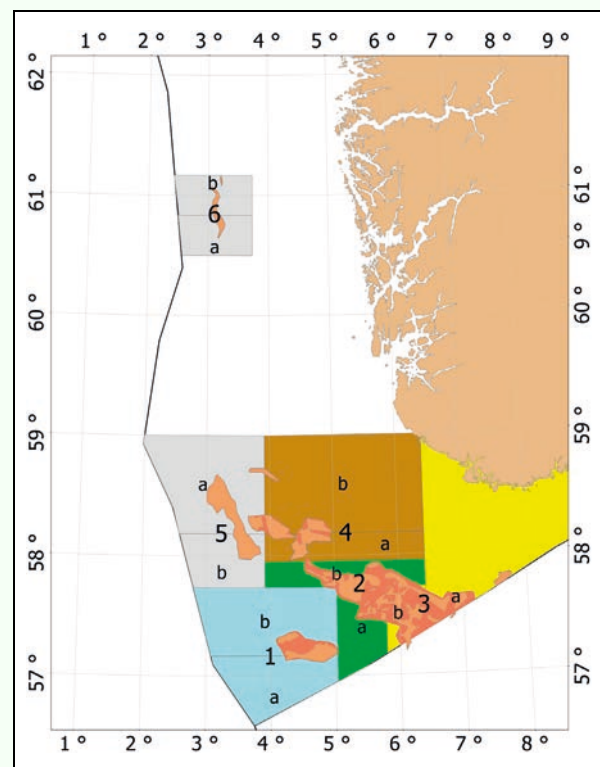


Figure 4.4 Area-based management of sandeel.

Source: Institute of Marine Research

It will be important to make use of experience gained from the implementation of the management plan. The plan will be evaluated and if necessary adjusted at the end of every season.

Box 4.2 Important fisheries rules in the Exclusive Economic Zone of Norway south of 62 °N

- Ban on discarding dead or dying fish.
- Specific rules on mesh design and minimum mesh size in trawls and Danish seines, and technical provisions on gear selectivity.
- Specific rules on mesh design and minimum mesh size when gill-netting for named fish species.
- Provisions on minimum sizes and measures to limit catches of fish under the minimum size.
- Provisions on bycatches to prevent fishing for larvae and undersized fish and prevent intermixtures of non-target species.
- Permanent and temporary closure of areas to fishing with small-meshed trawls to prevent fishing for larvae and undersized fish.
- Area-based regulation of sandeel fisheries to prevent depletion of local stocks.
- Periodical opening of certain fisheries (for example the small-meshed trawl fishery for Norway pout) to ensure the fishery is directed as closely as possible towards the target species.
- Requirement to use sorting grids when trawling for blue whiting, to reduce bycatches of whitefish (cod, saithe, haddock, etc.).
- Closure of fishing grounds when there are large numbers of juvenile fish (Real Time Closure Schemes).
- Restrictions on the use of specific types of fishing gear. These include measures such as close seasons, restrictions on the depths at which trawls may be used, requirements relating to the design of fishing gear, restrictions on the use of gear types, requirements relating to soak times for gill nets, and prohibitions on fishing for specific species during specific periods.
- Closure of areas to lobster trapping.
- Closure of coral reef areas to bottom fishing.
- Bans on fishing for certain species.

which adopts the quota regulations unless the Directorate itself is authorised to adopt them.

The regulations contain provisions on the allocation of quotas to vessel groups and individual vessels, the allocation of quotas for specific periods, bycatches, rules on replacing vessels, exemptions, and so on.

In addition to the annual quota regulations, Norway has a number of permanent national and local regulations. These include provisions on the use of gear, types of gear, mesh sizes, minimum sizes, the ban on discards, and requirements to use sorting grids.

Restrictions on bycatches

Bycatches are catches of all species other than the target species. Bycatches may consist of target species in other fisheries or of unintentional catches of species or sizes of fish that should not be harvested at all.

While some fisheries are relatively clean, others will always include a certain bycatch of other fish species. In addition, there may be bycatches of seabirds or marine mammals.

To ensure that bycatches are included in figures for the total harvest from a particular stock so that harvesting remains sustainable, a certain

proportion is set aside to allow for bycatches when the TAC is shared between different vessel groups. For example, trawlers engaged in industrial fishing often take bycatches of North Sea herring. A certain proportion of the TAC is therefore set aside in the quota regulations to allow for these bycatches.

The Norwegian authorities seek to reduce unwanted bycatches by imposing requirements to use selective gear or sorting grids or by opening and closing fishing grounds as appropriate. Such measures are specifically designed to avoid bycatches of larvae, undersized fish and species with unfavourable stock status. Efforts are also being made to develop gear and fishing methods that will reduce bycatches of seabirds and marine mammals. However, fishing gear will always take a certain proportion of bycatch together with the target species. For fishing to be at all possible, and to ensure compliance with the Norwegian requirement to land all catches, it is necessary to permit a certain intermixture of other species.

4.2 Shipping

The North Sea–Skagerrak area is one of the most heavily trafficked in the world. There are several

important transport routes, for example for vessels in transit along the Norwegian coast to northern waters, traffic to and from the Baltic Sea, and traffic between the major ports in Norway and other North Sea countries. The North Sea and Skagerrak are used by every vessel category and to transport all kinds of cargo.

4.2.1 Activity

There is a larger volume of shipping in the North Sea and Skagerrak than in other Norwegian sea areas, and it is more complex. Figure 4.4 shows that traffic is very heavy in the southern part of the area covered by the scientific basis for the management plan, and three-quarters of maritime transport in the North Sea takes place outside Norway's Exclusive Economic Zone. General cargo vessels and tankers (oil and/or chemicals) account for 22 % and 11 % respectively of total distance sailed in the area covered by the scientific basis for the management plan. The larger vessels (gross tonnage over 5000) account for a larger proportion of distance sailed outside Norway's Exclusive Economic Zone than inside it. Few of the largest vessels (gross tonnage over 50 000) call at Norwegian ports.

Domestic maritime transport accounts for around 70 % of all calls at Norwegian ports bordering on the management plan area. However, in terms of volume (tonnes loaded/unloaded) international shipping predominates, accounting for around 65 % of the total.

The volume of goods loaded and unloaded in the ports bordering on the North Sea and Skagerrak compared with the total volume of goods for all Norwegian ports can be found from the annual figures published by Statistics Norway. The statistics cover 81 ports, 37 of which border on the management plan area.

According to the statistics, the total volume of goods transported through Norwegian ports was around 200 million tonnes a year in the period 2002–10. This includes both domestic and foreign vessels.

In 2002, 75 % of the total volume of goods for all Norwegian ports was handled at the ports bordering on the management plan area, while in 2010 the proportion had dropped to around 62 %. This is largely due to the decrease in the volume of oil loaded and unloaded at the port of Bergen, which dropped by around 37 % from 2002 to 2009.

A general increase in the volume of freight transport is expected in the years ahead. One of the new goals of the national transport plan is to

shift more freight from road to sea and rail. Maritime transport projections indicate an increase in distance sailed of 11 % in the North Sea and Skagerrak as a whole from 2009 to 2030. The increase is expected to be greatest (18 %) outside Norway's Exclusive Economic Zone. Within the economic zone, the largest increase in traffic is expected for gas tankers and cargo vessels, while the distance sailed is expected to decline for offshore, supply and fishing vessels. The transport of oil from the Baltic through the Skagerrak is expected to increase by around 40 % up to 2030. Any change in activities will alter the traffic picture, and the demand for maritime transport is also influenced by global economic cycles.

4.2.2 Value creation and employment

Maritime transport is the predominant form of transport for Norway's foreign trade in goods. In the last five-year period, 20–28 million tonnes of goods were imported annually by ship, and 34–44 million tonnes were exported. In 2010, the share of total freight moved by maritime transport was 77 % for imports and 88 % for exports.

Maritime transport is also very important in the domestic freight market in Norway. In the last five-year period, sea and road accounted for over 90 % of freight transport. In 2010, maritime transport accounted for 42.4 % of domestic freight transport (excluding oil transports from the Norwegian continental shelf).

Table 4.1 shows value added generated by shipping-related industries in regions associated with the management plan area (the North Sea counties, the Skagerrak counties and the inner Oslofjord) in 2009. Total value added was calculated at NOK 54.0 billion, which is 4.6 % of total value added generated in the same area, and somewhat higher than these industries' share of employment. Sixty-nine per cent of the value added was generated by core activities, and the remaining 31 % by spin-off effects. International shipping was the largest shipping-related industry, and generated value added of more than NOK 42 billion (including spin-off effects).

Value added from maritime transport and related industries is much higher in the inner Oslofjord and the North Sea counties than in the Skagerrak counties, almost NOK 20 billion a year in both regions. This corresponds to 5.3 % of the total value added for the North Sea counties and 3.1 % of the total for the inner Oslofjord. International maritime transport is the dominant sector, and in the inner Oslofjord accounts for almost

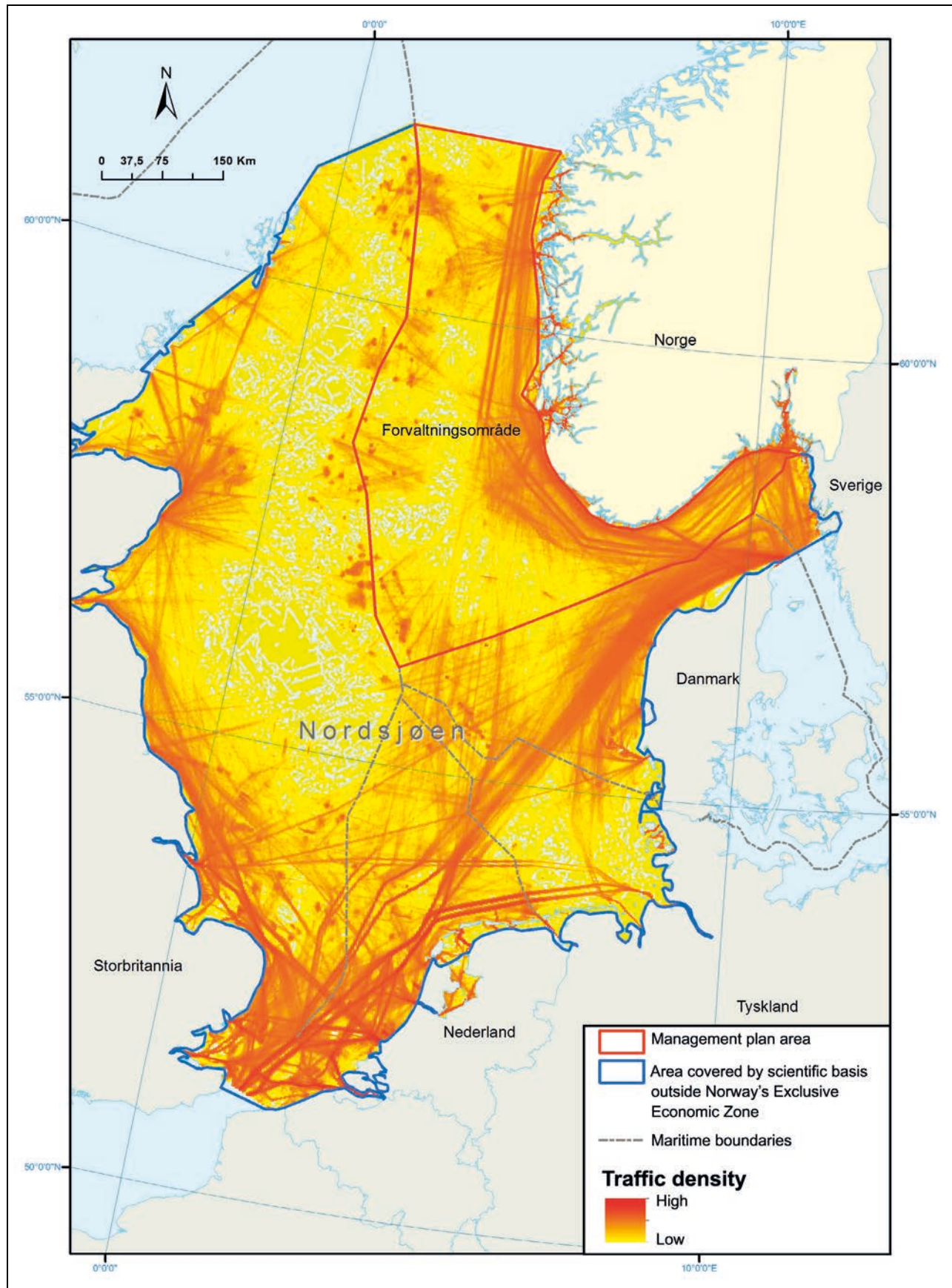


Figure 4.5 Shipping density in the North Sea and Skagerrak in June 2011, based on AIS data.

Source: Norwegian Coastal Administration

Table 4.1 Value added generated by maritime transport-related industries in the inner Oslofjord, Skagerrak counties and North Sea counties in 2009 (NOK million)

Value added, 2009	Inner Oslofjord	Skagerrak counties	North Sea counties	Total, all three regions
Total value added	652 440	198 500	373 060	1 219 730
Foreign shipping (incl. supply vessels)	14 240	3 810	14 190	31 520
Spin-off activities, foreign shipping	2 850	400	1 740	10 950
Domestic shipping (incl. service industries)	1 970	1 030	2 710	6 440
Spin-off activities, domestic shipping	880	260	1 320	5 980
Sum, shipping-related value added	19 940	5 490	19 950	54 890
Share of total value added	3.1 %	2.8 %	5.3 %	4.6 %

Source: SINTEF

85 % of the value added from all shipping-related activities. For the North Sea and Skagerrak counties the figure is just under 80 %.

In 2009 shipping-related industries in the three regions generated 45 000 person-years of employment, or 2.6 % of total employment. Of this, around 26 000 person-years were in core activities and the remainder in spin-off activities.

Table 4.2 shows employment generated by shipping-related industries in the three regions in more detail.

Employment in shipping-related activities is highest in the North Sea counties, around 15 700 person-years, or 3 % of total employment in all three regions. The inner Oslofjord comes second, with around 11 800 person-years of employment,

while the figure for the Skagerrak counties is around 8 300.

In the inner Oslofjord, foreign maritime transport including spin-off activities is the larger of the two shipping-related sectors, and provides around 6 300 person-years of employment. In the North Sea and Skagerrak counties, domestic maritime transport is larger, and provides 10 340 and 4 940 person-years of employment respectively.

Overall, domestic shipping is the largest of the shipping-related industries in terms of employment, while foreign shipping is largest in terms of contribution to GDP. The reason for the difference is that many of those employed in foreign shipping are hired labour from other countries, while domestic shipping employs a larger number of people registered in Norway.

Table 4.2 Employment in maritime transport-related industries in the inner Oslofjord, Skagerrak counties and North Sea counties (person-years) in 2009

Employment, 2009	Inner Oslofjord	Skagerrak counties	North Sea counties	Total, all three regions
Total employment	902 090	312 270	524 500	1 738 860
Foreign shipping (incl. supply vessels)	2 410	2 720	2 770	7 890
Spin-off activities, foreign shipping	3 860	630	2 580	14 620
Domestic shipping (incl. service industries)	4 810	4 560	9 070	18 050
Spin-off activities, domestic shipping	700	380	1 270	4 440
Sum, shipping-related employment	11 780	8 290	15 670	45 000
Share of total employment	1.3 %	2.7 %	3.0 %	2.6 %

Source: SINTEF

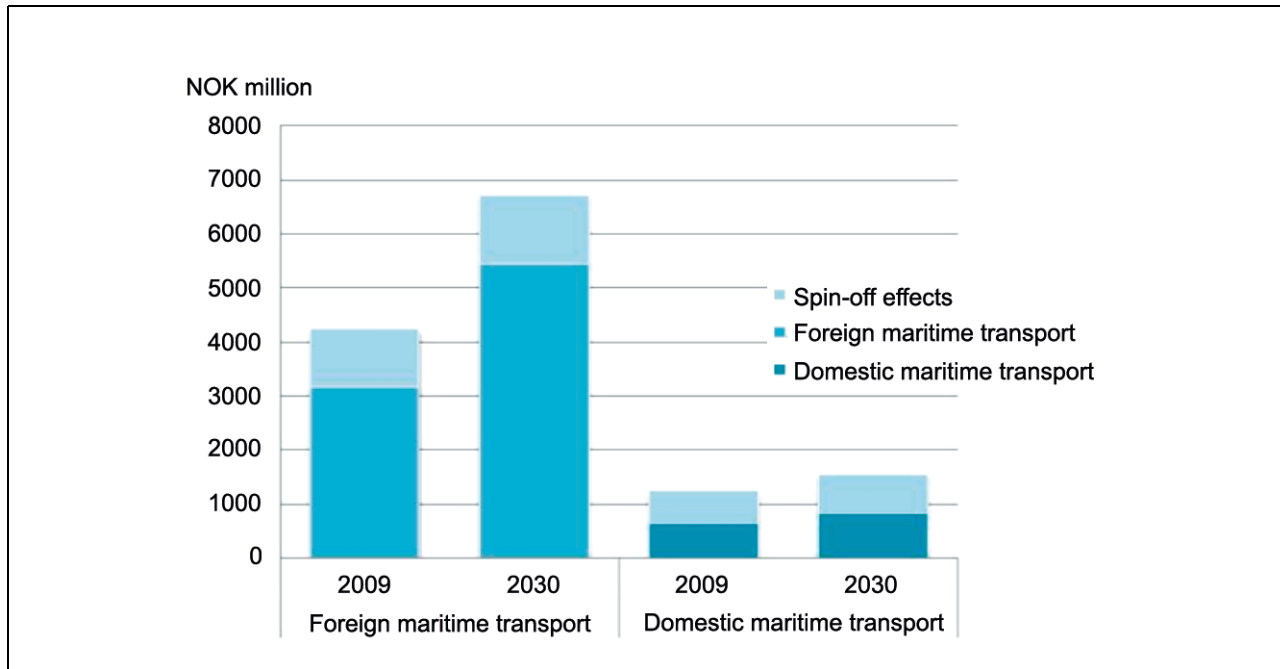


Figure 4.6 Value added from shipping in the three regions together – core activities and spin-off effects

Source: SINTEF

Projected figures for 2030

The volume of shipping in the North Sea and Skagerrak largely reflects the level of activity in other sectors. Changes in the activity level in the petroleum sector, international economic fluctuations, development of alternative forms of offshore energy production and climate change are examples of factors that could affect activity in the maritime transport sector. The most important factors, however, are general economic developments and business development on land.

SINTEF has estimated value added and employment in the maritime transport industry in 2030. It is estimated that shipping-related industries in the three regions will generate around 44 000 person-years of employment 2030, or 2.3 % of total employment in the area. Of these, 28 710 person-years will be in core activities and the remainder in spin-off activities. Domestic maritime transport (including service industries) will generate the highest level of employment, and account for 61 % of maritime transport-related employment in the area as a whole.

Figure 4.6 shows the projected figures for value added for the whole area for 2030 compared with the figures for 2009. It shows clearly that foreign shipping (core activities) is the largest industry in terms of contribution to GDP in both years.

Figure 4.7 shows the projected employment figures for 2030 for the whole area compared with

the figures for 2009. It shows clearly that domestic maritime transport is the largest industry in terms of employment in both years, and that it will become increasingly important up to 2030. The opposite applies to foreign maritime transport.

4.2.3 Management

Safety and accident prevention measures are a vital part of the management of maritime traffic. The main maritime safety measures are: 1) standards and controls for vessel construction, equipment and operation of vessels, 2) crew qualifications and working environment, 3) control of vessels (flag state control and port state control), 4) traffic regulation, 5) establishment and operation of maritime infrastructure and services.

New traffic separation schemes and recommended routes were introduced in the management plan area in June 2011 to route larger vessels (gross tonnage over 5000) and ships carrying dangerous or polluting goods much further away from the coast. These only apply to vessels in transit off the Norwegian coast and vessels sailing between Norwegian and foreign ports. They do not apply to fishing vessels or passenger or cargo vessels on fixed routes between Norwegian ports, but these vessels are not excluded from following the routing system. The objective of the routing system is to reduce both the probability of accidents and the consequences of any oil spills in the

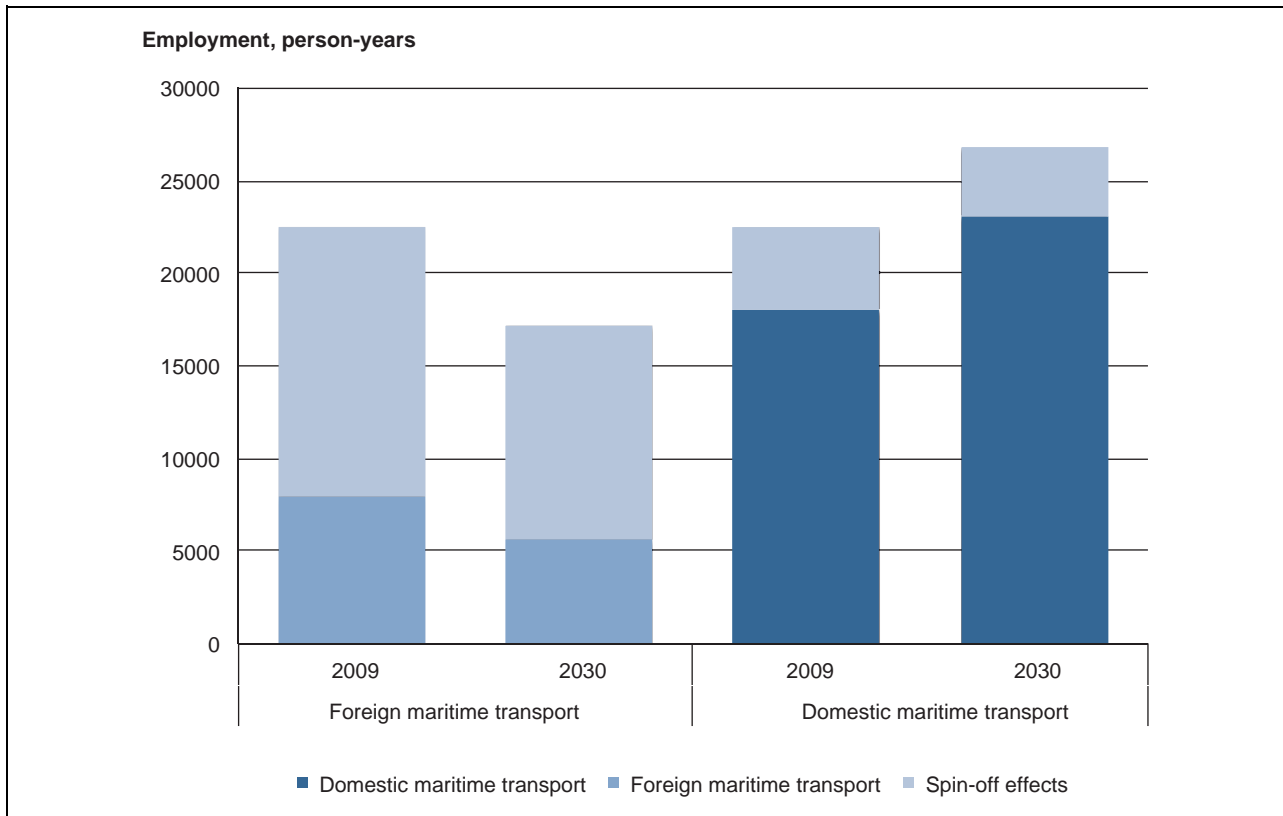


Figure 4.7 Employment generated by shipping in the three regions together – core activities and spin-off effects.

Source: SINTEF

event of accidents. The routing measures also strengthen the effects of other maritime safety and oil spill preparedness and response measures.

In situations where a vessel represents an acute pollution hazard, one course of action is to bring it to a port of refuge or, in extreme cases, to scuttle it under controlled conditions to limit the extent of pollution. Whether or not to use a port of refuge depends on the particular situation, including weather conditions and technical factors associated with the vessel in distress. Since 2008 the Norwegian Coastal Administration has been working on identifying and evaluating possible ports of refuge.

The North Sea and Skagerrak have been designated by the International Maritime Organization (IMO) as Special Areas under the International Convention for the Prevention of Pollution from Ships (MARPOL) with regard to discharges of oil and garbage and emissions of sulphur oxides (SO_x). This means that particularly stringent controls apply to discharges of oil and garbage. In the North Sea, which has also been designated as a sulphur oxide (SO_x) Emission Con-

trol Area, there are stricter controls on SO_x emissions in addition. A proposal to designate the North Sea a nitrous oxide (NO_x) Emission Control Area is in the pipeline. Given these requirements, Norway will promote greater use of liquid natural gas as fuel for ships, which will reduce emissions of NO_x, SO_x and particulate matter.

The new rules for SO_x emissions that will enter into force on 1 January 2015 will reduce emissions of both SO_x and NO_x.

Norway was one of the first countries to ratify the International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Convention). The convention will enter into force after ratification by 30 states representing 35 % of the world's merchant shipping tonnage. Pending this, Norway has adopted national regulations for the management of ballast water that regulate the depths at which ballast water may be exchanged, which took effect on 1 July 2010. In 2011 IMO adopted voluntary guidelines for the control and management of ships' biofouling to minimise transfers of invasive aquatic organisms.

4.3 Petroleum activities

The North Sea was the starting point for Norway's petroleum industry, and much of the area was opened for exploration as early as 1965. Production started in 1971 on the Ekofisk field. The North Sea still has considerable petroleum potential and will generate substantial value added for many years to come.

The petroleum industry is by far the largest of the industries in the management plan area in terms of both value added and employment.

Over the last 40 years a comprehensive set of tools has been developed that takes other industries and the natural environment into consideration in every phase of petroleum activity, from the opening of new areas for petroleum activities, via the award of production licences, exploration, development and operation, to field closure.

The North Sea differs from Norway's other sea areas in the scale of oil and gas activities. In 2010, the North Sea fields accounted for about two-thirds of production on the Norwegian shelf. The geology of most of the area is known, there are fewer technical challenges than elsewhere, and there is a well developed or planned infrastructure.

The present management plan provides a good basis for sound management and a predictable regulatory framework for the oil and gas industry. Petroleum activities are already in progress or planned in large areas of the North Sea, and these activities must coexist with the fisheries and comply with general environmental requirements. Comprehensive legislation has been established to ensure this. The current legislation lays down strict requirements for the industry, and a wide range of measures have been implemented to ensure that fisheries interests and environmental concerns are taken properly into account.

4.3.1 Activities and resources

Exploration drilling and production

Since the oil and gas licensing round in 1965 and up to autumn 2012, 1410 exploration wells have been drilled and 659 production licences awarded in the North Sea. Many large discoveries have been made that are still on stream, and new large discoveries are still being made.

According to figures from 2010, a total of 68 fields are on stream on the Norwegian continental shelf, 55 of them in the North Sea. In the same year, the North Sea fields accounted for about

two-thirds of production on the Norwegian shelf, or 153 million Sm³ oil equivalents. Ekofisk, Oseberg, Troll and Statfjord are large and important fields in the North Sea. In 2010, the first three of these accounted for 40 % of oil and gas production in the North Sea and 28 % of total production on the Norwegian shelf. The North Sea fields are mainly oil-producing.

Surveys of oil and gas resources

The North Sea is the most comprehensively surveyed petroleum province on the Norwegian continental shelf. Many wells have been drilled and the geology of most of the area is known. Up to the end of 2011, 85 % of Norway's total production of oil and gas had come from the North Sea, and 56 % of the remaining resources on the Norwegian shelf are expected to be discovered in this sea area. The figures show that the North Sea still has great potential for further discoveries, even large ones, as shown by the Johan Sverdrup oil discovery (16/2–6).

Production forecasts

The forecast for the petroleum sector up to 2030 is based on the authorities' forecasts of future petroleum production on the Norwegian continental shelf, which in turn are based on the petroleum companies' reports and the Petroleum Directorate's resource estimates. The forecast for the North Sea is based on the assumption that production will be relatively stable up to 2020, followed by a decline up to 2030. After 2020 an increasing proportion of the estimated production is attributed to undiscovered resources, and the figures are more uncertain. Since this forecast was made, there have been new large discoveries in the North Sea, and production in this area is therefore expected to be higher than previously forecast, especially in the period 2020–30.

4.3.2 Value creation and employment

The oil and gas industry is Norway's largest, measured in terms of value added, state revenues and export value. It currently generates about one-fifth of Norway's total value added and a quarter of state revenues. Oil and gas account for half of the total value of Norway's exports. Since the start of oil and gas production, the value added generated by the industry has amounted to around NOK 9000 billion at the current monetary value. The petroleum industry and related activi-

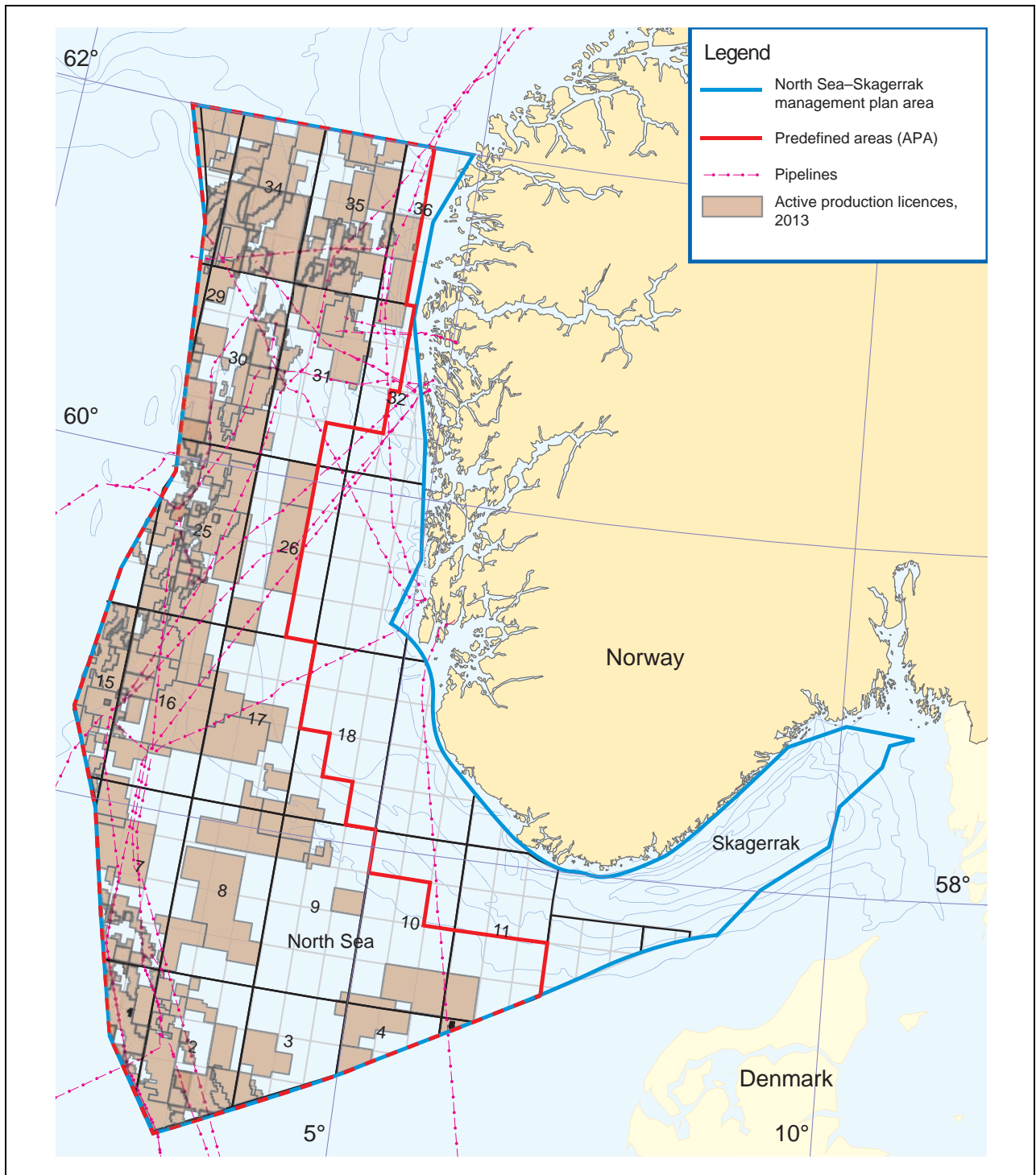


Figure 4.8 Petroleum activities in the North Sea.

Source: Norwegian Petroleum Directorate, Norwegian Mapping Authority

ties account for over 90 % of value added from sea-related industries in the North Sea and Skagerrak and the adjoining counties. In 2009, value added from oil and gas extraction in the North Sea amounted to around NOK 310 billion.

About 43 000 people are directly employed in the oil and gas industry in the country as a whole,

and over 200 000 jobs are directly or indirectly related to the activities on the Norwegian continental shelf.

The oil and gas industry generates more jobs than any other activity in the management plan area. In 2010, about 18 000 persons were directly employed in oil companies that operate the fields

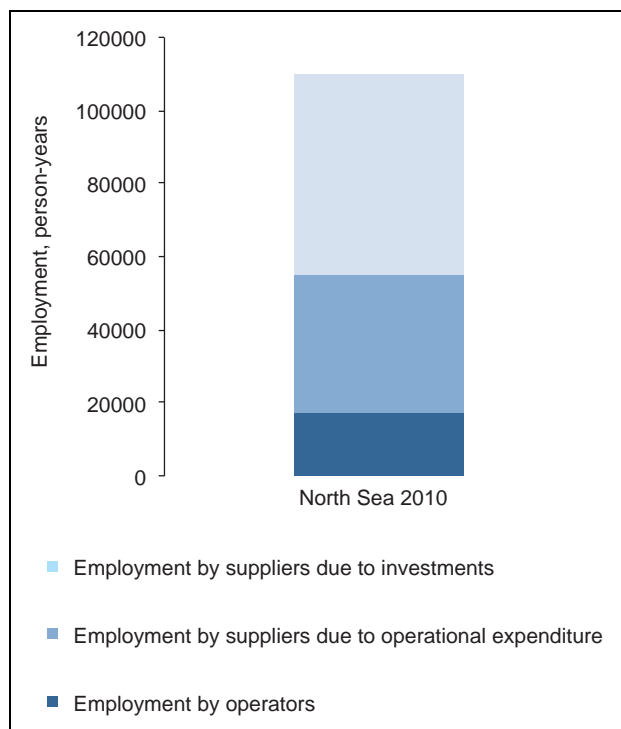


Figure 4.9 Total employment effects attributed to oil and gas activities in the North Sea.

Source: MENON and IRIS

in the North Sea, but suppliers and subcontractors also account for a large number of jobs, an estimated 110 000. The figure is expected to increase marginally up to 2020, and to decline to around 60 000 by 2030.

Suppliers to the petroleum industry come from many different sectors. This means that demands from the industry influence activities in a broad range of sectors, such as construction, transport, retail, banking/insurance and other private services. The substantial growth in the petroleum supplier industry over the last 10 years has resulted in higher employment, turnover and value added.

The economic region with the largest number of person-years in the petroleum supplier industry is the Stavanger region, but robust industries have developed in other parts of the country as well, for example in the Bergen region, the Kongsberg/Asker region, Sunnmøre, Sunnhordland and Southern Norway.

In addition to the spin-off effects in Norway, oil and gas activities have helped to build up a competitive Norwegian petroleum supplier industry that over the last 10 years has experienced substantial growth in international sales.

4.3.3 Framework and management

Each of the management plans establishes an overall framework for petroleum activities in the sea area in question. The management plans clarify where petroleum activities will be permitted within areas that have already been opened and within a specific time frame. The framework for activities in areas that have been opened may include environmental and fisheries-related requirements, spatial restrictions and restrictions on when drilling is permitted, and applies to new production licences regardless of whether they are issued during numbered licensing rounds or through the system of awards in predefined areas (APA).

Environmental requirements are applied to all phases of oil and gas activities, from decisions on whether to open areas, via exploration, assessment of whether a field should be developed, the production phase (in specific licences and annual amendments to the licences) to shutdown and decommissioning of installations.

Granting of production licences

The Norwegian continental shelf is generally divided into mature and frontier areas, and large parts of the North Sea are now mature areas. Oil and gas production in these areas goes back more than 40 years, which means that the geology of most of the area is known, there are fewer technical challenges and there is a well developed or planned infrastructure. It is very likely that new discoveries will be made in these areas, but less likely that they will be large, even though the successful exploratory activities of the last few years indicate that this cannot be excluded. Small discoveries are seldom worth developing on their own, and production will therefore have to depend on use of the existing infrastructure.

The Government introduced the APA system in 2003 to ensure that mature areas are thoroughly explored. The awards are made in an annual licensing round. Within the framework established in the management plans, petroleum-related assessments are used to determine which areas are to be included in the APA system and which should be announced in numbered licensing rounds. This arrangement is an important feature in the management of petroleum resources, and has proved to be an effective licensing policy and to contribute to sound utilisation of resources.

The Government has evaluated the APA system in a consultation round in which all the rele-

vant actors were invited to contribute input on their experience of the system. On the basis of the evaluation, the Government decided in summer 2011 to continue the APA system as an annual licensing round for all mature areas on the Norwegian shelf. It was also decided to introduce public consultations in connection with the APA licensing rounds in the same way as for the numbered licensing rounds. If the areas are covered by an integrated management plan for a sea area, the authorities will ask to be notified of any important new information obtained since the adoption of the plan that is relevant to the plan's provisions on where petroleum activities are to be permitted, and whether new or amended environmental or fisheries-related requirements are needed. The consultation round will thus ensure that relevant information acquired between updates of the management plans is taken into account. The numbered licensing rounds apply to frontier areas on the Norwegian shelf. The most recent allocation of blocks in the North Sea was in 2006. Numbered licensing rounds are normally held every other year. Petroleum companies are invited to nominate blocks. On the basis of these nominations and its own evaluation, the Petroleum Directorate then recommends which blocks should be announced. The Ministry of Petroleum and Energy makes a further assessment of which blocks should be announced, and holds a public consultation on its proposal. On the basis of the assembled responses, the Government makes a united decision on the areas to be announced, and a licensing round is held for these blocks. After the applications have been processed, negotiations are held with the applicant companies on the licensing conditions, and the Government makes the final decision on which companies are to be awarded licences.

The Skagerrak

The Skagerrak was opened for oil and gas activities in 1965 together with the rest of the North Sea, without a preliminary impact assessment. However, after the end of the 1970s there was little interest in exploration activities in the area. In 1987 preparations were started for an impact assessment under the Petroleum Act for the whole of the Skagerrak. This was presented in 1994 in a white paper on challenges and perspectives for petroleum activities on the Norwegian continental shelf. Based on the white paper the Storting decided to open part of the Skagerrak for limited exploration activities in 1994. An area

north of 57° 40' N and east of 8° 30' E is open for exploration activities under certain conditions. A licence may be awarded to drill up to four exploration wells in the area before any proposal to open the area for further activity is submitted to the Storting. Several dry wells have been drilled just west of the area, and according to the Petroleum Directorate, the potential is greatest in the southern part. The remainder of the Skagerrak is not open for oil and gas activities, and little seismic data is available.

Legislation

The key legislation for the management of Norway's petroleum resources is the Petroleum Act and the Petroleum Regulations. They include provisions on exploration licences, production licences (including for petroleum extraction), shutdown, environmental impact assessments, materials, information and management systems for activities.

The Pollution Control Act and Pollution Regulations contain provisions relating to pollution from oil and gas activities. New regulations on health, safety and environment in petroleum activities and certain onshore facilities entered into force on 1 January 2011. The regulatory framework now consists of:

- The Framework Regulations (which deal with health, safety and the environment in petroleum activities and at certain onshore facilities). The supervisory authorities are the relevant ministries, the Petroleum Safety Authority Norway, the Climate and Pollution Agency and the health authorities.
- The Management Regulations (which also deal with the duty to provide information), which apply to offshore activities and certain onshore facilities. The supervisory authorities are the Petroleum Safety Authority Norway, the Climate and Pollution Agency and the health authorities.
- The Technical and Operational Regulations for onshore facilities (these regulations have the same general structure as the Activities Regulations and the Facilities Regulations). The supervisory authorities are the Petroleum Safety Authority Norway and the health authorities.
- The Activities Regulations, which apply to offshore activities. The supervisory authorities are the Petroleum Safety Authority Norway, the Climate and Pollution Agency and the health authorities..

- The Facilities Regulations, which deal with the design and outfitting of offshore facilities. The supervisory authorities are the Petroleum Safety Authority Norway, the Climate and Pollution Agency and the health authorities.

At important stages and decision-making points in each project, operators must seek approval from the Petroleum Safety Authority Norway and apply to the Climate and Pollution Agency for a discharge permit (which includes requirements for emergency preparedness and response) under the Pollution Control Act. Operators must also apply to the Norwegian Radiation Protection Authority for a discharge permit in the case of radioactive substances. In addition the Ministry of Petroleum and Energy awards annual production licences and flaring permits, and the Petroleum Directorate awards drilling permits for exploration wells. Operators must demonstrate that they have sufficient control to ensure that activities will proceed in accordance with the legislation.

International instruments

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention) provides a comprehensive framework for protection of the marine environment against pollution and other environmental pressures. The OSPAR Commission adopts legally binding decisions and issues recommendations for action to combat pollution and protect the environment. These include common provisions and recommendations aimed at preventing and eliminating pollution and environmental damage from offshore oil and gas activities. Norway has incorporated OSPAR decisions on produced water, the disposal of disused offshore installations, and the use and production of chemicals into Norwegian law.

Common requirements for reporting and monitoring make it possible to evaluate progress and monitor environmental status and pressures on the marine environment so that further action can be taken if necessary.

4.4 Offshore renewable energy

One of the Government's climate policy goals is for Norway to become a low-emission economy by mid-century. This will require restructuring, among other things to produce more renewable energy. Offshore renewable energy production

includes offshore wind power, wave power, marine current power, tidal power and osmotic power. At present, offshore wind power is a marginal sector in Norwegian waters. Apart from a floating wind turbine off Karmøy, there are no offshore renewable energy installations in the management plan area. Although there is great potential for offshore energy in Norwegian sea areas, developments in the years ahead are uncertain, among other things because of the high costs.

4.4.1 Possible future developments in wind power

The degree of wind power development and other offshore renewable energy production will depend on whether technological advances and framework conditions, such as economic considerations and conflicts of interest, make such production profitable. There are a number of technologies available for development. Wind power is the form of offshore energy most likely to be developed in the management plan area. In 2010 a working group led by the Norwegian Water Resources and Energy Directorate conducted a rough screening of Norwegian sea areas to identify those suitable for wind power development. The group identified 15 areas, five of which are in the management plan area.

In 2011 and 2012 the Water Resources and Energy Directorate conducted a strategic environmental assessment of the 15 areas identified by the working group. The assessments included environmental, economic and business interests associated with these areas and their suitability in technological and economic terms.

After a comprehensive assessment, the Directorate recommended that priority should be given to a total of five areas, four of which are in the North Sea (Figure 4.11). The latter are: Frøya-grunnene, Utsira North, and Southern North Sea I and II. In Statnett's opinion, it will only be possible to connect one of the areas Southern North Sea I and II to the electricity grid by 2025. The Water Resources and Energy Directorate considers that the technical and economic feasibility of these four North Sea areas is very good, and that the cumulative effects on the environment and the consequences for activities in other sectors are acceptable.

Offshore renewable energy installations can make particular areas wholly or partly unsuitable for other activities. Large-scale offshore wind farms will affect relatively large areas; each tur-



Figure 4.10 Turbulence from Horns Rev offshore wind farm.

Photo: copyright Vattenfall

bine occupies an area of around 1 km², and the turbines are linked by a network of power cables on the seabed, which are joined to a cable that transmits the generated electricity to shore. The four North Sea areas identified as priority areas by the Water Resources and Energy Directorate measure from 58 km² to 2591 km². Each wind farm will occupy an area of 40–400 km². If the areas are fully developed, the total area affected will be up to 750 km², assuming a turbine size of 5 MW and that only one of the areas Southern North Sea I and II is developed. The possible spatial overlap with other activities is described in more detail in Chapter 5.

Offshore wind power is a growth industry in Europe, driven by the EU's Renewable Energy Directive, the poor conditions for onshore renewable energy production and the fact that a number of countries have introduced support schemes for specific types of technology. By mid-2012, just over 4 GW of wind power capacity had been developed in European marine waters, and installations

with a potential capacity of 20 GW were either under development or had been granted a development permit. The European Wind Energy Association has estimated that 40 GW of wind power capacity could be developed by 2020. In the UK alone, a total of 25 GW of wind power capacity will be in production or under development by 2020. An installed capacity of 25 GW generates around 100 TWh/year of electricity. In comparison, Norway's total electricity production is around 130 TWh/year.

Taken together, the four priority areas for development in the North Sea would produce 1.6–3.7 GW. In 2012, 30 wind farms, with a total capacity of 4.6 GW, had been installed and connected to the grid in the whole of the North-East Atlantic (the OSPAR area) (Figure 4.12). A further 61 wind farms had been authorised.

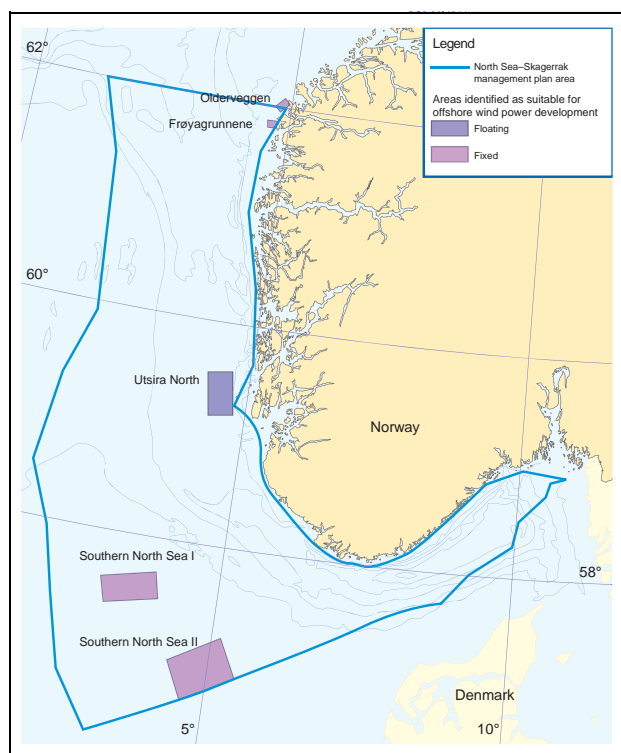


Figure 4.11 Proposed areas for floating and fixed wind power installations.

Source: Norwegian Mapping Authority, Water Resources and Energy Directorate

4.4.2 Possible value creation and employment in the future

The consequences of wind power development for employment and the business sector in the 15 areas were assessed in connection with the strategic impact assessment conducted by the Water Resources and Energy Directorate. Value creation was measured in NOK per MW and employment in terms of person-years per MW generated by the development and operation of wind farms over a 25-year period.

The results showed that large-scale development in areas far from existing onshore infrastructure (ports and the electricity grid) or in deep water have the largest estimated potential for national value creation. In the North Sea this applies particularly to Southern North Sea I and II and Utsira North. For the first of these areas to be developed, the national share of total value creation is estimated at just over NOK 60 million per MW over the full life cycle of the installations, and national employment is estimated at around 50 person-years per MW. In the strategic impact assessment, the Directorate estimated that the average annual number of person-years would be

around 150 for the smallest area (Frøyagrunnene) and 900 for the largest area (Southern North Sea II). However, almost 80 % of the labour is expected to be needed during the construction phase. The profitability of these developments for the local business sector will depend on the number of persons employed at the wind farms in relation to the number employed in the adjoining economic region.

4.4.3 Management

National framework

The Act relating to offshore renewable energy production (the Offshore Energy Act) entered into force in 2010. A strategy for offshore renewable energy had been put forward together with the bill (in Proposition No. 107 (2008–2009 to the Storting)). The Offshore Energy Act provides a framework for regulating offshore renewable energy production, and as a general rule applies outside the baseline and on the continental shelf, although it may also be made applicable inside the baseline. Under the Offshore Energy Act, offshore renewable energy production may in principle only be established after the public authorities have opened specific geographical areas for licence applications. The Act also stipulates that strategic impact assessments should be conducted under the auspices of the authorities before the decision to open geographical areas is made.

A public consultation on the strategic impact assessment on wind power was held, with a time limit for responses on 4 April 2013. The Government will follow up the assessment with a view to opening areas for licensing. The final decision on which areas are to be opened for licensing is taken by the King in Council. Under the Offshore Energy Act, environmental impact assessments must be conducted in connection with licence applications and when the detailed plans are drawn up. Licence awards and approval of the detailed plans must be based on the findings of the impact assessments and otherwise as far as possible on environmental considerations and other user interests.

International framework

There is no EU legislation that directly regulates matters of central importance for offshore energy. In 2008 the EU Commission presented the plan *Offshore Wind Energy: Action needed to deliver on*

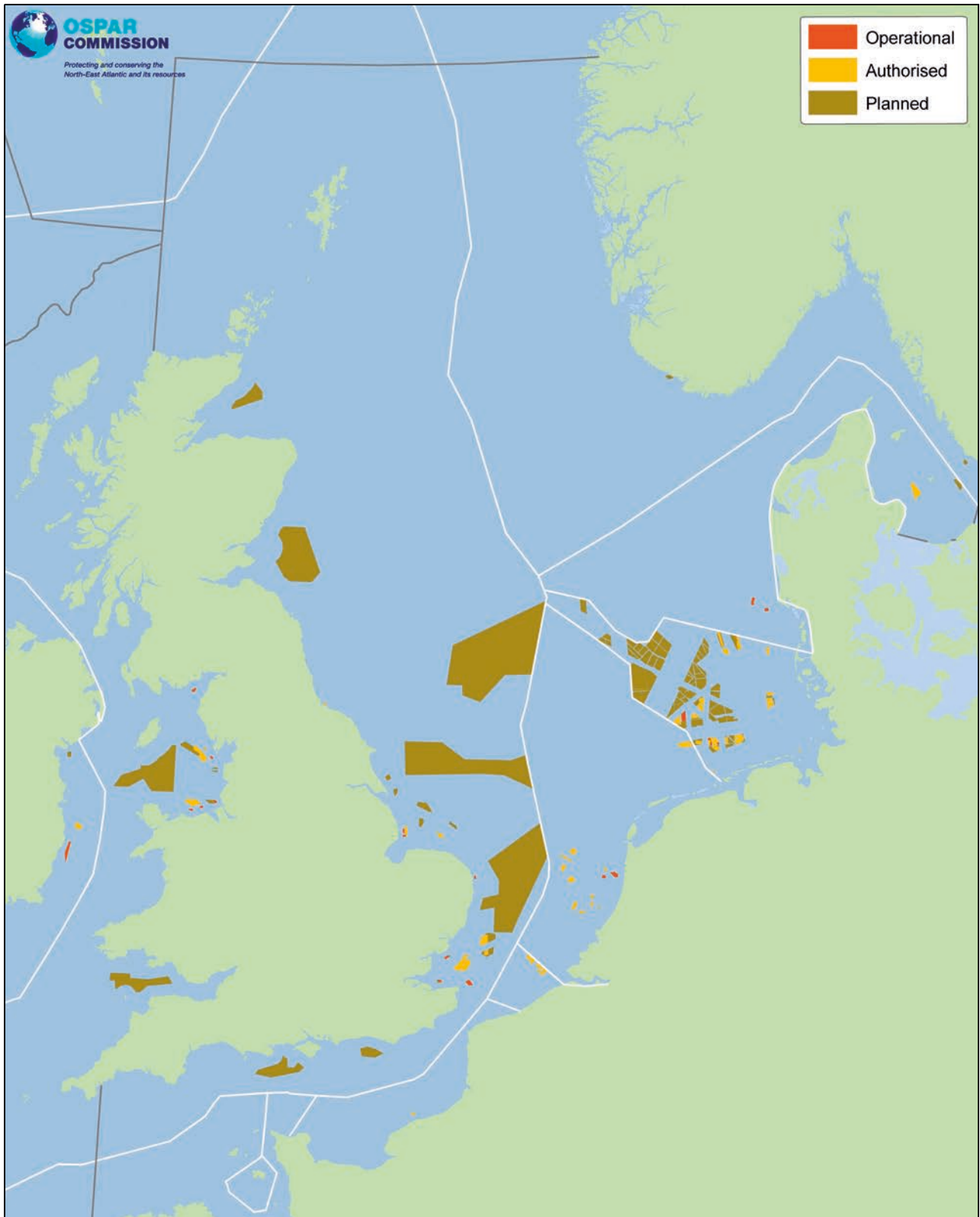


Figure 4.12 Planned, authorised and operational wind farms in the North Sea area.

Source: OSPAR database on offshore wind farms

the Energy Policy Objectives for 2020 and beyond. This states that wind energy will play an essential role in meeting the objectives of the new Energy

Policy for Europe and that a more strategic and coordinated approach will be important for exploiting Europe's wind resources. The Renewa-

ble Energy Directive (2009/28/EC) set a target of a 20 % share of energy from renewable sources to be reached by 2020.

In September 2012, the Commission presented the Communication *Blue Growth* as part of the EU Integrated Maritime Policy. The Communication stated that the Commission will assess options for giving industry the confidence to invest in ocean renewable energy, and that the aim is to address ocean renewable energy issues in a Communication in 2013.

EU countries are required by the EIA Directive to conduct environmental impact assessments before developing offshore renewable energy installations. Such activities must also take place within the framework set out in the EU Marine Strategy Framework Directive, the aim of which is to achieve good environmental status for the EU's marine waters by 2020.

The OSPAR Commission has published *Guidance on Environmental Considerations for Offshore Wind Farm Development*.

4.5 Travel and tourism and leisure activities

Access to the sea and opportunities to stay by the seaside and enjoy activities such as boating, swimming and fishing are important for a large proportion of the population, and form a basis for the tourist industry. And opportunities to enjoy the seaside are strongly dependent on a clean, rich and productive marine environment – a living sea means a living coast.

4.5.1 Value creation and employment

The sea and coast are very important areas for the travel and tourism industry and for leisure activities in Norway. The coastline bordering the management plan area is very attractive and heavily used by the local population. The coastal and marine environment is important for this sector in a variety of ways: it provides enjoyment, opportunities to engage in a variety of activities, and health benefits. In addition, the coastal and marine environment is an important basis for economic activity in the travel and tourism industry at both local and national levels.

It can sometimes be difficult to draw a line between recreation and commercial activities in analyses of the travel and tourism industry. Travel and tourism and leisure activities are often two sides of the same coin, since a number of tourist

activities are based on people's desire to engage in outdoor recreation and enjoy nature.

According to the tourism satellite accounts from Statistics Norway, the total output of the tourism industry was just over NOK 181 billion in 2009. Provisional figures for 2009 indicate that the industry generated employment of 139 000 person-years, equalling 6.5 % of total employment in mainland Norway.

In the same year, total value added for the tourism industry was estimated at almost NOK 79 billion, or 4.3 % of GDP for mainland Norway. The proportion has been more or less stable since 2003. It is not possible to deduce from the statistics how large a share of the industry is related to the use of coastal and sea areas.

The North Sea–Skagerrak area is very attractive for tourism and recreation. It is difficult to provide a full picture of the value added generated by tourism that is specifically linked to the management plan area, but the following examples indicate the importance of this area for the tourism industry.

Value added and employment in the travel and tourism industry

Statistics Norway's tourism satellite accounts provide figures for value added in the tourism industry by county. In 2007, the tourism industry in the North Sea and Skagerrak counties provided NOK 25 billion in total value added, NOK 11 billion of which came from hotels and restaurants. However, we have no information on how much of this is generated by the use of coastal and sea areas in the North Sea and Skagerrak.

The satellite accounts show that in 2007 tourism provided 58 000 person-years of employment in the counties bordering on the North Sea and Skagerrak. Of these, 16 800 in the North Sea counties and 12 600 in the Skagerrak counties were employed in hotels and restaurants.

Production in the hotel and restaurant sector

The tourism satellite accounts also provide figures for production by county and for hotels and restaurants, transport, and culture and entertainment. However, we have no information on how much of this is related to the areas closest to the coastline.

Figures for 2007 show that hotels and restaurants generated around NOK 13 billion in the North Sea counties and around NOK 8 billion in the Skagerrak counties.

Calculations show that in the coastal municipalities in the management plan area, 25 % of sales in the hotels and restaurant sector were made within the 100-metre belt along the shoreline.

Projected figures for 2030

The tourism industry is one of the world's fastest growing industries, and the aim is to ensure that the Norwegian tourism industry has a share in this growth. The Government's 2012 tourism strategy *Destination Norway* sets out three goals for the industry:

- higher value creation and productivity,
- a larger number of year-round jobs and more robust businesses, especially in rural districts,
- more unrivalled attractions that draw visitors with a high willingness to pay.

The Government is giving explicit priority to the tourism industry. The strategy sets out three priority areas for the Government's future efforts in this field:

- organisation,
- development of tourist attractions and destinations,
- sales and marketing.

4.5.2 Leisure activities along the coast

The coastline of the North Sea and Skagerrak provides opportunities for a wide range of leisure activities and recreational interests. More than

80 000 holiday cabins in the counties bordering on the management plan area are situated less than 1 km from the shoreline. Around 50 000 are in the Skagerrak counties from Østfold to Vest-Agder, while the remaining 30 000 or so are situated in the three North Sea counties.

The proportion of holiday cabins within 1 km of the shoreline for each of the Skagerrak counties is 93 % in Østfold, 91 % in Vestfold, 85 % in Telemark, 95 % in Aust-Agder and 74 % in Vest-Agder.

The table shows that over 42 % of all holiday cabins in the coastal municipalities are situated within the 100 m belt along the shoreline, and around 70 % within 500 m of the shoreline.

«Blue parks» – outdoor recreation and marine protected areas

Ytre Hvaler national park was established in 2009 and covers an area of 354 km², of which only 14 km² is land and the rest is sea and seabed. This means that a unique marine area is protected from activities that could impair its environmental value, such as development and large-scale commercial activities. At the same time, this maintains very favourable conditions for outdoor recreation. Ytre Hvaler is Norway's first «blue» national park. Other marine areas have been protected together with adjoining areas on land, for example around Svalbard and Jan Mayen.

Efforts to safeguard important marine areas and their species and habitat diversity for the

Table 4.3 Number of holiday cabins by distance from the shoreline for the coastal municipalities in the management plan area and the inner Oslofjord.

County	Distance from shoreline				Over	Total	Sum
	0–100 m	100–500 m	500–1 000 m	1 000 m			
Østfold	6 245	7 274	989	1 166	15 674	14 508	
Vestfold	5 407	5 533	939	1 110	12 989	11 879	
Telemark	4 372	1 973	301	1 200	7 846	6 646	
Aust-Agder	4 749	2 258	142	367	7 516	7 149	
Vest-Agder	5 459	2 357	432	2 845	11 093	8 248	
Rogaland	6 309	4 225	907	5 436	16 877	11 441	
Hordaland	11 551	5 464	947	10 997	28 959	17 962	
Sogn og Fjordane	2 945	1 275	338	5 398	9 956	4 558	
Akershus	2 199	3 623	878	1 646	8 346	6 700	
Oslo	623	22	3	1 650	2 298	648	
Buskerud	1 312	1 662	285	1 163	4 422	3 259	

Source: Statistics Norway

Boks 4.3 Recreation days in holiday cabins and contribution to value creation in the management plan area

In all, there are around 80 000 cabins within 1 km of the shoreline in the coastal municipalities bordering on the management plan area. Figures from earlier work by the Institute of Transport Economics indicate that these cabins are likely to be in use for roughly 8–12 million days a year. This can be used as an estimate of recreation days in the area.

The figures can be split between the North Sea counties, with an estimated 3–5 million recreation days a year, and the Skagerrak counties, with an estimated 5–7 million. The Institute of Transport Economics has estimated consumption per cabin user per day at around NOK 225. This includes food and beverage services, transport, petrol and other car-related expenses, supplies, activities and other expenses, but not maintenance or building work.

Using this as a basis, total consumption for all recreation days at holiday cabins in the management plan area is estimated at around NOK 1.8–2.7 billion a year. However, there may be an overlap between permanent residents and cabin users in these calculations.

future have been in progress for a long time under the national marine protection plan. In 2004 a broad-based advisory committee identified 36 important marine areas along the coast, which are being evaluated as part of these efforts. Work on the marine protection plan will be continued. A public consultation on draft Regulations relating to the protection of three marine protected areas under section 39 of the Nature Diversity Act (Saltstraumen in Nordland, Tauraryggen in Nord-Trøndelag and Framvaren in Vest-Agder) was begun in January 2013, with a view to their adoption in summer 2013. The Saltstraumen maelstrom is the world's strongest tidal current, while Tauraryggen is an example of Norway's unique cold-water coral reef complexes. Framvaren is known to researchers worldwide because of the highly unusual chemical conditions, which make it a natural historical archive that goes back several thousand years.

Fishing tourism

Recreational fishing has a long history in Norway, and in the last few decades it has become commercialised. A number of studies have been made to determine the extent of sea fishing tourism, and in 2010, 80 foreign travel and booking agents were found to have offered stays at tourist facilities for sea fishing, which means that the numbers have doubled in the last 10 years. The number does not include rental agents hiring out premises that are suitable for fishing, or private lets.

In 2005 the Institute of Transport Economics estimated the total number of tourists engaged in sea fishing who had travelled to Norway by car at 274 500. The study did not include tourists who came by bus or plane.

There are a number of different estimates of the economic value of sea fishing tourism in Norway. The most comprehensive survey was published in 2002, using figures from 1999/2000. On the basis of figures from over 900 enterprises, it was estimated that fishing tourism brought in NOK 2.2–2.4 billion a year. The counties bordering on the management plan area accounted for 46 % of this, amounting to around NOK 1 billion a year, or NOK 1.3 billion at the 2011 monetary value. A more recent study by NORUT Northern Research Institute showed that direct revenues from overnight accommodation and boat hire offered by a selection of fishing tourism enterprises amounted to NOK 220 million, almost NOK 80 million of which came from enterprises in Southern and Western Norway. The figures do not include spin-off effects, activities based on rentals by private citizens, which is a widespread practice in Southern Norway, or investments in facilities and equipment at the national level.

4.6 Other possible future industries

4.6.1 Marine bioprospecting

Bioprospecting can be described as a systematic and targeted search for components, bioactive compounds and genetic material in organisms for commercial exploitation. These organisms can be found on land, in the sea, on the seabed and in oil reservoirs under the seabed. They include all types of organisms – microorganisms such as bacteria, fungi and viruses and larger organisms such as plants, shellfish and fish.

In spite of the fact that the sea covers more than 70 % of the earth's surface, and that evolution in the marine environment began several million

years before evolution on land, little research has been done on marine biodiversity. Many marine organisms are likely to have properties that can be exploited and used in the manufacture of new products and processes in a number of industrial sectors. Marine bioprospecting therefore has a potential for value creation, and Norway is considered to be in a good position to make its mark internationally in this field.

The Government has defined marine bioprospecting as a priority area, and substantial funds are being channelled into incentives for R&D. The aim is to activate the entire range of value creation potential opened up by marine bioprospecting.

A public consultation on draft Regulations relating to the collection and utilisation of genetic resources (the Bioprospecting Regulations) was started in December 2012, with a time limit for responses of 5 April 2013.

4.6.2 Mineral extraction

At present, there is no mineral extraction from the seabed in the North Sea and Skagerrak or in other Norwegian sea areas. There has been little exploration of the seabed in the management plan area, and it is therefore possible that seabed mineral potential will be discovered. Better mapping

and the development of new technology may lead to value creation from seabed mineral deposits.

We have good data from the 1990s on the sand and gravel deposits on the seabed of the Skagerrak. Mapping of this sea area has shown that the areas with most potential for mineral extraction are deposits of sand and gravel at depths of less than 150 m on the North Sea Plateau and the southern and western slopes of the Norwegian Trench. A belt of sand and gravel up to 40 cm thick extends for more than 50 km along the eastern edge of the North Sea Plateau. In some areas with strong bottom currents the sand is moved along the seabed, and in some places even gravel may be moved. There are also deposits closer to the Norwegian coast, both beyond and inside the baseline. These are mainly moraines, for example in the Jomfruland area. Although number of countries around the North Sea extract sand and gravel from the seabed, this is not done in Norwegian waters. In the longer term, Norway's sand and gravel have potential economic value. Shell sand would be a valuable resource in the coastal zone, where there are deposits between islands and skerries in sounds with strong currents and in wave-exposed areas. There is some small-scale extraction in Aust- and Vest-Agder and along the coast of Western Norway.

5 Spatial management – challenges and coexistence between industries

5.1 The spatial element of the management plans

The intensive use of the North Sea and Skagerrak puts considerable pressure on these waters, and it is important to maintain the renewable resources and prevent damage to the marine environment.

The main aim of this chapter is to discuss the challenges associated with spatial overlap between different commercial activities, such as petroleum activities, fisheries, maritime transport and offshore wind power. Chapters 3, 6 and 7 discuss how to keep a balance between sustainable use and conservation of ecosystems. The white paper *Protecting the Riches of the Sea* (Report No. 12 (2001–2002) to the Storting) stated that the expected increase in the use of coastal and marine areas will make it difficult to strike a balance between the various user interests and environmental considerations, so that spatial planning in marine areas will be an important tool. A differentiated and sustainable spatial management regime must be based on knowledge of ecosystems and the impacts of different forms of use. Digital mapping tools are extensively used in the management plans to illustrate different types of use and protection of marine areas.

A comprehensive scientific basis has been compiled for each of the management plans for Norway's sea areas, and the plans include a number of general decisions about spatial management. A digital mapping management tool will simplify and rationalise the process of updating the plans. It will also make the scientific basis and decisions regarding spatial management more readily accessible, and allow them to be presented in a coherent and visual manner.

5.2 International developments

The ultimate aim of maritime spatial planning in the EU and other countries and international organisations is to plan human activities in areas

of sea that are outside the baselines but under national jurisdiction while at the same time protecting marine ecosystems.

The 2007 EU Integrated Maritime Policy identified maritime spatial planning as a key tool for integrated marine management. The 2008 EU Marine Strategy Framework Directive also refers to the use of digital management tools for achieving good environmental status in European marine waters.

In March 2013 the European Commission presented a proposal for a directive establishing a framework for maritime spatial planning and integrated coastal management that emphasised an ecosystem-based approach and the importance of coordinating sectoral interests. The proposal establishes a framework for maritime spatial planning and integrated coastal management in the form of a systematic, coordinated, inclusive and transboundary approach to integrated maritime governance. It obliges member states to carry out maritime spatial planning and integrated coastal management in accordance with national and international law. The geographical scope of the directive includes internal waters and extends to the external border of the member states' national jurisdiction in marine areas.

The proposed directive will be considered in the EU. The EEA relevance of the directive will be considered in accordance with the normal procedure.

The UN system, in particular through the International Oceanographic Commission (IOC) under UNESCO, has issued a guide to a step-by-step approach to ecosystem-based management and set up a website to help countries implement it in practice. The methods described here are also relevant to Norwegian conditions.

In 2003 the OSPAR Commission appointed a working group on marine spatial planning. OSPAR has also published the *OSPAR Guidance on Environmental Considerations for Offshore Wind Farm Development*, which includes the issue of conflicts of interest.

In 2010, it was decided at a Ministerial Meeting of the Helsinki Commission (HELCOM), which is the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, that marine spatial plans should be developed for the Baltic Sea through close cross-border cooperation. Under the EU Strategy for the Baltic Sea Region, the EU countries bordering on the Baltic Sea have set a target for marine spatial planning to be in place by 2015.

In 2011 the Swedish Government established the Swedish Agency for Marine and Water Management, whose responsibilities include marine spatial planning. Marine spatial plans are to be developed for three areas: the Gulf of Bothnia, the Baltic Sea, and the Skagerrak. In the UK the Marine and Coastal Access Act of 2009 contains provisions relating to marine planning and established the Marine Management Organisation. Guidelines for marine planning were issued in 2011 and marine plans are being developed for inshore and offshore waters.

The countries that have made most progress are the Netherlands, Germany and Belgium, all of which have developed marine spatial plans. They make extensive use of maps to show areas and features that are used or protected in different ways and to clarify their legal status.

Countries outside Europe are also engaged in marine spatial planning, including Australia, Canada, New Zealand and a number of other countries. The US has developed recommendations for coastal and marine spatial planning.

Cooperation between the countries around the North Sea and Skagerrak is crucial, both to address problems in these sea areas and to exchange experience of integrated marine management.

5.3 Spatial overlap between activities in the North Sea and Skagerrak

5.3.1 Spatial overlap between maritime transport and fisheries

Under normal circumstances the main conflict of interest between maritime transport and fisheries arises when cargo vessels sail through or very close to fishing grounds where there are large concentrations of fishing vessels. This is primarily a question of safety, especially for smaller vessels. Some fishing vessels operate on their own, are small and can be difficult to see in poor light. They may also be difficult to capture on radar if there is a lot of background noise.

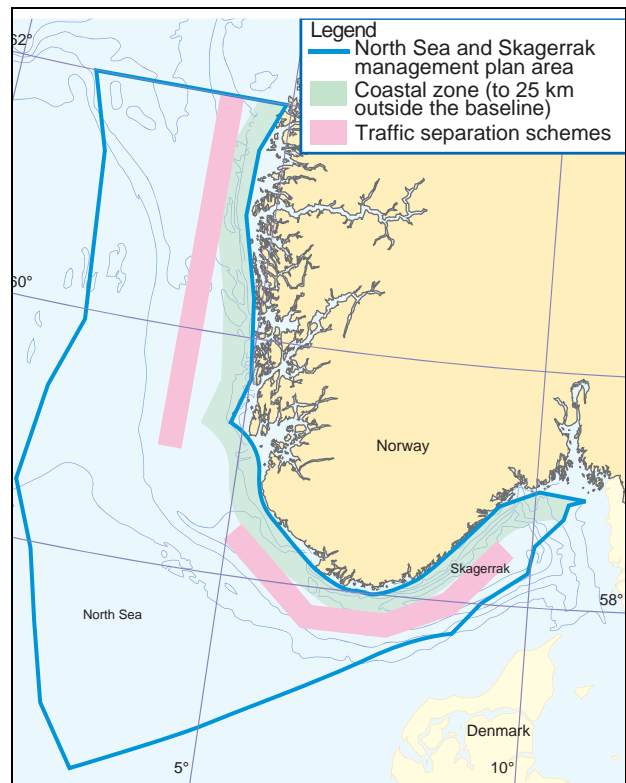


Figure 5.1 Traffic separation schemes in the North Sea and Skagerrak

Source: Norwegian Coastal Administration, Directorate for Nature Management, Norwegian Mapping Authority

Large concentrations of fishing vessels in the path of a shipping route make it necessary for ships to deviate considerably from their course to avoid the risk of collision.

Over the years several collisions have occurred between cargo vessels in transit along the coast and vessels engaged in fishing. In some cases this has resulted in shipwreck and loss of life, while in others it has only damaged the vessel.

On 1 June 2011, new traffic separation schemes and recommended routes were introduced off Western and Southern Norway for vessels of gross tonnage of 5 000 and over, and for vessels carrying dangerous or polluting goods. These ships now sail further away from the coast and the potential for conflicts with the fisheries has been considerably reduced.

Ships may also damage fixed fishing gear or markers for such gear.

Wrecks on the seabed may obstruct fishing. The Nairobi International Convention on the Removal of Wrecks (Wreck Removal Convention) was adopted by IMO on 18 May 2007. The Convention contains provisions on locating, marking

and removing ships and wrecks. Although the Convention primarily applies in the exclusive economic zone of a state party, a coastal state may notify IMO that it will extend the application of part or all of the Convention to wrecks located in its territorial sea and internal waters. Norway is considering whether to ratify the Convention and incorporate it into Norwegian law.

There are international rules for the conduct of ships towards vessels engaged in fishing, and the location of important fishing grounds was taken into account in the process of establishing traffic separation schemes along the coast. The schemes channel ships in transit along fixed routes. Conflicts usually only arise when a particular ship fails to obey the rules and thereby increases the risk of a major or minor accident.

The establishment of maritime corridors along the entire Norwegian coast, together with the reduction in the number of fishing vessels, makes it unlikely that the level of conflict will be any higher in 2030 than it is today, even with an increase in traffic.

The rules should be tightened up to make it possible under certain circumstances to require the removal of wrecks that interfere with fishing operations. At present the main grounds for removing wrecks are their presence in a nature reserve or the environmental risk they pose. If a wreck is allowed to remain, its position must be made known, clearly and accurately, to the fishing fleet.

In addition to the above, the most effective means of promoting coexistence between shipping, fisheries and other industries (aquaculture, offshore wind power, etc.) are visual or electronic marking and routeing schemes.

5.3.2 Spatial overlap between maritime transport and offshore wind power installations

Offshore wind power developments would require certain restrictions on the use of the areas around installations that could affect maritime traffic. In many cases conflicts of interest could be resolved by measures such as altering maritime routes or establishing corridors between wind turbines. The Water Resources and Energy Directorate conducted a strategic impact assessment of offshore wind power development based on the 2010 report identifying Norwegian sea areas suitable for such development (the Offshore Wind Power Report), and in this connection the Coastal Administration assessed the impacts of wind

power development in these areas on maritime traffic, navigation, and safety and emergency preparedness.

In the Olderveggen and Utsira North areas, offshore wind farms would have major impacts on maritime traffic. However, for Utsira North the impacts could be reduced by reducing the size of the area developed. Wind power development in Southern North Sea II and Frøyagrunnene is assessed as having moderate impacts on maritime traffic. Development in Southern North Sea I and Stadhavet is assessed as having little impact on maritime traffic because the two areas are situated in the open sea where traffic density is relatively low.

The main measure to mitigate impacts on maritime traffic would be to limit the size of the areas opened for wind power development. Other measures would have to be considered for the individual developments, for example alterations in fairways or maritime routes, or removal or alteration of aids to navigation.

Procedures for resolving conflicts between maritime transport and offshore wind power development should be clarified before any development takes place.

5.3.3 Spatial overlap between the petroleum and fisheries industries

Oil, gas and fish are Norway's most important exports, and ever since oil and gas activities started on the Norwegian shelf about 40 years ago, the authorities have emphasised the importance of coexistence with other industries, the fisheries industry in particular. This has laid the foundation for value creation based on Norway's fisheries and oil and gas resources.

Occupation of an area by petroleum activities takes place in phases, which are either short- or long-term. Seismic surveys, exploration drilling, construction and field closure are short-term activities, while fixed installations occupy an area over the long term. Seismic surveys occupy the largest area. These surveys are conducted during all phases of petroleum activity, from exploration to final production. Even though seismic surveys only last for a relatively short time in each phase, this is the activity that leads to the greatest conflict with the fisheries.

Under Norwegian and international safety regulations, a *safety zone* is established around platforms and other permanent and dynamically positioned facilities or vessels that project above the sea surface. The safety zone is a geographically

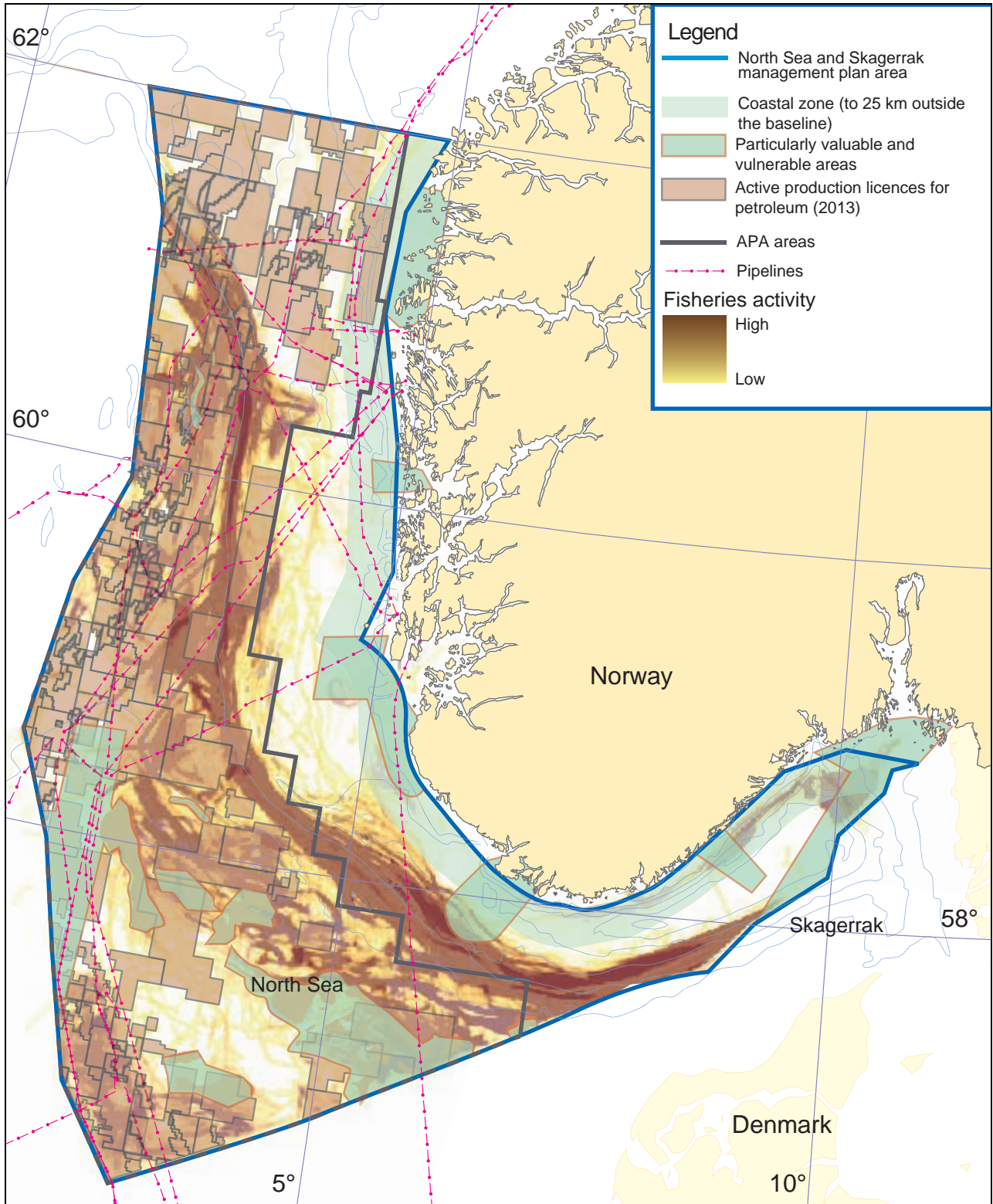


Figure 5.2 Petroleum and fisheries activities in the North Sea and Skagerrak

Source: Norwegian Petroleum Directorate, Directorate of Fisheries, Directorate for Nature Management, Norwegian Mapping Authority

defined area within a distance of 500 metres from any part of an installation that unauthorised vessels are prohibited from entering, remaining in or operating in. The impacts of occupied areas

depend on the position of the safety zones in relation to important fishing grounds and on the type of fishing gear used. The safety zones round

petroleum installations are regarded by all parties as essential for safety purposes.

Exploration drilling occupies areas, although only temporarily, since a 500-m safety zone is established around the drilling facility or vessel. An exploration rig, including its anchor spread, occupies an area of about 7 km², in other words, an area considerably larger than the safety zone. Dynamically-positioned rigs will occupy a somewhat smaller area, while anchoring in deeper water will occupy a larger area. Drilling operations usually take two to three months.

During the *development phase*, after a plan for development and operation has been approved, there will be periods of varying length when smaller or larger areas are occupied, particularly in connection with construction and pipeline- and cable-laying. The size of the occupied area will depend on the development concept.

Under Norwegian law, *subsea installations and pipelines* must be designed to avoid interference with fishing operations. This means for example that they must be overtrawlable and constructed in such a way as to avoid damaging fishing gear. This means that safety zones are not established around subsea structures, including pipelines. In this respect, Norwegian legislation differs considerably from the rules in other part of the North Sea. In other countries' zones, liability for damage to a pipeline lies with the operator who has caused the damage. In practice this means that there is no fishing in the neighbourhood of pipelines or subsea structures.

Fisheries using conventional gear such as gill-nets and longlines, and pelagic fisheries using purse seines and pelagic trawls, are not normally affected by subsea structures.

The habits of sandeels are quite different from those of other fish. Sandeels spend long periods burrowing in sandy substrate. Suitable substrate is only found in clearly delimited areas, and the distribution of sandeels is therefore limited by the extent of their habitat.

In December–January, mature sandeels emerge from the sand to spawn directly above the substrate. The fertilised eggs are attached to sand grains until they hatch and the larvae drift in the water column. There are strong indications that each area of sandeel habitat has its own local sandeel stock. Since both the spawning grounds and the spawning period are limited, individual stocks are very sensitive to disturbance, unlike species that spawn over large areas and for long periods. Releases of pollutants from petroleum activities in the first-mentioned areas are there-

fore strictly regulated. To protect sandeel areas of habitat and spawning grounds, and avoid sediment deposition from drilling activities, discharges of drill cuttings are prohibited in the areas, and any field developments must be designed to minimise changes to benthic conditions in areas of sandeel habitat. Ways of minimising disturbance to spawning are also considered when drilling permits are issued.

From April to the end of June sandeels emerge from the sand during the day to feed, and this is the period when they can be harvested and there is a sandeel fishery. Restrictions on petroleum activities have been introduced at this time of year to avoid conflict with the sandeel fishery.

Rock fillings are sometimes used to support or stabilise pipelines and at pipeline crossings. The fillings do not seem to cause particular problems for larger trawlers, but trials of overtrawling by smaller trawlers have shown that problems arise to a varying degree. Fishing gear may catch on or be damaged by a pipeline or cable with surface damage that lies on or is only partly buried in the seabed. Experience has shown that in practice fishing operators tend to avoid such areas. Thus pipelines may occupy areas in practice and result in reduced catches for vessels fishing in such areas.

The OSPAR prohibition on dumping of disused offshore installations has been incorporated into Norwegian law. This means that the authorities make the final decision on the disposal of oil and gas installations after shutdown based on a decommissioning plan, which includes an impact assessment. So far 44 offshore installations have been removed from the Norwegian part of the North Sea during decommissioning. As a general rule, pipelines and cables may be left in place provided that they do not constitute a nuisance or safety risk for bottom fisheries that is proportionate to the costs of burying, armouring or removal. This means that in practice they remain in place in areas where there are no important bottom fisheries or where they have been properly buried or armoured.

The rules allow for exemptions to be made from the prohibition on dumping and for certain specific categories of installations, primarily concrete installations, to be left in place. So far two concrete structures (the Ekofisk 2/4 tank and Frigg TCP2) have been left in place in the Norwegian part of the North Sea. Such structures have little negative impact on fish populations, but there may be conflict with fisheries interests

because of restrictions on access to the area concerned.

5.3.4 Fish and seismic surveys

Seismic surveys are geophysical surveys that constitute the main source of information about conditions beneath the seabed. Seismic data are therefore needed to map petroleum deposits, and are crucial for maximising production from oil and gas fields. Seismic surveys are carried out in all phases, from exploration to production, and continued development of seismic surveying has always been played an important role in the development of the Norwegian petroleum industry.

Fisheries are a dynamic industry in the sense that there can be considerable variations in a fishery from one year to the next. However, knowledge and long experience have shown that certain areas and times of year are particularly important. To promote coexistence between fisheries and seismic surveying, the authorities have developed legislation to provide a clear framework and more predictable conditions for both activities.

The basic method used for seismic surveying is to discharge sound pulses from a vessel or other source on the surface, which travel down below the seabed. These are reflected back to the surface from the boundaries separating the geological layers under the seabed. The reflected signals are recorded by receptors, usually towed behind the vessel just below the surface.

Seismic surveying has been a source of conflict between the petroleum and fisheries industries. Several impact assessments for seismic activity have therefore been conducted, and a number of measures have been introduced.

With regard to the scare effect of seismic activity on fish, it is important to know how far away from the source of the noise the effect makes itself felt. Relatively little research has been done on scare effects and studies have shown conflicting results. The way sound waves travel and the distance travelled depend on horizontal and vertical salinity and temperature conditions, which vary through the year and often from area to area. Topography and seabed conditions also have a strong influence on the distance travelled by sound under water. The authorities have therefore refrained from setting a recommended minimum distance between seismic activity and fishing activities, fish farming, and whaling and sealing. However, the legislation does require seismic survey vessels to maintain a reasonable

distance from vessels engaged in fishing and from fixed or drifting gear.

The relatively few studies on the scare effect agree that there are large differences in the scale of the effects. For example, in a 1992 study in the Nordkapp Bank area, the Institute of Marine Research found a reduction in trawl catches of cod and haddock within a radius of 18 nautical miles of a seismic vessel. However, apart from the studies on cod and haddock, little research has been done in this area, especially with regard to the effects of seismic activities on pelagic species.

In the last 20 years the technology used in seismic data acquisition has reduced the impacts on the fisheries. In summer 2009, the Institute of Marine Research carried out a research project in connection with seismic data acquisition by the Petroleum Directorate in the waters off the Lofoten and Vesterålen Islands. The study showed that the noise affected fish behaviour and that there were changes (increases or decreases) in the size of catches while the surveys were being conducted, depending on the gear being used and the species involved. No specific distance was found for the scare effect, but the recorded distances were considerably shorter than the distance observed in the Nordkapp Bank area in 1992. The Institute's report concluded that no injuries to fish had been recorded as a result of seismic activities. Other studies have shown that generally speaking seismic activities do not in themselves injure marine life, although injury to fish eggs and larvae within a radius of 5 m of the source of the noise has been reported. However, the Institute of Marine Research has concluded on the basis of previous studies that such damage is not significant at population level.

There is an annual handline fishery for mackerel in the North Sea. It takes place during a limited period in late summer and autumn, mainly from small vessels with a limited action radius. This is an important fishery for around 150 vessels. Handlining gear is used in the upper part of the water column, where the effects of noise are greatest. In addition, mackerel are fast swimmers and particularly sensitive to noise, which causes them to swim rapidly away from noise sources. For several years there has been a conflict between seismic surveying and handlining for mackerel in the northern part of the North Sea. In early summer 2012, it became clear that some planned seismic surveys could come in conflict with handlining for mackerel. The Ministry of Petroleum and Energy and the Ministry of Fisheries and Coastal Affairs have developed joint guide-

lines for addressing cases of overlapping interests. They were used to deal with the cases above, and during the process the parties were encouraged to cooperate on finding solutions.

In summer 2012 a pilot project was carried out with a view to establishing a mechanism for dealing with possible conflicts between seismic surveys and the mackerel handline fishery. In the project, seismic data acquisition was put on hold in specific cases based on regular assessments, to enable the mackerel to move away without being disturbed by seismic activity. When it became clear that catches in the area were low, partly because the fish had moved closer to land, seismic activity was resumed on the understanding that it would be halted again if necessary. The parties involved in the project (Statoil, the Norwegian Fishermen's Association and the Directorate of Fisheries) have evaluated the project, and agreed that the 2012 season had proceeded without serious conflict between the fishery and the seismic surveys. The project contributed significantly to the lack of conflict, helped by the fact that the mackerel migration pattern changed in 2012. The project is being continued in 2013.

Cooperation between authorities, industry and organisations has resulted in a number of measures, including amendments to the Resource Management Regulations and the Petroleum Act and appurtenant regulations and measures to promote communication, coordination and competence-building. The amendments to the Resource Management Regulations include requirements for fisheries experts on board seismic vessels to follow a training course on seismic surveying and small adjustments to the requirements for reporting surveys and the tracking of seismic vessels. The Petroleum Directorate has established a web-based system for the reporting and notification of seismic surveys that allows interactive searches of data that has been reported and notifications of surveys. A cooperation agreement has been concluded between the Norwegian Coast Guard, the Directorate of Fisheries and the Petroleum Directorate under which the Coast Guard is the primary point of contact for fisheries experts. Guidelines have been introduced on how to resolve disagreements between the Directorate of Fisheries and the Petroleum Directorate regarding individual surveys. The Directorate of Fisheries has for several years been intensifying its efforts to supply information on fisheries activities to rights-holders and/or seismic companies, and has been involved in training fisheries experts on board seismic vessels. Incorporating such information

into the planning and operational phases can make seismic surveying more effective.

In the course of 2012, the authorities considered a number of additional measures to improve coexistence. If seismic surveying in the North Sea can start earlier in the year than has been usual until now, it may be possible to show more flexibility in the planning of surveys. In this connection petroleum companies are now able, in consultation and close cooperation with the Directorate of Fisheries and the Institute of Marine Research, to plan seismic data acquisition so that it is carried out in a more flexible way than can be done when the starting time is fixed. For example, this will make it possible to complete a larger number of surveys before the start of the handline fishery for mackerel.

The Ministry of Petroleum and Energy and the Ministry of Fisheries and Coastal Affairs will take the initiative together with representatives of the business sector to institute an annual meeting on seismic surveying. The aim will be to reduce the likelihood of conflict between fisheries activities and seismic surveying. The meetings will therefore be held in time to apply to surveys in the coming season. Discussing possible areas of conflict and how to adapt seismic surveying in terms of time or through coordination between the parties will reduce the risk of conflict.

The Ministry of Fisheries and Coastal Affairs and the Petroleum Directorate have also decided to draw up guidelines for seismic surveying in order to clarify the existing legislation and processes and thereby promote sound planning and coordination of activities.

Parallel with these efforts, the Norwegian Oil and Gas Association is developing guidelines for the petroleum industry for planning and carrying out seismic surveys. They will be made publicly available so that the information can also be used on board fishing vessels.

Most seismic surveys do not lead to problems with fisheries. Although the authorities have implemented a number of measures to ensure cooperation between petroleum and fisheries activities, in the form of legislative amendments, improved communication and competence-building, it is important to keep up the work and continue the process of promoting further cooperation between the two industries. The aim is to strike a balance that promotes long-term, sustainable management of marine resources and ensure that cooperation continues to function smoothly in the years ahead.

The measures already implemented, combined with those that are planned, such as the new guidelines, seem likely to improve the situation in cases of spatial overlap between petroleum and fisheries activities.

5.3.5 Spatial overlap between petroleum activities and offshore wind power

If offshore wind farms are established, it will be difficult to carry out seismic surveys and exploration drilling to map petroleum deposits, and also to carry out oil and gas production, in the same area as the wind farms. In preparing the Offshore Wind Power Report described in Chapter 4.4, the working group took full account of important areas for petroleum exploration and production. The possible impacts on petroleum activities of the establishment of wind farms were also assessed in the subsequent strategic impact assessment, on the basis of information from the Petroleum Directorate.

Conflicts of interest with the petroleum industry in the event of offshore wind power development in each of the areas considered in the strategic impact assessment for offshore wind power will primarily depend on the resource potential of the area. Existing infrastructure and the available area are also important factors. Of the five areas in the North Sea, Southern North Sea I and Southern North Sea II have the greatest petroleum resource potential. The Petroleum Directorate concluded that the impacts on petroleum activities in these areas would be moderate. For Stadhavet, the impacts on petroleum activities were assessed as minor. The impacts in Utsira North, Frøya-grunnene and Olderveggen were assessed as insignificant.

The assessed sea areas are large, and it is generally considered likely that solutions can be found that would allow several interested parties to coexist. If offshore wind farms are established in the management plan area, efforts will be made to resolve any overlapping interests through processes prior to a development.

5.3.6 Spatial overlap between fisheries activities and offshore wind power development

The establishment of offshore wind farms would affect fisheries, since fishing vessels would be prevented from fishing inside the area occupied by wind power installations or within a certain distance of turbines.

Fishing activities take place in all the areas that have been assessed, so that wind power developments in any of them would have impacts on the fisheries. The Directorate of Fisheries assessed the conflict potential in the areas in connection with the strategic impact assessment. The impacts were assessed as severe for Olderveggen and Frøya-grunnene, and as major for Stadhavet. However, Stadhavet contains several smaller areas with less fisheries activity and the impacts on the fisheries will decrease southwards. The impacts for Utsira North and Southern North Sea I and II were assessed as minor, and in some smaller areas as insignificant.

The impacts on fisheries would depend strongly on the size of the areas occupied by wind farms, on the regulations governing fisheries in and around wind power installations, on any adjustments that have to be made to take these into account, and on which types of gear it would be possible to use in the area.

Many areas that are suitable for wind power development overlap important fishing grounds, and it will be essential to involve local fisheries interests at an early stage of the detailed planning and licensing processes. Since the assessed areas are larger than is needed for one wind farm, it should be possible to avoid or reduce conflicts by adapting development to local conditions and interests.

5.4 The need to strengthen the spatial element of the management plans

5.4.1 Existing databases and portals

An important step in strengthening the spatial element of the management plans for Norwegian sea areas is to ensure that there are appropriate data and tools available. There are already several databases and portals that provide information on Norwegian sea areas. The following deserve particular mention:

- BarentsWatch is being developed as a comprehensive monitoring and information system for marine and coastal areas. Around 30 partner institutions cooperate on the portal, headed by the Coastal Administration, and the information is based on updated, quality-assured data supplied by the partners. BarentsWatch will also have its own portal for publishing information for the authorities and the maritime sector, and a further aim is to supply new, specialised services. Priority is given to providing good real-time information.

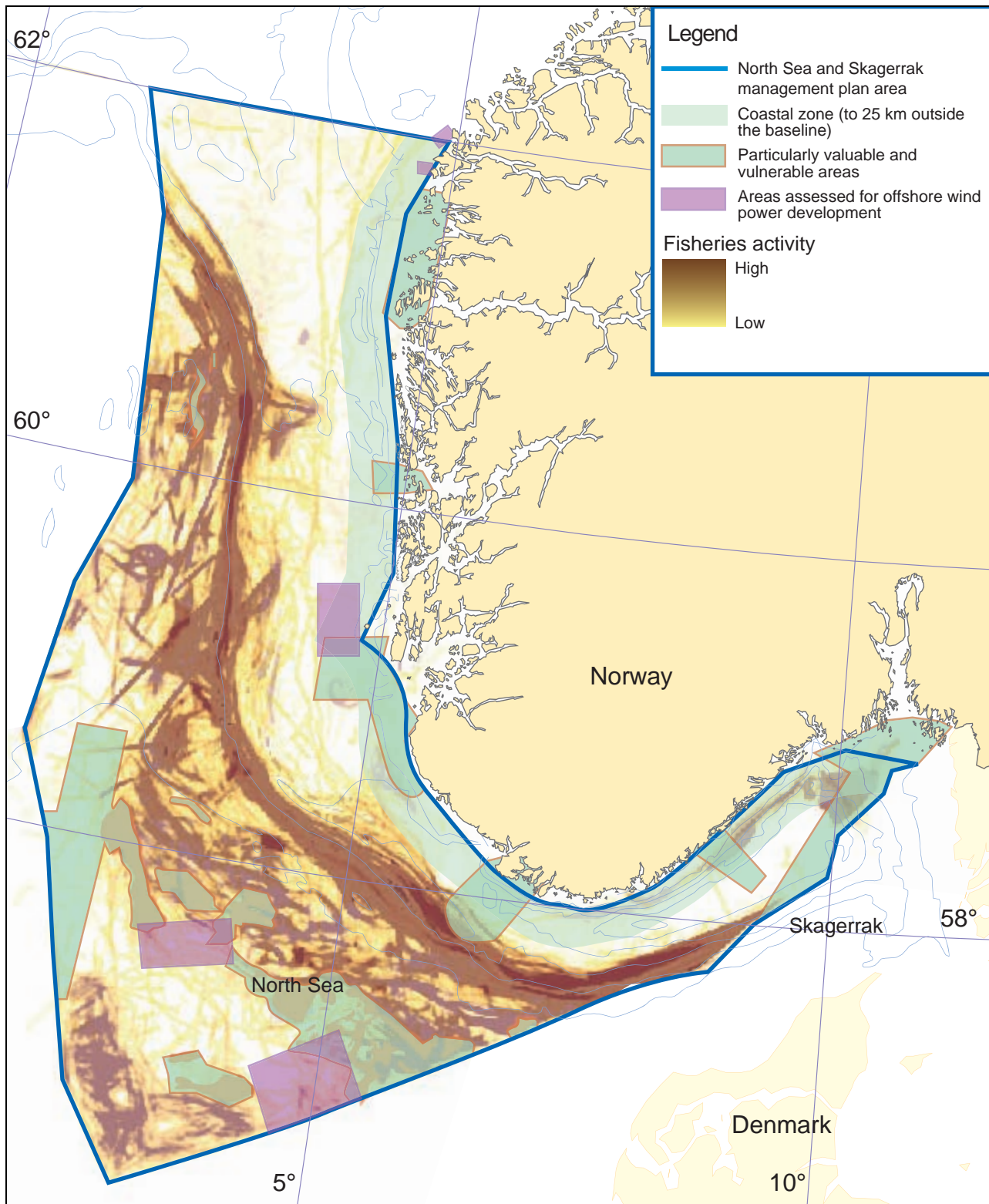


Figure 5.3 Fisheries activities and areas included in the strategic impact assessment for offshore wind power in the North Sea and Skagerrak.

Source: Directorate of Fisheries, Water Resources and Energy Directorate, Directorate for Nature Management, Norwegian Mapping Authority

– The website miljostatus.no is a channel for dissemination of information on the state of the environment and environmental trends, main-

tained by the environmental authorities. The maps module includes maps on a range of topics related to marine and coastal waters, which

supplement articles on various topics and descriptions of indicators. There are map layers on environmental status (for example on coral habitats and vulnerable habitats), activities (aquaculture, maritime transport), fish and crustaceans (mainly indicator species), ocean currents and depths, oil and gas (fields, installations and offshore emissions), marine mammals (indicator species) and energy, including areas that have been assessed for offshore wind power development.

- The website havmiljø.no is a tool for displaying the assessed ecological importance and vulnerability of Norwegian waters. Areas are assessed particularly in terms of their biological productivity, importance for threatened species and/or habitats, and species biodiversity and density. The assessments are based on the most recent data from the monitoring programme for seabirds (SEAPOP), the mapping programme for the seabed (MAREANO) and other national sources, and have high temporal and spatial resolution. There are also map layers showing various aspects of the natural environment, administrative boundaries and human activities. These can be supplemented by other information, for example on the conditions specified in licences for petroleum activities.

These websites are mainly based on databases developed and maintained by a number of different agencies and research institutions such as the Coastal Administration, the Norwegian Mapping Authority, the Norwegian Polar Institute, the Petroleum Directorate, the Climate and Pollution Agency, the Directorate for Nature Management, the Institute of Marine Research, and the Norwegian Institute for Water Research. Altogether these databases and portals provided a very sound basis for work under the management plans. However, additional functionality should be developed to meet the requirements for an interactive digital mapping tool. Moreover, the existing tools do not meet the necessary requirements for uniform, standardised use of symbols and colour schemes or presentation of the spatial management element of the management plans.

5.4.2 Developing a tool for the spatial management element

As mentioned elsewhere in this management plan, maps are widely used to illustrate spatial

information, such as areas where a framework for petroleum activities has been adopted, areas where vulnerable benthic animals are found, and important spawning grounds. Together with the written text and the scientific basis, maps provide a good picture of the topics discussed in this and the other management plans.

However, there are no mapping tools that provide integrated information on all the activities for which the authorities have developed overall frameworks under the management plans. A tool of this kind would provide an overview of the most important spatial frameworks determined in the management plans and would be a useful tool for the authorities, business sector, other users of the sea areas and the general public.

The overview could be supplemented with map layers for the most important industries, resources, species and habitats, and so on. This would provide a flexible system in which map layers for different topics could be overlaid and maps of different parts of the management plan area produced. For example, it should be possible to display up-to-date information on the legal status of any restrictions and guidelines established under the relevant legislation.

The main objective of this tool would be to rationalise the process of updating the management plans. It would provide a better overview of the spatial management decisions and measures implemented under previous plans. It would also help identify the political considerations that should be taken into account in future updates. Furthermore, it would ensure a more inclusive process by increasing transparency, and strengthen stakeholder participation in the work on the plans.

The tool could also be a source of information on the content of and scientific basis for the management plans and on developments in the various sea areas. It should be possible to illustrate activities on the surface, in the water column, and on and beneath the seabed.

To ensure that they are easy to use, all map layers will have to be based on the same background map and use standardised symbols, colours and so on.

The digital mapping tool must be developed within the framework of the work on the management plans and in close cooperation with the authorities responsible for the various portals and databases. It should also be able to serve as a platform for cooperation with other countries on management and maritime spatial planning.

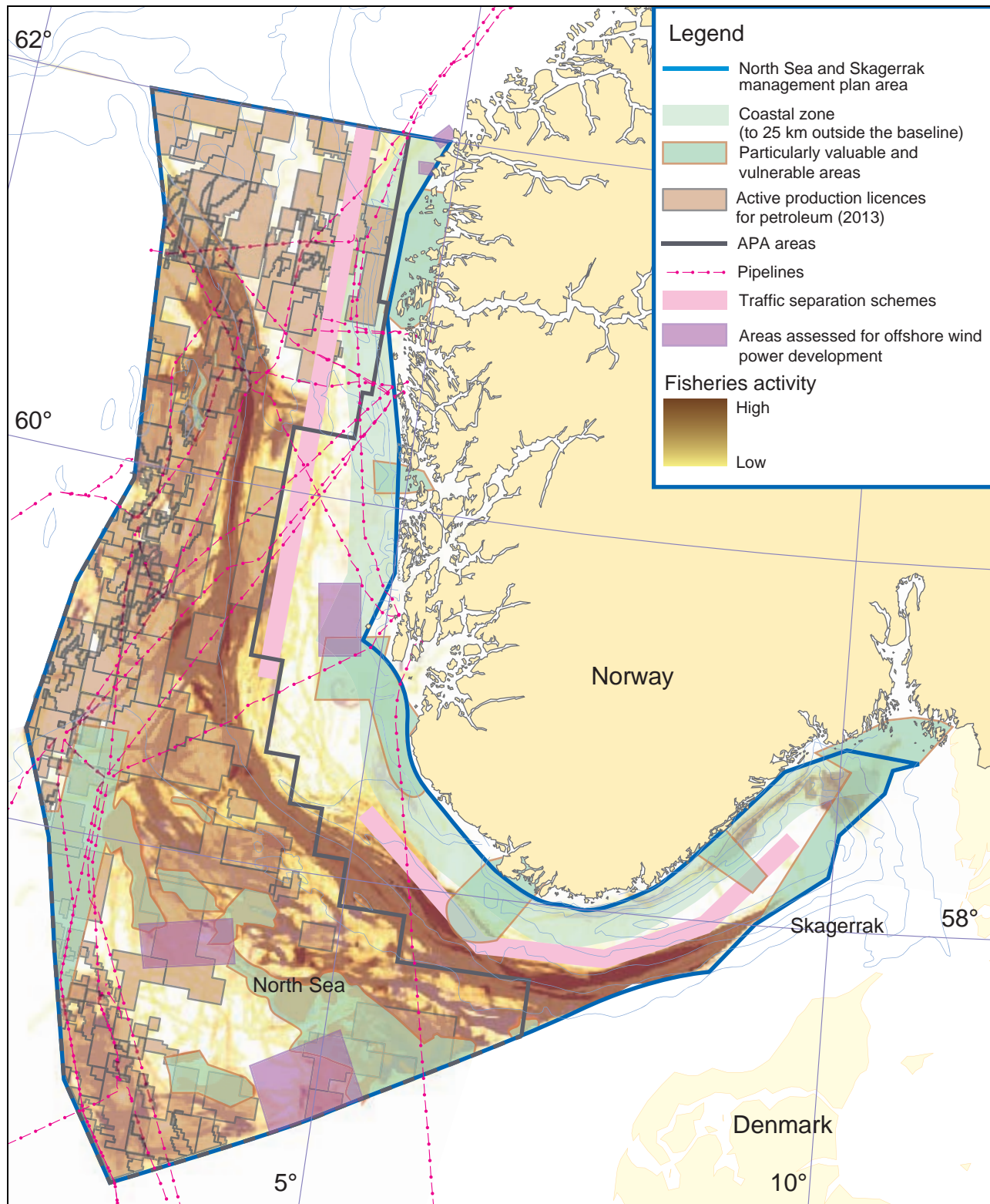


Figure 5.4 Overview of activities in the North Sea and Skagerrak

Source: Petroleum Directorate, Directorate of Fisheries, Directorate for Nature Management, Water Resources and Energy Directorate, Norwegian Coastal Administration, Norwegian Mapping Authority

6 Acute pollution: risk and preparedness and response

Risk is expressed as a combination of the probability of an event occurring as a result of human activity and the consequences of that event, taking uncertainties into account. Risk is not static, but changes over time depending on the activities in an area and factors such as the implementation of measures, training, introduction of new technology and updating of legislation.

Environmental risk expresses the probability of a spill of oil or other environmentally hazardous substances combined with the scale of the expected environmental damage, taking uncertainties into account.

The level of environmental risk can be assessed by considering the probability of a spill, its influence area, the presence and vulnerability of valuable species, habitats, and so on, and whether a spill would have consequences for these. In addition to the probability of a spill occurring, other factors that influence the level of environmental risk are spill size and duration, and the geographical position of a spill in relation to vulnerable areas and resources. Environmental risk often fluctuates during the year, since many species move from one area to another or have an annual cycle during which their vulnerability varies. The probability of an accident may be much the same in two different areas if activity patterns are similar. On the other hand, the level of environmental risk may be very different in the two areas if natural conditions are different. The effectiveness of preventive measures and of preparedness and response to acute pollution are also important factors.

Assessments of environmental consequences are based on knowledge of the species, habitats and ecological goods and services in the management plan area. During the preparation of the management plan, 12 particularly valuable and vulnerable areas were identified in the North Sea and Skagerrak (see Chapter 3.4). The vulnerability of these areas to oil spills is shown in Table 6.1.

Most petroleum activity in the North Sea takes place far from the coast, so that the probability of oil reaching several of the particularly valuable and vulnerable areas closest to the coast after a

spill is low. The coastline is generally vulnerable to landfall of oil from shipping and petroleum activities.

6.1 Shipping

6.1.1 Probability of accidents that could result in acute pollution

There is a larger volume of shipping in the North Sea and Skagerrak than in other Norwegian sea areas, and it is more complex, see Chapter 4.2. Maritime transport projections indicate an increase in distance sailed of 11 % in the North Sea and Skagerrak as a whole from 2009 to 2030. The volume of transport from the Baltic Sea through the Skagerrak is also expected to increase.

Maritime accidents, including groundings, collisions, structural failure and fire or explosion, occur at irregular intervals, and can result in acute pollution. Groundings account for half of all maritime accidents in the North Sea and Skagerrak. In 2011, the Maritime Directorate registered a total of 113 groundings, 21 of which resulted in spills of various sizes. In recent years, three groundings have resulted in significant oil spills in the North Sea and Skagerrak: *MS Server* (2007, about 530 tonnes of oil), *MV Full City* (2009, about 293 tonnes of oil) and *MS Godafoss* (2011, about 112 tonnes of oil). All of these were near-shore accidents that resulted in spills of heavy bunker oil, and the response was organised using governmental resources and headed by the Norwegian Coastal Administration.

An analysis has been made of the probability of acute pollution from shipping in the management plan area. This shows a higher frequency of spills near the coast, with the highest frequency along the coast of Western Norway, roughly between Stavanger and the Sognefjorden. Spills of bunker oil of up to 400 tonnes dominate the picture. On the basis of the situation in 2009, an average of about three incidents a year must be

Table 6.1 Particularly valuable and vulnerable areas and species and habitat types that are vulnerable to acute pollution

Particularly valuable and vulnerable area	Why area is classified as valuable	Vulnerability to oil spills
1. Bremanger–Ytre Sula	Breeding, feeding, moulting, passage and wintering area for seabirds; common seal whelping area	High
2. Korsfjorden	Representative of islands and skerries off Western Norway: wide variation in habitat types, landscapes, geology, history; kelp forests, birds	Less vulnerable than areas 1, 4, 5, 8 and 9
3. Karmøyfeltet bank area	High biological production; spawning grounds for Norwegian spring-spawning herring	Vulnerable, but less so than areas 1, 4, 5, 8 and 9
4. Boknafjorden/Jærstrendene protected landscape	Breeding, feeding, moulting, passage and wintering area for seabirds; whelping ground for seals	High
5. Listastrendene protected landscape	Wide variety of landscape and habitat types; passage and wintering area for seabirds	High
6. Siragrunnen bank area	Spawning grounds for Norwegian spring-spawning herring and retention areas for eggs and larvae; feeding area for birds	Vulnerable, but less so than areas 1, 4, 5, 8 and 9
7. Skagerrak transect	Representative of the Skagerrak. Variety of habitats and landscapes; geologically and historically important; important for kelp and birds	Less vulnerable than areas 1, 4, 5, 8 and 9
8. Outer Oslofjord	Breeding, passage and wintering area for seabirds; world's largest known inshore cold-water coral reef	High
9. Skagerrak	Moulting and wintering area for seabirds	High
10. Sandeel habitat north (Viking Bank)	Habitat and spawning grounds for sandeels and feeding area for whales	Vulnerable, but less so than areas 1, 4, 5, 8 and 9
11. Sandeel habitat south	Habitat and spawning grounds for sandeels and feeding area for whales	Vulnerable, but less so than areas 1, 4, 5, 8 and 9
12. Mackerel spawning grounds	Spawning grounds for mackerel	Vulnerable, but less so than areas 1, 4, 5, 8 and 9

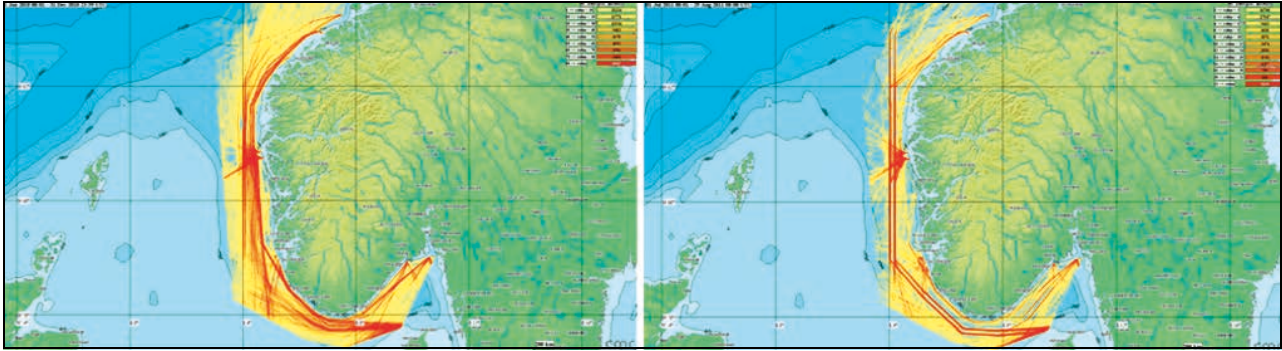


Figure 6.1 Traffic patterns before (left) and after (right) the introduction of the traffic separation schemes

Source: Norwegian Coastal Administration

expected to result in oil spills in the management plan area.

New activities or changes in the level of activity will generally change the risk level and nature of the risks. Unless preventive measures are taken, the frequency of incidents and accidents will be related to the level of activity (total distance sailed).

For 2030, the probability of spills was estimated both with and without the maritime safety measures that have been implemented in the last few years – traffic separation schemes, traffic surveillance and control, and emergency tugboat services. Without these measures, the analysis indicates that the frequency of spills would rise to about four per year as a result of the growing volume of traffic. When preventive measures are included, the analysis indicates that spill frequency will be reduced to about 2.5 per year.

Thus, emergency tugboat services, traffic surveillance and control, and traffic separation schemes are effective measures that substantially reduce the probability of acute pollution from shipping along the mainland coast. With these measures in place, the proportion of groundings that result in spills is expected to be 81 % lower than it would be without them.

6.1.2 Preventive measures

Preventive measures are very important for avoiding loss of human life and material assets, and for protecting society and the environment from pollution. Key maritime safety measures include standards for vessel construction, equipment and operation; crew qualifications; control of vessels; traffic regulation; and maritime infrastructure and services.

A number of steps have been taken to improve maritime safety in recent years. From 1 June 2011, new traffic separation schemes and recommended routes were introduced off Western and Southern Norway after approval by the International Maritime Organization (IMO). Similar routing measures have already been introduced between Vardø and Røst, and there is now a continuous system along the whole Norwegian coast. The routing measures in the North Sea and Skagerrak consist of eight traffic separation schemes and seven recommended routes. They apply to all oil and chemical tankers carrying harmful liquid substances in bulk and to other vessels of gross tonnage 5000 or more that are in transit along the Norwegian coast or in international traffic to or from a Norwegian port.

The routing measures reinforce the effects of other maritime safety and oil spill preparedness and response measures. Moving traffic further out from the coast ensures that there is more time to deal with a drifting ship or an oil spill that is heading towards land. There is more time to alert response personnel and others, and more opportunity to deploy tugboats and or oil spill response equipment.

The emergency tugboat services in Norway are in principle based on the availability of private actors. However, in North Norway there is also a government emergency tugboat service that uses three hired tugboats. In 2010, this system was extended to Southern Norway, where one vessel operates along the stretch of coastline between Risør and Egersund on a state contract. In 2011, the system was further strengthened by one vessel in Western Norway, which operates between Fedje and Kristiansund. This model is being continued in 2013. The tugboats can be deployed rapidly to assist ships that are drifting out of control

and prevent grounding and the risk of acute pollution. If necessary, they can also tow ships to a port or port of refuge where they can receive further assistance.

A process has now been started to establish a long-term model for a national emergency tugboat service along the whole Norwegian coast.

Monitoring of maritime traffic in Norwegian waters has also been strengthened. The Vardø VTS Centre was established in 2007. It monitors all tankers and other high-risk traffic along the entire Norwegian coast, and also monitors compliance with the rules for the traffic separation schemes and recommended routes off the coast. If a vessel deviates from the system or from normal sailing patterns, the VTS Centre calls up the vessel, guides it onto the right route, and if necessary summons assistance from the government emergency tugboat services or others. In addition, the Horten, Kvitsøy and Fedje VTS Centres monitor shipping in the parts of the management plan area where is heaviest and the risk of accidents is highest. New satellite-based systems and other developments are providing a better overview of maritime traffic, and a new surveillance aircraft is being used to identify and monitor oil spills.

6.1.3 Consequence assessment: acute pollution from shipping

Experience of spills

Immediately after the oil spills from *MS Server* (2007), *MV Full City* (2009) and *MS Godafoss* (2011), all of which occurred close to the coastline within the management plan area, environmental studies were started to gain an overview of environmental damage and consequences, and document the effects of the steps taken to limit the damage. These showed that the consequences were greatest for species and habitats associated with the water surface, the upper part of the water column and the shore zone. In these three cases, the consequences were more severe for seabirds than for other ecosystem components, but not so severe that they threatened populations of these species in the affected areas. The estimates of the numbers of seabirds killed are considered to be uncertain. The effects on fish and shellfish were minor in all three cases. Large-scale shoreline-cleaning operations were initiated, and these had a direct effect on the scale of the damage and on the recovery period in the shore zone. Studies show that the flora and fauna in the shore zone



Figure 6.2 *MS Godafoss* aground off Frederikstad, in Ytre Hvaler national park.

Photo: Copyright Norwegian Coastal Administration

had recovered well after two years. The general conclusion was that no significant long-term effects or consequences at population level were documented for the species affected by these oil spills, and the results indicate that the species and habitats in the areas affected largely recovered within only a few years. However, the three spills were all of moderate size, and the consequences of a large spill could be more serious.

Simulated spills from maritime accidents and potential environmental consequences

As part of the scientific basis for the management plan for the North Sea and Skagerrak, three maritime accident scenarios were chosen and simulations of the resulting oil spills were run. The simulated spills are considerably larger than those that have actually occurred in the management plan area, and the effects of measures to reduce the spread of oil and its adverse impacts (preparedness and response measures) were not taken into account in the simulations. Large-scale spills were chosen for the scenarios both because the possibility of such incidents cannot be excluded and because it is important to form a picture of the potential consequences of major spills. The simulated incidents were chosen on the basis of two criteria: knowledge of where and when oil spills are likely to occur, and knowledge of where there are vulnerable species and habitats. The selected incidents give an idea of the kind of spills that could occur, but the size of the spills is not representative of incidents that are likely to occur in the management plan area.

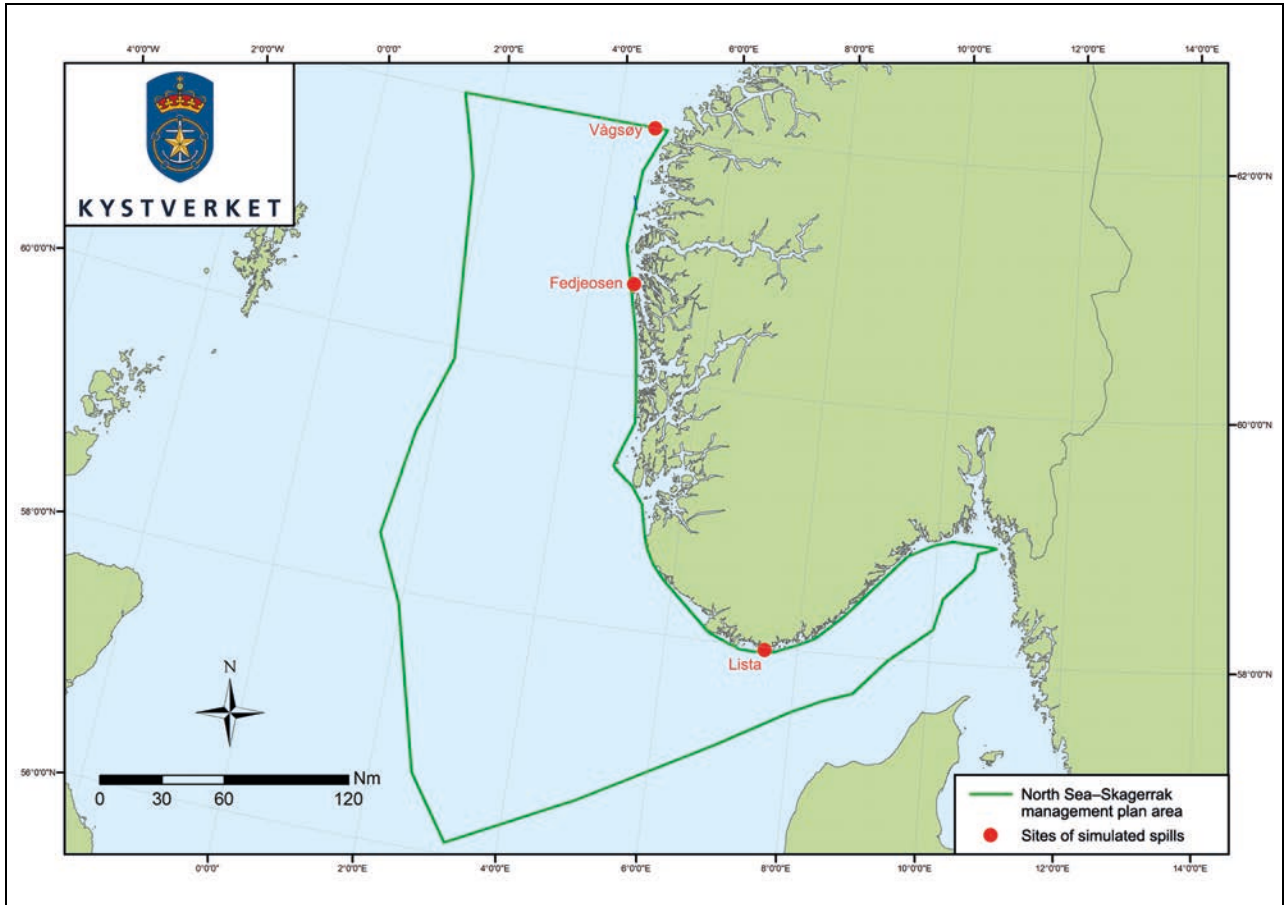


Figure 6.3 Geographical location of the three simulated incidents

Source: Norwegian Coastal Administration

The sites for the three simulated incidents were Lista (10 January), Fedjeosen (25 May) and Vågsøy (11 March), and they involved spills of 2 700 tonnes bunker oil and 100 m³ marine diesel, 27 000 tonnes crude oil and 500 m³ bunker oil, and 120 000 tonnes crude oil respectively. The Vågsøy accident is a worst-case scenario, with a very large spill of long duration. Even accidents involving large oil tankers very rarely result in spills of this order of magnitude. Such large-scale spills are very rare, and there has never been an oil spill of anything like this size in Norway. The size of the simulated spill is also much larger than that used by the Norwegian Coastal Administration in designing the capability of the governmental oil spill response system.

The simulations show that the Vågsøy scenario would result in the surface spread of oil over a large area both north and south of the discharge point, and in landfall of oil as far north as Sør-Trøndelag. A spill on this scale in spring could have impacts on herring larvae, which drift with the coastal current at this time of year. It could also affect a large proportion of the overall breed-

ing populations of pelagic diving and surface-feeding birds in the North Sea and Skagerrak, and more local populations of coastal diving and surface-feeding birds. It could have serious consequences for all these ecological groups.

The consequences of spills modelled off Lista and Fedjeosen could be serious for local seabird populations, but are not expected to be serious for overall breeding populations of seabirds in the management plan area. The simulations also indicated that the spills are not expected to have any noticeable consequences for fish/fish larvae or marine mammals.

6.1.4 Environmental risk assessment of maritime transport

The environmental risk to ecosystem components such as seabirds, marine mammals, fish and coastal waters/the shore zone is assessed on the basis of the probability that an oil spill will occur and that it will affect vulnerable ecosystem components. The concentration of vulnerable species and habitats varies from one part of the coast to

another, resulting in variations in vulnerability, but as a general rule vulnerability is considered to be highest in spring and summer. The pattern of risk can be partly explained by looking at the probability of spills and their potential size, and partly by the distribution of vulnerable resources and the consequences a particular type of spill is expected to have.

A report from the Norwegian Coastal Administration presents calculations of the environmental risk associated with acute oil pollution from shipping along the coast of mainland Norway in 2008 and projections for 2025. The report shows that for seabirds, shoreline habitats and fish, the calculated level of environmental risk is higher in the North Sea and Skagerrak than in other Norwegian sea areas. The potential consequences are generally more serious in northern waters. However, maritime traffic is much heavier further south, which means that the probability of spills is higher, and the calculated environmental risk is also higher. In the coastal waters of the Skagerrak, Swedish and Danish shipping also makes a substantial contribution to the risk level. Moreover, there is heavy tanker traffic along the Danish coast, and calculations of drift trajectories show a substantial probability that a spill here could reach Norwegian coastal waters. However, because of the long drift time, the oil would have time to weather, and this would reduce any environmental consequences in Norwegian waters and along the shoreline.

Experience of actual spills from ships shows that species and habitats associated with the sea surface, the upper part of the water column and the shore zone are most seriously affected. Seabirds are particularly vulnerable, but in cases where spills have actually occurred, the consequences for seabirds have nevertheless been assessed as minor. The simulations that have been run show that very large spills could have serious consequences for seabirds and in the worst case also affect fish eggs and larvae. However, such spills are extremely unlikely to occur.

Particularly valuable and vulnerable areas

The whole management plan area is open to shipping, including the particularly valuable and vulnerable areas, many of which lie near the coastline. The calculated frequency of spills from shipping is higher in near-coastal areas, but fairly evenly distributed along the coast. Thus, the probability of a spill will be highest, and the potential environmental consequences of a spill most seri-

ous, in the particularly valuable and vulnerable areas near the coast. The probability of a spill has been assessed as highest in the following particularly valuable and vulnerable areas: Outer Oslofjord, Boknafjorden/Jærstrendene protected landscape, Karmøyfeltet bank area and Bremanger–Ytre Sula. The potential environmental consequences will depend on the size and type of spill, and when and where it occurs, since the distribution and presence of different ecosystem components and their vulnerability to oil varies from one time of year to another. The environmental consequences of oil spills are often greatest for seabirds. Preventive measures such as emergency tugboat services, routeing measures including traffic separation schemes, and VTS centres help to reduce the probability of spills along the whole Norwegian coast. Oil spill preparedness and response measures reduce the environmental consequences when a spill has occurred.

6.2 Petroleum activities

6.2.1 Risk of accidents that could result in acute pollution

Petroleum activity is higher in the North Sea than in other parts of the Norwegian continental shelf. However, collation of data on acute pollution incidents involving the petroleum industry on the Norwegian continental shelf with various activity indicators shows that there is no direct linear relationship between activity level and the number or size of spills. The influence of activity level on the level of risk should therefore not be overestimated.

The Petroleum Safety Authority Norway runs a project to survey trends in the risk of acute discharges from petroleum operations. The annual reports provide information on trends in risk level for the Norwegian continental shelf as a whole and for each sea area separately. They show that both the number of crude oil spills from petroleum activities and the number of near misses that could have led to spills on the Norwegian continental shelf have been greatly reduced in the period 2001–11.

In the North Sea there has been a marked reduction in the number of crude oil spills per year and per installation-year for the period 2001–11 as a whole, see Figure 6.4. The quantities of oil released to the sea as a result of these incidents vary widely. A few large spills account for most of the volume of oil in oil spills over the period. Most

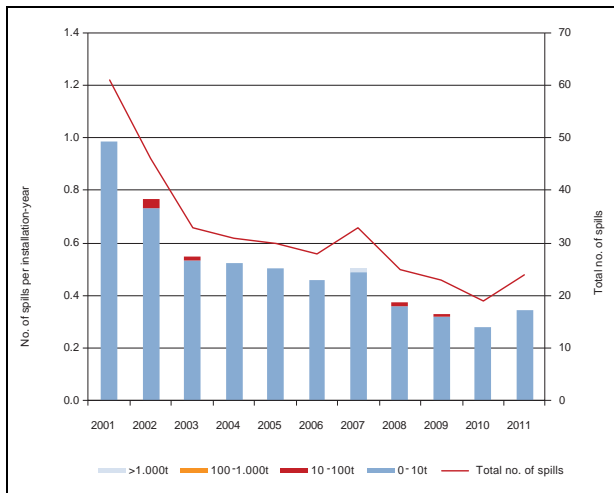


Figure 6.4 Number of crude oil spills in the North Sea in the period 2001–11, total and per installation-year.

Source: Petroleum Safety Authority Norway

spills are small, less than 10 tonnes, while the two largest were 3 700 tonnes (Statfjord A, 2007) and 80 tonnes (Statfjord C, 2009).

The number of near misses (incidents that could have led to oil spills), and the severity of the spills that could have resulted from them, have also been declining in the North Sea in the latter part of the same period. The effectiveness of barriers intended to prevent near misses from developing into major accidents is considered to be stable and high for the Norwegian shelf as a whole. Historical data on spills must be considered in conjunction with other relevant information on safety performance before it is possible to draw any conclusions on the risk of accidents in connection with petroleum activities in the North Sea and Skagerrak.

Many factors acting alone or in combination determine whether an oil spill occurs and how much oil is released. These factors are constantly changing.

In the period up to 2030, the accident risk is considered to be more closely related to the continuation of existing petroleum activities than to any future field developments. However, new elements and changes in the pattern of petroleum activities may alter the nature and level of risk. For example, there are fixed installations on many of the existing North Sea fields, whereas much greater use is being made of subsea installations with pipelines to existing installations in new field developments. In future there may be further changes, for instance greater use of unmanned

solutions and subsea installations that include processing and separation systems.

The surveys of trends in risk level (both the general surveys and surveys of the risk of acute discharges) should be continued in order to provide a better overview of the situation and to put the industry in a better position to take action in the event of a negative trend.

6.2.2 Preventive measures

The objective is to maintain a low risk level and make continuous efforts to reduce it. The risk level in the North Sea is influenced by the large number of installations in operation and the fact that some of them are ageing and have reached the end of their original design life. Nevertheless, the risk of accidents is not considered to be particularly high in the North Sea.

Key preventive (risk reduction) measures in the petroleum industry are:

- assigning clear responsibilities to operators and licensees, together with responsibility for ensuring that any subcontractors also comply with the rules;
- a properly functioning health, safety and environment (HSE) system that takes into account the risks associated with specific activities;
- a risk-based inspection and enforcement system, based among other things on annual risk reports;
- properly functioning tripartite cooperation on safety and legislative developments;
- the requirement to make continual efforts to improve safety.

The risk-based HSE legislation is an essential framework for the industry's efforts to prevent accidents. The rules require companies to make a thorough review of all relevant risks and ensure that the number and type of barriers are adapted to the risks associated with each activity. The legislation also requires health, safety and environmental risks to be considered both separately and together. This ensures that systems for preventing acute pollution and the oil pollution emergency response system are adapted to the characteristics and location of an activity. Under the regulations, characteristic features of different parts of the management plan area also have to be taken into account in risk management, for example stricter requirements can be imposed in vulnerable areas. Strict regulation and an effective inspection and enforcement system for petroleum activi-

ties are important in preventing oil spills and minimising their impact.

The HSE legislation does not generally specify particular solutions, but sets out functional requirements, leaving each actor responsible for developing or using solutions that ensure satisfactory safety levels. The overall goal is to employ solutions to meet the functional requirements that are adapted to the specific risks in each case. A key principle for the oil and gas industry is that it must not be possible for one isolated fault or error to result in an accident. This means that more than one barrier must be used to reduce the probability of escalation as a result of an error, hazard

or accident, and to limit the damage and nuisance that may result from such situations.

Risk management is necessary at all stages, from planning to decommissioning, and requires actors to analyse their own activities in detail and to update the analyses if the assumptions on which they are based change. The legislation reflects experience gained from petroleum industry accidents in Norway and abroad, so that it constitutes a sound basis for responsible operations. A white paper on working life in Norway includes an account of the HSE situation in the petroleum sector (Meld. St. 29 (2010–2011) *Felles ansvar for eit godt og anstendig arbeidsliv*).

Box 6.1 Key risk factors

Table 6.2 Key factors influencing the risk of oil spills from petroleum operations: status and changes in the period 2001–10

Key factors	Status and changes 2001–10
Factors specific to particular areas, for example weather conditions, reservoir conditions, water depth, danger of slides or earthquakes, shipping	<p>Weather conditions in the North Sea are well documented.</p> <p>Reservoir conditions in the North Sea are well documented.</p> <p>On some fields, new installations have been planned and approved that take into account the possibility of seabed subsidence.</p> <p>The North Sea is considered to be a far more complex shipping area than other parts of the Norwegian continental shelf (the Norwegian Sea and the Barents Sea–Lofoten area). Most of the North Sea and Skagerrak is not specifically regulated, for example for petroleum activities, and is heavily used by shipping. The VTS centres now monitor a number of oil and gas fields to reduce the risk of collisions.</p> <p>There is a trend towards the use of larger supply vessels with a bulbous bow.</p>
Factors specific to particular activities, for example installation type, technical solution, maintenance, activity level, and the operations carried out on a specific installation, the actors involved, how the activities are organised	<p>A number of the fields and installations in the North Sea are ageing.</p> <p>A focus on well integrity is needed for both old and new wells.</p> <p>Several new methods of operation are being used for existing fields and installations.</p> <p>A great deal of modification has been carried out on existing fields and installations to enhance oil recovery and link up installations to new small fields nearby.</p> <p>Acute discharges in connection with injection of drill cuttings have increased considerably.</p>
Factors that affect the industry as a whole, for example economic fluctuations, the legislative and other framework determined by the authorities, the actors involved, activity level in the industry	<p>The activity level on the Norwegian shelf has been high, and there have been major changes in the actors involved and substantial economic fluctuations. These factors may influence capacity, expertise and priorities, and could have a negative influence on risk trends.</p>

Box 6.1 continues

Table 6.3 Key factors that influence the risk of oil spills in connection with petroleum activities: projected changes up to 2030

Key factors	Projected changes up to 2030
<p>Factors specific to particular areas, for example weather conditions, reservoir conditions, water depth, bottom conditions, danger of slides or earthquakes, shipping</p>	<p>A certain rise in temperature and precipitation is expected, which may result in somewhat more frequent and more severe extreme weather events.</p> <p>Reservoir pressure is expected to drop during production from a field. The discovery of new fields with higher reservoir pressure or different reservoir characteristics or sizes is not considered to be particularly likely. However, problems associated with sand and water production may increase on mature fields.</p> <p>Seabed subsidence is expected to continue to be a relevant risk factor, especially in the southern part of the North Sea.</p> <p>Shipping volumes are expected to increase.</p> <p>The trend towards larger supply vessels equipped with a bulbous bow is expected to continue.</p> <p>Maritime safety measures (monitoring, regulation of traffic) can compensate for the negative effects of growing shipping volumes.</p>
<p>Factors specific to particular activities, for example installation type, technical solution, maintenance, activity level, and the operations carried out on a specific installation, the actors involved, how the activities are organised</p>	<p>Knowledge gained during continued activities in the area and implementation of the integrated ecosystem-based management plan are expected to reduce uncertainty regarding activity-specific factors and increase the industry's expertise in accident prevention.</p> <p>There will be more ageing fields and installations. It is expected that some of the existing fields will be shut down and installations decommissioned, while the life of other fields and installations will be extended. Some fields that have been shut down may be re-opened.</p> <p>Increasing use of new methods of operation is expected on both existing and new installations.</p> <p>It is expected that a number of smaller fields will be developed using subsea solutions and linked to existing infrastructure. More use of standardised fast-track solutions is also expected.</p> <p>More use of new concepts using smaller and simpler types of installations is also expected.</p> <p>Problems related to the maintenance of ageing installations are expected to increase.</p> <p>Changes are expected in the way activities are organised, for example in connection with new methods of operation, major fusions, early-retirement incentives or the introduction of a system of rotating maintenance teams on installations.</p>
<p>Factors that affect the industry as a whole, for example economic fluctuations, the legislative and other framework determined by the authorities, the actors involved, activity level in the industry</p>	<p>The high level of activity on the Norwegian shelf is expected to continue in the years ahead. This means that limited capacity and expertise will continue to be relevant risk factors.</p> <p>Continued changes in the actors involved and further economic fluctuations can be expected. Knowledge development concerning factors that affect the industry as a whole should reduce uncertainty in managing these factors.</p> <p>The legislative and other framework for the industry is expected to be further developed and implemented as technology and know-how are developed and the authorities acquire more expertise on integrated, ecosystem-based risk management across sectors.</p> <p>It is uncertain whether changes in the framework set by the authorities will be pushed through by international actors in response to the Deepwater Horizon accident, and what influence this will have on risk management by the industry.</p>

Box 6.2 Follow-up of the Deepwater Horizon accident

After the Deepwater Horizon accident in the Gulf of Mexico, various projects have been started to develop more effective ways of halting or diverting a wellstream as quickly as possible in the event of a blowout. R&D activities have also been started or carried out on improving understanding of risk, better adaptation of technology to a number of factors that influence risk level, planning and monitoring of operations, earlier detection of operational deviations, more rapid and effective intervention, better access to essential information, and so on. Moreover, R&D has reduced the level of uncertainty for a number of factors that influence risk level. There has also been a focus on developing technology for drilling and well control, process technology, sensors, materials, and information and communication solutions to deal with safety challenges associated with different phases, reservoirs and areas.

Principles and measures include the following:

- Updating of drilling standards to incorporate lessons learned from the Deepwater Horizon accident and further improvements in drilling operations on the Norwegian continental shelf.
- An important and well-established principle for drilling on the Norwegian shelf is that there must always be two independent, tested well barriers, and that these must be monitored.
- Improvements in drilling technology and real-time monitoring of well barriers, which reduce the risk of spills.

- Use of new technology to make vertical seismic profile (VSP) surveys, which provide better information from below the drill bit.
- Assessment of internal verification processes and well management systems.
- Establishment of plans for well plugging and halting a blowout.
- Making sure that the right kind of expertise is available in each case.
- Development of new capping stack technology that can halt a blowout much more rapidly than has been possible until now. Since March 2013, the first capping stack has been available in Norway, one of only four systems in the world using the new technology. It will be based in Bodø.

However, reports, analyses and the follow-up and reviews by the Petroleum Safety Authority Norway in the wake of the Deepwater Horizon accident show that improvements and further developments are still needed in a number of areas. These include risk management processes, risk communication, management of change, maintenance, competence, capacity, safety management and learning from accidents. There is also a need to improve technology and operating conditions relating to loading of oil, the detection of leaks in subsea facilities, slip joints, flexible risers and injection of drill cuttings. In addition, there is a need for improvements in the overall management of well barriers, well barrier monitoring and well integrity in temporarily abandoned wells.

Some key measures have been identified that will reduce the level of risk further.

Measures to be carried out by companies:

- Development of an integrated approach to accident risk, including better identification and management of conflicts between goals relating to the environment, safety, working environment and value creation.
- Close cooperation between actors in the petroleum industry, for example joint industry projects and standardisation.

Measures to be carried out under the auspices of the authorities:

- Further development of the framework for petroleum activities, including legislation, allocation criteria when new areas are opened and conditions in production licences based on an HSE approach.
- Continued improvement of the surveys and monitoring of trends in the risk of acute discharges from petroleum activities.
- Promotion of the development of technology and expertise to improve integration of HSE considerations and the evaluation and communication of accident prevention methods.

6.2.3 Consequence assessment and environmental risk assessment: spills in selected oil-producing areas of the North Sea

A spill can in principle originate from any petroleum installation in the management plan area that is in contact with hydrocarbon-bearing formations, and that stores or transports hydrocarbons or large quantities of chemicals. There is widespread drilling activity in the North Sea and a large number of fields on stream in different phases of their production lifetime. This results in very wide variations in the types of incident that could occur, where they might occur and the probability of spills.

As part of the scientific basis for the management plan, oil spills from five discharge points in the North Sea have been modelled. The discharge points are in the Tampen, Troll-Oseberg, Heimdal, Sleipner and Ekofisk areas, see Figure 6.5. The discharge points were selected by the Norwegian Petroleum Directorate and according to expert assessments are representative of activities in the North Sea.

Representative oil types and blowout rates/durations were selected for the five discharge points, based on data from existing fields in the same areas. Large numbers of simulations (almost 2 700) were run for each discharge point, using four different spill rates (range 1 248–6 346 tonnes per day) and four different durations (2, 5, 15 and 38–67 days). The number of simulations run for these variables was large enough to cover the range of weather conditions throughout the year. For each discharge point, it was also assumed that a spill could occur either on the seabed or at the surface. The modelling results show the geographical spread of a spill from one of the five discharge points and the probability of a spill reaching a particular area.

The results of the oil drift modelling were used as a basis for calculating the probability that a spill would have consequences for seabirds, marine mammals, the shoreline and fish in areas that might be contaminated by a spill. In a consequence assessment, it is assumed that a spill does occur, and data from oil drift modelling are used to calculate various factors, including geographical overlap between oil and the distribution of various species (seabirds, marine mammals, fish and plankton) and between oil and shoreline habitats, and to assess damage and mortality and how long populations will take to recover. The effects of measures to reduce the consequences of spills (oil

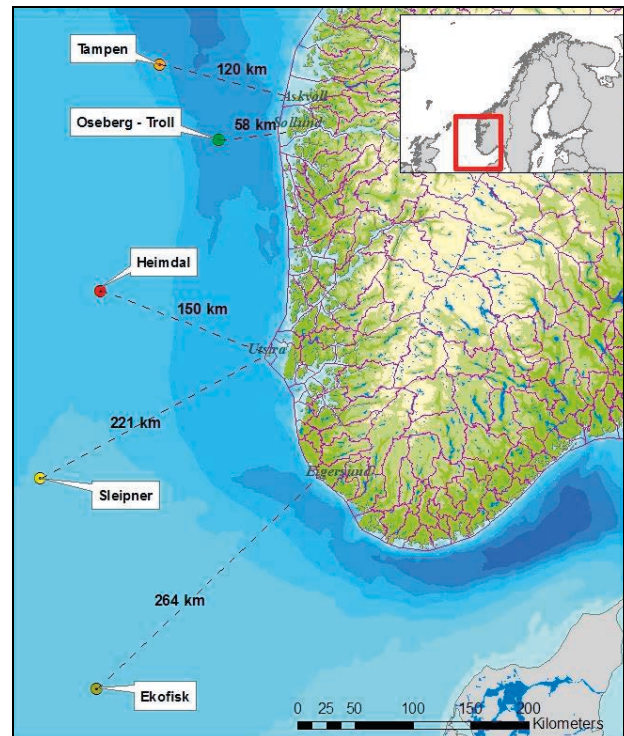


Figure 6.5 The discharge points used for simulation of oil spills

Source: Norwegian Petroleum Directorate

preparedness and response) are not taken into account. In these assessments, pre-defined categories were used for the environmental consequences, which were population mortality and recovery time. For recovery time, the categories were *serious* (> 10 years), *substantial* (3–10 years), *moderate* (1–3 years), *minor* (< 1 year) and *none*. The recovery time is the time from the occurrence of the spill to the point when the situation is the same as before the spill.

Of the five areas, Troll–Oseberg is the closest to land, and a spill from the discharge point here is therefore most likely to lead to beaching of oil (landfall), with consequences for shoreline habitats and seabirds in near-shore areas. Landfall could occur along much of the coast of Western Norway and as far north as Sør-Trøndelag, because the current patterns in the area are such that oil could drift both southwards and northwards. The area that might be affected is important for a wide range of seabird species, and there are many breeding colonies. The calculations show that the most vulnerable species are shag in near-shore areas and little auk in the open sea, and that mortality is likely to be highest in winter. The environmental consequences of an oil spill for seabirds were generally calculated to be minor or moderate (recovery time up to 3 years), but there

was also a small probability of substantial consequences (recovery time 3–10 years). Modelling of oil in the water column showed that oil concentrations after a blow-out in this area would be limited because the oil would spread widely, lowering the concentrations in the water column and the probability of effects on fish and other aquatic organisms.

A blow-out in the Ekofisk area is not very likely to result in landfall of oil because of the distance from land, and would mainly affect seabirds in a limited area of open sea and fish and other aquatic organisms. There are spawning grounds for several fish species in the area, so that the possible consequences of a spill would depend heavily on the time of year. The shallow water in this area and the presence of sandbanks also mean that the oil could contaminate the seabed and affect the benthic fauna and sandeels.

Oil on the sea surface after a blow-out in the Sleipner or Heimdal area would spread widely in an easterly direction, and could also result in landfall of oil along the Danish coast. The probability of consequences for marine mammals is highest in the event of a blow-out in the Sleipner area, since there is a possibility of landfall along the coast of Rogaland, including the Tjør islands, which are a whelping site for grey seal, and important whelping sites for both grey and common seal in the Jæren area.

According to the calculations, the potential consequences of a blow-out would generally be smaller in 2030 than in 2010, because changes in pressure conditions in the reservoirs mean that there will be a lower probability of the highest blow-out rates and longest spill durations.

The oil drift simulations show that the area of the water column affected by a spill from any of the five discharge points chosen in the North Sea would be relatively small, and that the influence area of an oil spill would only overlap to a correspondingly limited degree with fish spawning grounds. As a general rule, the scenarios that have been analysed indicate only a low risk of losses of eggs and larvae from spawning stocks in the North Sea on a scale that would affect recruitment to a year class. Effects in the water column are also strongly dependent on the oil type and wind and current conditions, which determine patterns of dilution and spread. The potential consequences also depend on the proportion of eggs and larvae that are concentrated in limited areas of the spawning grounds. If only parts of the spawning grounds are used each year, the dam-

age potential will be higher in years when spawning takes place near oil installations.

A blow-out in the Heimdal area would result in an influence area in the water column overlapping with spawning grounds for the largest number of species (saithe, haddock, whiting and Norway pout), while corresponding influence areas for Sleipner and Ekofisk are inside the spawning grounds used by mackerel. None of the areas overlaps directly with the areas defined as sandeel habitat, but both Sleipner and Ekofisk are close to these areas.

The results show that the discharge point for a blow-out, particularly whether or not it is close to and could affect vulnerable species and habitats, plays a major role in determining the potential consequences, and is more important than spill rate or duration.

Environmental risk assessment

The consequence assessments described above are based on the assumption that an oil spill has occurred. To assess the environmental risk associated with a spill, the probability of a spill must also be taken into account. Calculations of environmental risk combine the frequency (probability) of events with the probability of damage if a spill does occur. The blow-out frequencies used have been calculated partly on the basis of historical data, using Norwegian and international data for a number of years up to 2010. It is normal industry practice to use frequency data for specific activities in environmental risk assessments, but this may not give an accurate picture of the probability and environmental consequences of an incident in a large area where many different types of activities are in progress at the same time, and it does not take into account other factors that may influence probability (see Chapter 6.1.2).

The environmental risk associated with activities in the five areas analysed was calculated to be highest for Troll-Oseberg, as a result of the combination of the potential consequences and a higher probability of a blow-out than in the other areas. Seabirds in near-shore areas (shags) account for much of the risk, and the overall risk level is about 0.85 % per year (cumulative risk of environmental consequences with a recovery time exceeding one year), or 8.5 incidents per 1000 years of activity. The calculations also show that in most cases, the recovery time would be three years or less.

The risk of consequences is considerably lower for marine mammals and the shoreline than for seabirds.

For the five areas used in the consequence assessments, it was generally found that the environmental consequences of an oil spill would be most serious for seabirds in the open sea. Both the potential environmental consequences and the environmental risk are greater in the northern part of the management plan area because petroleum activities take place closer to the coast.

Results for the particularly valuable and vulnerable areas

Apart from those in the northern part of the management plan area, the North Sea oil and gas fields are relatively far from land, whereas many of the particularly valuable and vulnerable areas are close to the coast. This is reflected in the results of the consequence and environmental risk assessments. For four of the five areas considered (Tampen, Sleipner, Heimdal and Ekofisk), there is only a limited probability that an oil spill would affect coastal areas and the particularly valuable and vulnerable areas along the coast. Troll-Oseberg is closer to land, and there is a much higher probability that an oil spill here would result in landfall of oil. The probability of a spill affecting a particularly valuable and vulnerable area along the coast is also highest here (up to 35 % probability of oil reaching Bremanger–Ytre Sula). This shows that the location of a spill is important in determining its environmental consequences. An oil spill from the Tampen or Troll-Oseberg area could spread as far as Sør-Trøndelag in the coastal and other ocean currents, and could therefore affect particularly valuable and vulnerable areas in the Norwegian Sea.

The Sleipner and Ekofisk areas are close to one of the particularly valuable and vulnerable areas, «sandeel habitat south», and a spill from these fields could result in pollution of the water column in parts of the sandeel habitat. Oil drift modelling shows the highest concentrations of oil in the upper layers of the water column. Simulations also show that after a blow-out from either of these discharge points, a substantial proportion of the oil could sink to the bottom and contaminate the seabed. This could particularly affect sandeels, which are highly stationary and spend much of the year burrowing in the sand. The influence area (in the water column) of a spill from the Sleipner area would also overlap with another par-

ticularly valuable and vulnerable area, mackerel spawning grounds.

6.2.4 Assessment of the environmental consequences of acute pollution elsewhere in the North Sea

Most of the North Sea has been opened for oil and gas activities, and there is activity much closer to the coastal zone and the particularly valuable and vulnerable areas than the areas that were selected for the consequence assessments.

Acute pollution near the coast or the particularly valuable and vulnerable areas could have serious environmental consequences. Most of the particularly valuable and vulnerable areas lie along the coast, and Table 6.1 shows that all of them are either vulnerable or highly vulnerable to oil pollution. The shoreline is generally vulnerable to landfall of oil pollution from shipping or the petroleum sector.

It is important to minimise environmental risk through preventive measures, comprehensive emergency planning and robust preparedness and response systems. However, current technology does not make it possible to prevent damage from an oil spill under all circumstances. If there is a spill from activities close to land, there is little time to deal with an oil slick on the sea before it makes landfall. Activities near the coast could have serious environmental consequences in the event of a spill. The emergency preparedness and response requirements are therefore more stringent for near-coast activities than for those further out to sea.

6.3 Acute pollution from other sources

6.3.1 Nuclear facilities

The most important potential sources of acute radioactive pollution in the North Sea and Skagerrak are an accident or an accidental discharge from a nuclear power plant or a nuclear fuel reprocessing plant, or an accident involving a ship carrying spent nuclear fuel or a nuclear-powered vessel. However, the probability of such accidents is considered to be low.

Several of the North Sea countries use nuclear power to meet part of their energy needs. An accident at a nuclear facility, for instance a power plant or reprocessing plant, could result in substantial releases of radioactivity to the atmosphere and the sea. A number of nuclear power plants currently in operation release radioactivity directly or indi-

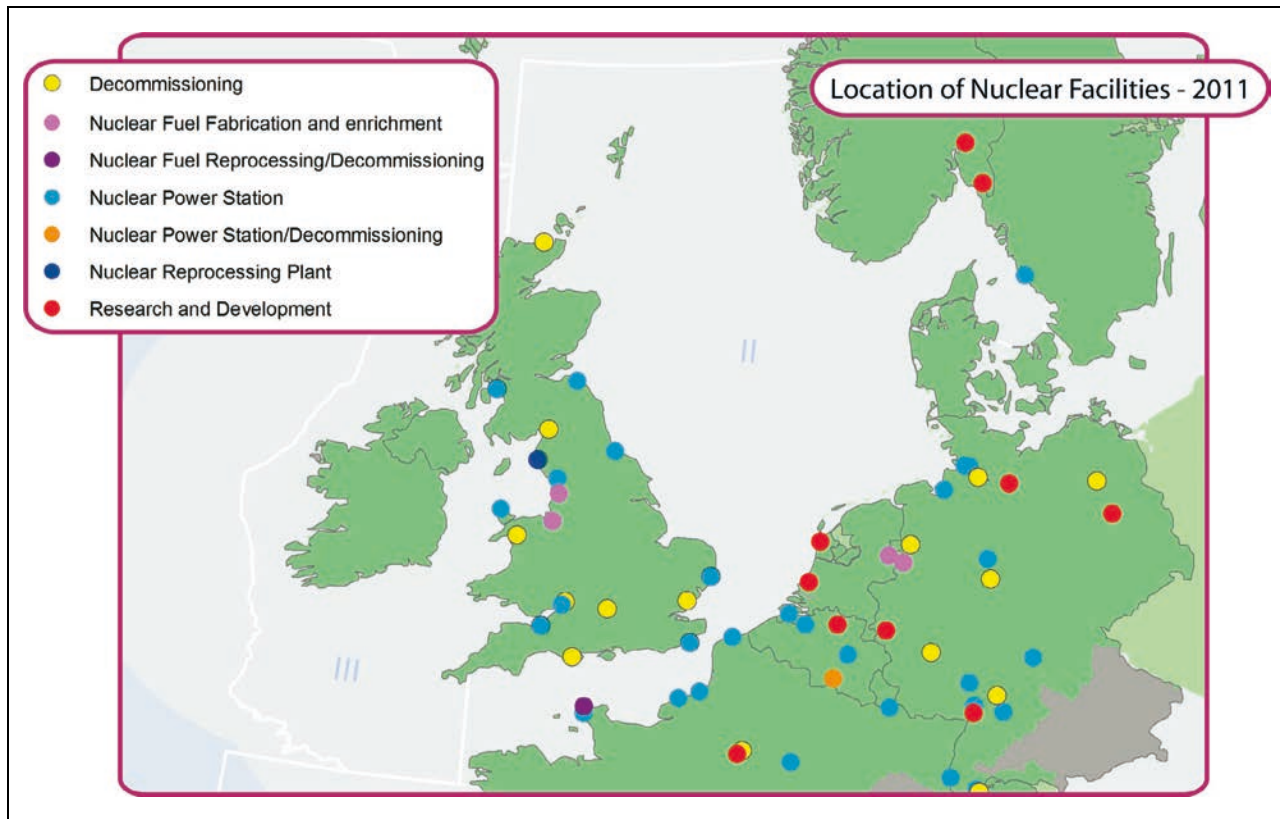


Figure 6.6 Nuclear facilities around the North Sea

Source: OSPAR

rectly to the North Sea. It is uncertain what trend can be expected in the risk level in the years ahead. There are plans to construct a number of new nuclear power plants in Europe, particularly in Russia, but other power plants are being shut down.

Shipments of spent highly enriched nuclear fuel from countries in the former Eastern European bloc along the Norwegian coast to Murmansk pose a risk of pollution in the event of a shipwreck. Since 2009, six such shipments have been registered, and a further four are planned between now and 2015. Moreover, climate change may result in the Northeast Passage becoming ice-free, and this would make it possible to transport spent nuclear fuel between Asia and Europe along the Norwegian coast.

Nuclear-powered vessels (submarines and ice-breakers) are widely used in Norwegian and adjoining sea areas, and regularly call at Norwegian ports. Russia has plans to construct and upgrade a number of nuclear-powered vessels, which will increase the risk level in the area.

Preventive measures

There is a continual process at global level to limit the risk of serious nuclear accidents, and risk-reduction measures are being implemented at several levels, both through cooperation between national authorities and through international and national agreements and decisions. The following measures reduce the risk of accidents and the level of environmental risk:

- The Norwegian Coastal Administration and the Radiation Protection Authority cooperate on the exchange of information, notification and a preparedness and response system for dealing with incidents at sea.
- There is currently no requirement to notify coastal states of maritime transport of radioactive material, but the International Atomic Energy Agency (IAEA) General Conference recommends that the practice of notification of coastal states by the sending state is followed. The Radiation Protection Authority will follow up the recommendation in order to strengthen and improve notification procedures.
- The Norwegian Coastal Administration, the Vardø VTS Centre and the Radiation Protection

Table 6.4 Predicted consequences of the nuclear accident scenarios assessed.

Ecosystem component	Nuclear accident scenario		
	Release to air from the Sellafield plant	Submarine wreck	Transport of spent nuclear fuel
Seafood safety	Major *	Major *	Major *
Plankton	Moderate 2 *	Moderate 2 *	Moderate 2 *
Benthic communities	Minor 2 *	Major **	Moderate 2 *
Fish	None 2 **	Moderate 2 *	None 2 **
Seabirds	Unknown 3 *	Unknown 3 *	Unknown 3 *
Marine mammals	Unknown 3 *	Unknown 3 *	Unknown 3 *
Ecological relationships/ processes	Unknown 3 *	Unknown 3 *	Unknown 3 *

The uncertainty of the assessments is indicated by the numbers (1 = low, 2 = moderate, 3 = high), and the knowledge level by the number of stars (= poor, ** = moderate, *** = relatively good).*

Authority have formalised notification routines to ensure that information is exchanged if one of these agencies becomes aware of such a transport. Transports are kept under continual observation by the Vardø VTS Centre while they are in Norwegian waters.

Assessment of the potential consequences of acute radioactive pollution

Although the probability of a radiation accident is very low, events after the tsunami in Japan demonstrate that even accidents that are considered to be very unlikely can happen. Releases of radioactivity can have very serious consequences. A serious nuclear accident could affect the marine environment both locally and in a wider area, and also have transboundary impacts.

The environmental consequences for the management plan area of acute radioactive pollution in or around the North Sea would depend on the scenario, the quantity released, the time and location of the release and the type of radioactive substance released. Depending on the scenario, acute radioactive pollution could affect species at different levels in the water column or on the seabed. Three different scenarios have been analysed: a release of radioactivity to air from the Sellafield plant, the wreck of a nuclear submarine and an accident during transport of spent nuclear fuel. Table 6.4 provides an overview of the calculated consequences of the three scenarios on a number of ecosystem components.

A release of radioactivity to air could have serious consequences for Norway and require large-scale, costly countermeasures on land. Calcula-

tions for seabirds, marine mammals, fish and other marine organisms show that they would only contain elevated levels of caesium-137 for a short period after the accident. This scenario would have less impact on benthic organisms and communities than on organisms that live in the upper levels of the water column, largely because the pollution would be deposited on the water surface and diluted in the water column. In all three scenarios, it was found that the concentration of radioactivity in fish would rise considerably, and would exceed the limit values for human consumption for a period. It is likely that acute radioactive pollution would have major consequences for exports of fish and other seafood even if the quantity released is not large enough to have any noticeable effects on the marine environment.

For all three scenarios, the modelling results indicate that the maximum dose of radioactivity received by most organisms would generally be less than 10 µGy per hour, which is the level above which effects can be expected. The only exception was in the scenario for an accident involving a nuclear submarine, where it was calculated that certain species of benthos would locally be exposed to doses of up to 70 µGy per hour.

At present, radioactive pollution is not having detectable effects on plants and animals in the marine environment of the North Sea and Skagerrak. Nevertheless, knowledge of the possible effects on plants and animals in the event of an accident is important. The effects of ionising radiation on organisms vary with the dose, the type of radiation and the sensitivity of the organisms in question. Known effects include elevated morbidity, lower reproductive success, cytogenetic

effects and higher mortality. Acute effects (damage that becomes apparent shortly after exposure) only occur after exposure to high doses of radiation.

6.3.2 Onshore activities

Accidents at onshore industrial installations and subsequent acute pollution can also affect the coastal and marine environment. Spills of oil or chemicals from oil refineries or chemical plants are the most likely to be a threat to the marine environment in the North Sea and Skagerrak. There are a number of industrial installations along the coast where a major accident could have impacts on particularly valuable areas in coastal waters, especially in the event of an oil spill.

Consequence assessments have been carried out for spills from two Norwegian oil refineries, at Mongstad and Slagentangen, and from the Preem-raff oil refinery in Lysekil in Sweden. The overall conclusion is that these scenarios would have moderate consequences. However, the level of uncertainty for these assessments is very high.

6.4 Other consequences of acute pollution

In addition to environmental consequences, acute pollution may have substantial consequences for commercial activities and outdoor recreation interests along the coast. Conditions for aquaculture are particularly favourable in Norway because of the long stretches of sheltered coastline, the large areas available, and the clean waters with a high rate of water exchange and high water quality.

The aquaculture industry is dependent on suitable, clean production conditions and good biological conditions in recipients, and is therefore vulnerable to pollution that reduces water quality and results in poorer growing conditions for farmed organisms.

Acute pollution could in the short term have an extremely negative effect on aquaculture and fisheries in commercial terms and in terms of market access and consumer confidence.

In the event of an acute pollution incident, oil-based or other environmentally harmful substances would become biologically available and enter marine food chains, thus affecting seafood safety. Monitoring and control of levels of contaminants in seafood from areas where oil or chemical spills have occurred are necessary to document

compliance with the statutory maximum levels of contaminants and to show that seafood is safe.

Satisfactory control of food safety by the authorities is essential for the high national and international reputation of Norwegian seafood products. These products, particularly those from more northerly waters, do have a good reputation at present. Previous experience of oil spills and of cases where a product has attracted negative attention has shown that in the short term it can be difficult to sell products from the polluted area.

The proximity of spectacular untouched nature is considered to be one of the Norwegian tourist industry's main comparative advantages in competition with other countries. Acute pollution incidents could in the short term have an extremely negative effect on tourism in coastal areas bordering on the management plan area. The coastline of the North Sea and Skagerrak are heavily used for outdoor recreation activities. The many holiday cabins are popular, there are large numbers of leisure craft, and many people engage in recreational fishing and other outdoor activities along the shoreline and in coastal waters. Oil or chemical spills are also likely to cause serious disruption to such activities.

6.5 Preparedness and response to acute pollution: reducing the consequences of spills

Norway's aim is to maintain a preparedness and response system for acute pollution that is appropriately dimensioned to the risk level, and that protects the environment and helps to achieve the goal of a clean, rich and productive marine environment. In the event of a spill, the primary aim is to avoid environmental damage and secondarily to limit the scale of any damage. In the event of an incident involving a risk of environmental damage, steps must be taken to avoid pollution. At sea, this generally means taking steps to prevent oil from being discharged into the sea. If this is not possible, the main aim is to minimise the spread and scale of the pollution and any subsequent environmental damage.

6.5.1 Governmental preparedness and response

The governmental preparedness and response system is intended to deal with major incidents of acute pollution that are not covered by private or municipal systems, and the risk of such spills.

There are no general requirements for the shipping industry to maintain its own preparedness and response system to deal with acute pollution, and the governmental system is therefore designed mainly to deal with acute pollution from ships.

Governmental preparedness and response capability and the locations where equipment and other resources are available must be determined on the basis of knowledge of environmental risk. Just as for preparedness and response in other sectors, this means that the governmental system is not based on the worst-case scenarios or on a situation where it is necessary to respond to several incidents at the same time. Nevertheless, the scenarios used as a basis for designing the system involve large spills and serious pollution.

A new governmental preparedness and response analysis for Norway was presented in June 2011. It was based on an analysis of the probability of incidents involving spills from shipping and an environmental risk analysis. The preparedness and response analysis uses scenarios of fairly serious spills in a number of geographical areas along the Norwegian coast where there is an elevated environmental risk. Four of these scenarios would affect the management plan area (spills in the Oslofjord near Moss, near Langesund (Telemark) affecting the coast of Southern Norway, in the Jæren area (Rogaland) and off Fedje (Hordaland)). The analysis recommends strengthening preparedness and response in these areas.

The analysis was intended to provide a basis for designing governmental preparedness and response capability for dealing with acute pollution. It also included simulation of the effects of oil spill response measures for each scenario to illustrate how these reduce the consequences of spills. Other factors that were taken into account include variations in weather and current conditions, mobilisation and transport times for equipment, availability of personnel and infrastructure. The quantity of oil recovered, the length of shoreline affected by landfall, the influence area at sea and the quantity of oil in areas defined as environmentally vulnerable are important factors when assessing the effect of the oil spill response.

On the basis of the simulations and a cost-benefit analysis of the results obtained using different quantities of oil spill response equipment and different response times, recommendations were made for governmental preparedness and response capability. Next, a gap analysis was performed, comparing the current and recommended preparedness and response capability.

The Ministry of Fisheries and Coastal Affairs and the Norwegian Coastal Administration keep the preparedness and response situation along the coast under review.

Experience of oil spill response operations shows that their effect depends strongly on the weather conditions. Effective damage limitation at sea is only possible for about 60 % of the year, and in practice there are considerable limitations on the effectiveness of the equipment. On average, only about 10–20 % of the total quantity of oil in a spill can be recovered from the sea surface, although under favourable conditions a considerably larger proportion can be recovered. After *MS Godafoss* grounded in 2011, conditions were good during the recovery operation, and almost 50 % of the oil released was recovered. On the other hand, both simulations and experience of previous oil spill operations show that oil reaches land rapidly after accidents near the shoreline, and it is almost impossible to avoid landfall. In most cases, a considerable stretch of coastline will be contaminated, necessitating large-scale clean-up operations.

The Ministry of Fisheries and Coastal Affairs has the overall responsibility for the governmental preparedness and response system. The Coastal Administration maintains operational preparedness, and also functions as the supervisory authority for private and municipal acute pollution response operations. It can provide assistance for such operations and if necessary can take over operations to deal with major spills either partly or completely. Municipalities and private services have a duty to provide assistance to governmental operations if requested. The Coastal Administration is operative 24 hours a day, and receives and deals with reports of acute pollution. It maintains an emergency response organisation with well-trained personnel who can be deployed to avoid or reduce damage after a release of acute pollution.

There is a great deal of petroleum activity and shipping in large parts of the management plan area, and this is reflected in the ready availability of preparedness and response resources. Both the petroleum industry and the Coastal Administration have access to considerable resources in the event of a serious acute pollution incident. It is also possible to draw on relevant resources in other countries. The Copenhagen Agreement and the Bonn Agreement deal with international assistance in the event of a threat of acute pollution, and both apply in the management plan area. Furthermore, Norway and the UK have a bilateral agreement on assistance (the NORBRIT Plan),

and assistance from other European countries can be requested through the EU Monitoring and Information Centre (MIC).

The most important resources that can be deployed for governmental acute pollution response operations in the management plan area are as follows:

- the Coastal Administration's emergency response organisation, which has specialised, trained personnel;
- seven of the governmental main depots with a staff of about 10 at each depot;
- three supplementary depots;
- 4–5 Coast Guard vessels permanently carrying oil spill response equipment on board;
- two oil recovery vessels for operations near the coast;
- one surveillance aircraft fitted with equipment for oil detection;
- satellite monitoring;
- assistance agreements with onshore terminals and refineries;
- resources in other countries.

In the event of a major oil spill operation in the management plan area, equipment from all 16 governmental main depots could be deployed.

In recent years, a number of steps have been taken to strengthen governmental preparedness and response to acute pollution in the management plan area:

- Emergency response equipment at all depots has been renewed, replaced and reallocated.
- New Coast Guard vessels carrying oil spill recovery equipment have been phased in, which has increased capacity and mobility for ocean-going response resources. The Coast Guard's new multi-purpose offshore vessel *OV Utvær*, which is equipped with integrated high-capacity oil spill recovery equipment, is now operative.
- The emergency cargo transfer capacity for bunker and cargo oil has been strengthened by the deployment of new equipment. Two sets of equipment are stored at depots in the management plan area.
- The competence of personnel in the governmental system has been strengthened by increasing the frequency of courses and exercises.
- The knowledge base for environmental risk and preparedness analyses has been strengthened, for example by testing and further developing three-dimensional modelling of oil drift. A better overview has been gained of prepared-

ness and response resources, including municipal resources.

- New regulations have been adopted concerning the use of vessels for oil spill response, and contracts have been signed with the owners of vessels that have the necessary certificates.
- Guidelines have been developed through a project headed by the Norwegian Coastal Administration for general competence-building for preparedness in coastal waters and shoreline clean-up.
- The preparedness and response system for spills of chemicals and hazardous substances from ships has been strengthened by purchasing equipment and training personnel in Oslo and Bergen for operations at sea.
- The Coastal Administration has identified sites for ports of refuge and completed consultation processes concerning these sites for the entire management plan area.

6.5.2 Municipal preparedness and response

Municipal resources form part of the public-sector preparedness and response system. A municipality is responsible for providing the necessary preparedness and is duty bound to respond to minor acute pollution incidents that occur within its boundaries if there is no private-sector system to deal with them, and if those responsible for the pollution are not in a position to take action. They are also responsible for dealing with incidents where the polluter is unknown.

Minor incidents are acute pollution incidents that may occur in connection with normal activities within the municipality and where no private-sector resources are available. This typically means transport-related acute pollution incidents, such as a spill from an overturned tanker, a minor spill from a ship, or a rail accident. Municipal sea- and land-based capabilities must be determined on the basis of environmental risk and preparedness analyses carried out by the municipalities. Factors considered in these analyses include the types of activity within a municipality, the kinds of incidents that may occur, the type and size of spills that may occur and how they can be dealt with to protect identified environmental assets.

All the municipalities take part in mandatory cooperation in this field through the 33 intermunicipal acute pollution control committees. A host municipality has been appointed in each of the 33 regions. This system makes it possible to strengthen local and regional capabilities more effectively.

In all, about 70 000 metres of lightweight booms and 300 oil skimmers are stored at municipal and intermunicipal depots. Municipal and intermunicipal equipment for combating acute chemical pollution is held by the larger fire brigades or by the local port authorities. It is mainly their personnel who are trained to use the equipment and who are deployed during clean-up operations.

6.5.3 Private-sector preparedness and response

Private-sector systems must have the capability to deal with acute pollution caused by an enterprise's own operations. The Climate and Pollution Agency has set special requirements for a number of enterprises, including petroleum companies, tank farms, refineries, and land-based enterprises that handle environmentally hazardous chemicals. Operators must design and establish their own preparedness and response systems, which must comply with the requirements set by the Climate and Pollution Agency under the health, safety and environment regulations and in specific permits. For the petroleum industry, the capability of a system is based on environmental risk and preparedness and response analyses carried out for a particular exploration well or production from a specific field. Important input data for the analyses includes weathering studies of relevant oil types and oil drift forecasts for specific localities. The potential quantities of oil on the sea surface, in the water column and on beaches determine the amount and type of equipment that is needed and the types of response that are appropriate. The choice of method and response time also depends on the distance from the spill to vulnerable species and habitats such as seabirds, spawning stocks of fish and shoreline habitats, and whether a spill happens at a time of year when vulnerability is high.

Preparedness and response systems are normally designed to deal with blowout rates calculated on the basis of the pressure and flow rate for specific wells, and spill durations that are often based on the length of time needed to drill a relief well. The operators do not design their systems to deal with a worst-case scenario (highest blowout rate/longest duration), but are nevertheless responsible if such an event should occur.

The operating companies on the Norwegian continental shelf have the overall responsibility for combating acute pollution from subsea and surface installations. The Norwegian Clean Seas

Association for Operating Companies (NOFO) has established and maintains the oil spill emergency preparedness and response on the continental shelf on behalf of 30 operating companies. This includes resources for dealing with spills in open water, near the coast and in the shore zone.

The petroleum industry aims to combat an oil spill as close to the source as possible. The strategy for preventing and dealing with oil spills involves a number of barriers:

- Barrier 0: Preventive measures on the installation itself;
- Barrier 1: Systems for use in open waters close to the source;
- Barrier 2: Systems for use in the oil spill trajectory towards the coast;
- Barrier 3: Systems for use in coastal waters and on the shoreline;
- Barrier 4: Shoreline clean-up.

The oil spill preparedness and response resources in the management plan area consist of a combination of private- and public-sector resources. The main private-sector resources are:

- three NOFO bases (Stavanger, Mongstad and Kristiansund), each equipped with two offshore recovery systems, dispersants and three coastal recovery systems;
- the preparedness and response system for the fields Tampen, Troll, Oseberg, Balder, Gjøa, Sleipner and Ula/Gyda, with NOFO offshore recovery systems on standby vessels;
- the preparedness and response system for the fields in the Ekofisk area;
- preparedness and response resources at the following refineries: Slagentangen, Mongstad, the Sture terminal and Kårstø.
- personnel and equipment from the company MMB, and personnel from World Wildlife Fund (WWF) and NOFO's Spesialteam.

In the event of a spill from non-petroleum activities, private emergency response actors have a duty to assist the government. In this way they provide a supplement to public-sector resources and improve safety for all users of Norway's seas. Resources include helicopters and upgrading of the fishing fleet to provide towing and tugboat capability. This additional capability could be very important in the event of non-petroleum-related accidents at sea or along the coast. In the same way, private search and rescue resources will function as a supplement to governmental resources.

7 Cumulative environmental effects: environmental and social impacts

The industries in and associated with the North Sea and Skagerrak can put pressure on ecosystems, and much has been done to reduce their impacts and the pressure on the environment. Nevertheless, there are still environmental problems in this area, and there is concern about the cumulative effects of all the different pressures on the marine environment. In future, new pressures may emerge, and we do not have a full overview of what their impacts may be.

Current, planned and future commercial activity in the management plan area must take into account the environmental problems that have been identified and the cumulative effects on the area.

The scientific basis for the management plan for the North Sea and Skagerrak concludes that there are substantial environmental problems in the area. They include overfishing of certain fish stocks, the decline of seabird populations, long-range transboundary pollution and the risk of acute pollution. Climate change and ocean acidification are new threats, and so far we know little about their impacts.

7.1 Summary of pressures and impacts

7.1.1 Summary by sector

Harvesting of biological production by the *fisheries* is the human activity that has the greatest impact on ecosystems today. The impacts of harvesting are assessed as moderate for some of the commercial fish stocks and minor for others. Bottom trawling is considered to have moderate to major impacts in areas that are trawled frequently. No estimate has been made of the proportion of the seabed affected by frequent trawling, but the impacts for the management plan area as a whole are considered to be minor. The impacts of bycatches vary from minor to moderate, depending on the species and gear type. The impacts of changes in food supplies for seabirds are assessed as moderate, but the scientific basis for the man-

agement plan points out that there are serious gaps in our knowledge in this area.

Maritime transport can put pressure on the environment through operational discharges to water and air, illegal discharges, the introduction of alien species via ballast water or attached to hulls, discharges of litter, and noise. According to the scientific basis for the management plan, no impacts of operational discharges have been demonstrated, but little is known about the long-term effects on seabirds and other marine life. There has been little investigation of the impacts of discharges from stern tube lubricants, sacrificial anodes and other unregulated sources. Operational discharges to air from maritime transport have not in themselves been found to have direct impacts. Increasing use of anti-fouling systems containing copper could become an environmental problem, even though these are less environmentally harmful than the TBT-containing systems they have replaced. Elevated copper concentrations have been found in certain harbours. Maritime transport involves a risk of collisions that may result in acute oil or chemical pollution. The impacts of such incidents on seabirds will vary from minor to major depending on the size and type of spill, its location, the time of year and physical environmental conditions.

Petroleum activities involve operational discharges to air and water, a risk of acute pollution, and other pressures such as physical disturbance of the seabed and effects of seismic surveys on fish and marine mammals. Operational discharges from petroleum activities are generally so strictly regulated that they are considered to have no or only minor impacts during normal operations. The scientific basis for the management plan concludes that they only have more local effects, and these are ranked as insignificant for the management plan area as a whole. This conclusion is based on consequence assessments of oil spill scenarios in five selected oil-producing areas of the North Sea. However, there is still some uncertainty as regards the possible long-term effects of

discharges of produced water from petroleum activities. The environmental consequences of acute pollution have also been assessed on the basis of modelling of the drift and spread of oil from discharge points in the five selected areas.

7.1.2 External pressures

The state of the environment in the North Sea–Skagerrak area is also affected by activities in other parts of the world. There are inputs of nutrients and hazardous substances into coastal waters from land-based and coastal activities, and these substances are also transported into Norwegian sea areas via air and ocean currents. Nutrients have direct impacts in coastal waters and fjords, and indirect impacts on the management plan area as a whole. Hazardous substances are considered to have moderate impacts because they tend to bioaccumulate and are therefore present in marine organisms all along the food chain.

The *ocean climate* in the management plan area is changing as a result of greenhouse gas emissions worldwide, ocean acidification is increasing and alien species may be introduced from other sea areas. Up to 2100, it is particularly climate change and ocean acidification that are expected to have major impacts on the management plan area. Climate change and ocean acidification may reduce the resilience of ecosystems to other pressures. The future management regime will therefore have to be adapted to changes in ecosystems.

7.1.3 Cumulative environmental effects

All ecosystem components in the North Sea and Skagerrak are affected by one or several human activities. 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. In many of the cases where cause and effect are clearly understood, steps have been taken to reduce the impacts of a pressure. However, despite this there are still problems to be addressed.

The greatest cumulative effects are considered to be on certain fish stocks and seabird species. Threatened species and habitat types and declining populations are particularly vulnerable to any increase in cumulative effects. Habitat fragmentation and degradation is considered to be a serious threat to biodiversity today, in marine environments as elsewhere. There is particular

concern about burrowing and sessile species and benthic fish species such as sandeels.

Although each source of disturbance or damage may put little pressure on the environment, their combined effects result in the cumulative effects and problems that have been identified in the management plan area. The environmental impacts of any spills and other accidents are additional to those of normal activities and releases of pollutants. In the event of a large oil spill from a blow-out or shipwreck, seabirds, marine mammals and coastal ecosystems are expected to be most seriously affected.

The impacts it is most difficult to do anything about are those of the rising concentrations of greenhouse gases in the atmosphere, which are resulting in global warming, a higher CO₂ content in seawater and ocean acidification. For many of the other pressures, it will be possible to take steps that result in good environmental status in the long term.

7.2 How environmental impacts and cumulative environmental effects are assessed

As part of the scientific basis for the management plan, six reports on environmental impacts were compiled. Five of them deal with activities in and around the North Sea and Skagerrak (petroleum activities; shipping; fisheries and aquaculture; offshore renewable energy production; land-based and coastal activities). In addition, the environmental impacts of external pressures – climate change, ocean acidification and long-range transport of pollutants – were assessed. Figure 7.1 shows how this work has been organised.

The assessments describe current pressures and impacts for the level of activity in 2010, and as far as possible also projected pressures and impacts in 2030. The assessments of environmental impacts are based on:

- information about the pressures in the area covered by the scientific basis for the management plan (where they act, scale);
- knowledge about the vulnerability of the ecosystem to different pressures;
- knowledge about the occurrence of species and habitat types.

A three-point scale (major – moderate – minor) was proposed and has where possible been used in assessing the impacts of different pressures. The assessments reflect the methods normally

used by the administrative bodies involved when assessing the impacts of various pressures on different ecosystem components. The three-point scale was easier to use in cases where more information was available on pressures and impacts than in cases where information was more sketchy. In many cases, knowledge of the biological impacts of pressures is still inadequate. In some cases, there were already tried and tested assessment scales – for example for evaluating the impacts of fisheries on harvested stocks or the environmental consequences of oil spills. For other pressures, expert opinion and qualitative assessments have to be used. Where information on the population status of species, the range and ecological status of habitat types, or the impacts of environmental pressures is inadequate, assessments of environmental impacts are bound to be uncertain.

With such a variable knowledge base, it has been essential to ensure that the basis for the different assessments and the sources of uncertainty are clearly described. This information is available in the impact assessments for different sectors and the other background reports listed in Appendix 1.

How cumulative environmental effects are assessed

An important goal of integrated, ecosystem-based management is to consider the cumulative environmental effects of all pressures and impacts on

the environment. This is difficult to do for a large and complex ecosystem. Different pressures act on different ecosystem components, and different pressures may have either synergistic or antagonistic effects on particular ecosystem components.

The pressures and impacts associated with different sectors are so different in character that it is not currently possible to arrive at exact values for cumulative effects resulting from different pressures and across a range of geographical scales. However, by using the same methodology for all the impact assessments, it has been possible to provide a systematic overview of pressures and impacts.

The impacts of different pressures from activities within and associated with the management plan area are described in Chapter 7.3, and the cumulative effects on individual ecosystem components are discussed in Chapter 7.4. This approach is in accordance with the requirement to assess cumulative environmental effects and apply the precautionary principle, as set out in the Nature Diversity Act.

7.3 Impacts of different environmental pressures

In the impact assessments, environmental pressures were grouped into categories. For each of these categories, a table in the text below summa-

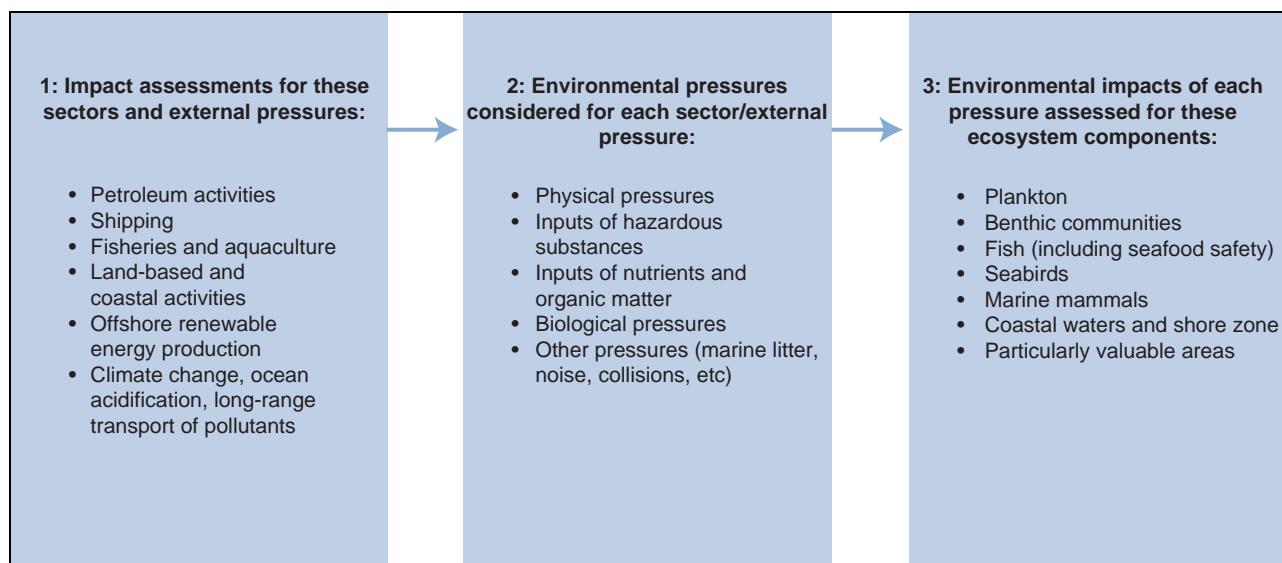


Figure 7.1 Steps in the preparation of environmental impact assessments. For each of the six reports, environmental pressures were identified (for the type of activity or associated with climate change, ocean acidification and long-range transport of pollutants), and the environmental impacts of each pressure on different ecosystem components were assessed.

Source: Climate and Pollution Agency

Table 7.1 Overview of sectors and pressures that were considered in the environmental impact assessments.

Sector	Biological pressures (Table 7.2)	Physical pressures (Table 7.8)	Releases of hazardous substances (Table 7.4 and 7.5)	Releases of nutrients and organic matter (Table 7.6)	Marine litter (Table 7.7)	Noise (Table 7.9)
Petroleum activities		Drill cuttings on the seabed Installations Pipelines	Produced water Drill cuttings Oil spills			Seismic data acquisition
Shipping	Introduction of alien species		Operational discharges Oil spills		Marine litter	Propeller noise
Fisheries	Harvesting Bycatches	Damage to seabed from trawling			Marine litter	
Offshore renewable energy	Artificial reefs	Installations				Noise in construction period
Land-based and coastal activities	Selective harvesting of species Introduction of alien species	Disturbance in seal whelping season and bird breeding season	Inputs of hazardous substances, including radioactivity	Inputs of nutrients and organic matter	Marine litter	
Climate change, ocean acidification (Table 7.10)	Climate change may affect species and habitat distribution		Changes in temperature and salinity may affect metabolism, uptake and toxicity of these substances	Climate change may affect inputs and metabolism of nutrients		

risers the results of the impact assessments for the different sectors for 2010. If a sector does not appear in a table, it is not considered to be responsible for measurable pressures or impacts. Table 7.1 provides an overview of the pressure categories and the pressures assessed for each activity. When cumulative environmental effects are assessed, this information is considered in conjunction with any environmental degradation or damage that has already been caused or that may arise in the future.

7.3.1 Biological pressures

The greatest biological pressure is the deliberate harvesting of commercial stocks. Harvesting is an

intentional and managed pressure on the ecosystem, but can have environmental impacts if harvesting levels are not sustainable and the reproductive capacity of certain species is reduced. The overall conclusion of the impact assessment for the fisheries is that most fish stocks are being managed sustainably. The environmental impacts of harvesting on these species are therefore considered to be minor. However, there is a risk that harvesting of mackerel and the shrimp *Pandalus borealis* is not sustainable (Table 7.2), and there are still spawning stocks of cod and sandeel that are below critical levels, even though harvesting is now considered to be sustainable. The sandeel stocks on the Viking Bank and around the West Bank and Outer Shoal were over-exploited for

Table 7.2 Environmental impacts of different biological pressures. Based on the report *Cumulative Environmental Effects*, part of the scientific basis for the management plan (Climate and Pollution Agency 2012), with supplementary information.

Biological pressure		Known environmental impacts	Comments
Shipping	Alien species (ballast water, hull fouling)	<i>Major</i> impacts at ecosystem level	Low probability of introductions but if a species becomes established, it may have major impacts
Fisheries	Harvesting	<i>Minor</i> impacts on blue whiting, Norway pout, plaice, North Sea herring, saithe <i>Moderate</i> impacts on shrimps, mackerel, sandeel, cod	
Fisheries	Bycatches	<i>Minor to moderate</i> impacts on seabirds <i>Moderate</i> impacts on marine mammals (seals)	Impacts on non-commercial fish species are uncertain
Fisheries	Changes in food availability for other species	Impacts on seabirds are uncertain	High uncertainty in assessment of both pressure and impacts. Inadequate knowledge base

many years. Harvesting now follows precautionary advice from the International Council for the Exploration of the Sea (ICES), and no catches have been taken in this area since 2004 because of uncertainty about stock status. Sandeel biomass is still low in some of the other areas of sandeel habitat. The environmental impacts of the current sandeel fisheries are assessed as minor to moderate. The mackerel spawning grounds in the south-western part of the management plan area are important for the stock. In the management plan area, the mackerel stock is above the precautionary level, but the lack of a coastal state agreement combined with large increases in the Icelandic and Faeroese quotas means that the overall mackerel harvest is considerably larger than the level recommended by ICES. However, studies by Norway, Iceland and the Faeroe Islands suggest that the stock is still in good condition.

Fisheries primarily affect the target species, but may also have impacts on other fish species, seabirds and marine mammals that are taken as bycatches. Harvesting fish can also have indirect impacts on seabirds by changing the availability of food supplies. The impacts of these types of biological disturbance are assessed as moderate, but it should be noted that there is a lack of information and that the assessments are therefore uncertain.

The introduction of alien species could potentially have major impacts, at ecosystem level as well as species level. In the management plan area, the problems are mainly related to shipping and the transport of species with ballast water and as fouling on ships' hulls. The impact assessment for shipping concludes that the probability of an invasive species becoming established is small, but that species that do become established could have major environmental impacts.

Biological pressure exerted by the fisheries up to 2030 will depend partly on the EU's new fisheries policy. The development of gear technology will be an important factor in reducing bycatches. International rules for ballast water management are now being put in place, and will help to reduce the probability of introductions of alien species.

7.3.2 Hazardous substances still cause for concern in the North Sea and Skagerrak

One of Norway's environmental targets is for releases and use of substances that pose a serious threat to health or the environment to be continuously reduced with a view to eliminating them by the year 2020. In the longer term, the aim is to reduce concentrations of the most hazardous chemicals in the environment towards background values for naturally occurring substances

and close to zero concentrations for man-made synthetic substances (white paper *Working together towards a non-toxic environment and a safer future – Norway's chemicals policy* (Report No. 14 (2006–2007) to the Storting)).

Inputs of hazardous substances to the environment come from many different sources and affect all parts of ecosystems. Levels of such substances that are high enough to give cause for concern are being found in fish, seabirds and marine mammals, which are all groups that are particularly vulnerable because they are high up in food chains. Hazardous substances hardly ever cause acute poisoning, but there is a risk of delayed injury and chronic effects, such as a reduction of species' reproductive capacity or survival rates. There is therefore concern about their impacts on marine organisms and on ecosystems as a whole. Elevated levels of contaminants in seafood are also a threat to food safety (see Chapter 3.2.2). Ensuring that seafood is safe by monitoring levels of contaminants and taking steps to reduce

these levels is important both for consumers and for the fisheries industry.

Shipping, petroleum activities, industry and other land-based and coastal commercial activities, and also long-range transboundary pollution transported by winds and ocean currents, all result in inputs of hazardous substances to the North Sea and Skagerrak. Because these substances accumulate along food chains, the impacts of both long-range inputs and inputs from land-based and coastal activities are assessed as moderate for seabirds, marine mammals, fish, and sea-food safety. Operational discharges from shipping and petroleum activities are assessed separately as having minor environmental impacts (Table 7.4). However, all pollution, even in small amounts, adds to the cumulative environmental effects on the management plan area. Given the intrinsic properties of persistent, bioaccumulative and toxic substances, and on the basis of the precautionary principle, the environmental authorities and actors in the various sectors are seeking

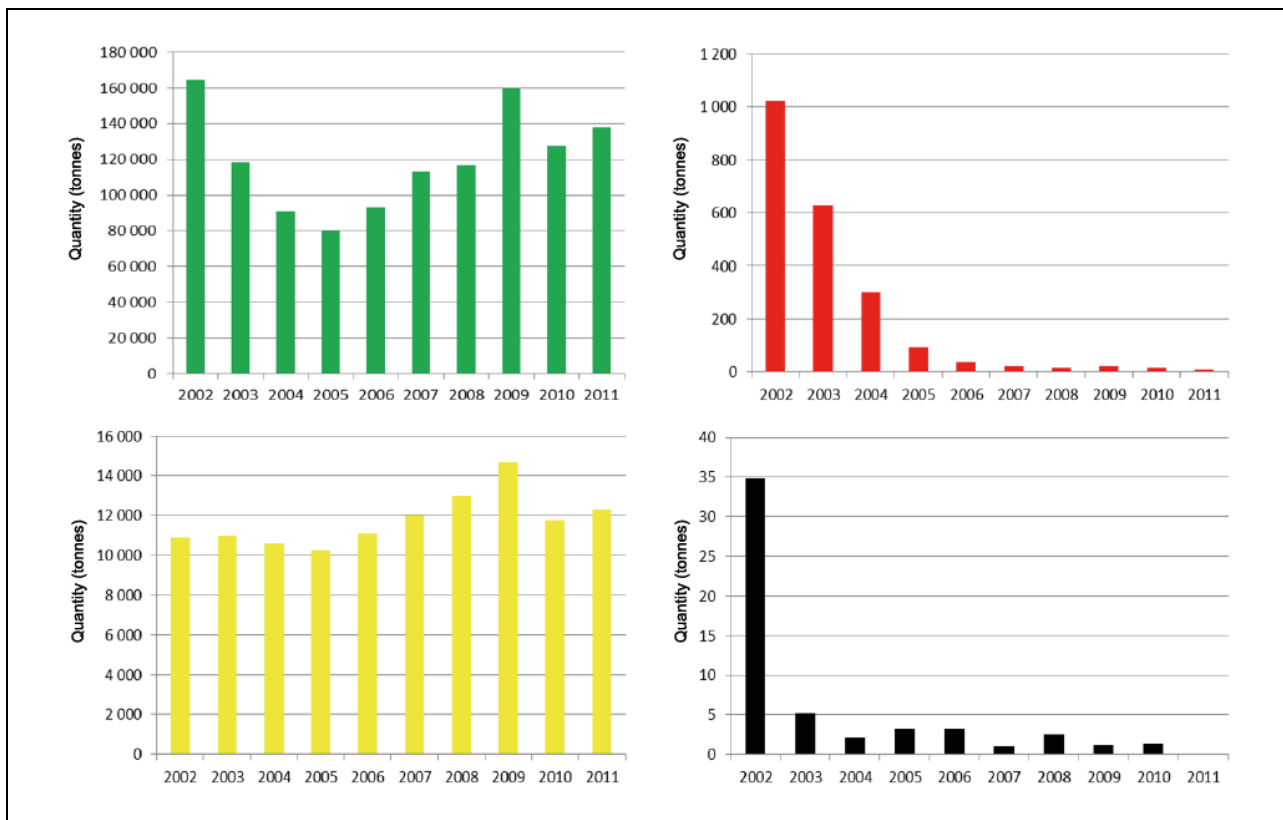


Figure 7.2 Discharges of added chemicals from the Norwegian continental shelf. Black-category substances are generally banned, and their use and release requires an exemption. Red-category substances are being phased out by substitution. The intrinsic properties of yellow-category substances mean that they are not defined as red- or black-category, and green-category substances are presumed not to have a significant impact on the environment. Note the different scales in the figure.

Source: EnvironmentWeb

Box 7.1 General zero-discharge targets for the oil and gas industry

Hazardous substances

- Zero discharges or minimal discharges of naturally-occurring environmentally hazardous substances that are also priority substances.
- Zero discharges of added chemicals in the black category (use and discharges prohibited as a general rule) or red category (high priority given to phasing them out by substitution), cf. the Activities Regulations for the petroleum industry.

Other substances

Zero discharges or minimal discharges of the following if they may cause environmental damage:

- oil (components that are not environmentally hazardous),
- yellow-category substances (not defined as belonging to the black or red categories, but not on the PLONOR list drawn up by OSPAR), and green-category substances (included on the PLONOR list and considered to pose little or no risk to the environment), cf. the Activities Regulations for the petroleum industry,
- drill cuttings,
- other substances that may cause environmental damage.

Radioactive substances

- Discharges of naturally occurring radioactive substances to be gradually reduced until, by 2020, the concentrations in the environment are close to the natural background levels.

The following is a more detailed list of the targets and measures:

- As a rule, oil and environmentally hazardous substances may not be discharged to the sea. This applies both to substances added as part

of the production process and to naturally-occurring substances. The precautionary principle is to be used as the basis for assessing the potentially damaging impacts of the discharges.

- Environmentally hazardous substances (red- or black-category) may only be discharged if serious technical or safety considerations make this necessary.
- Replacement of added environmentally hazardous substances must be given high priority. Operators must draw up plans for substitution of added environmentally hazardous substances and report them annually to the authorities, cf. the Activities Regulations for the petroleum industry.
- The steps taken to replace added environmentally hazardous substances must be based on an overall assessment. This means that for example if the use of a small amount of a red-category substance would reduce releases of other components and thereby reduce the overall environmental risk, this should be taken into consideration.
- Releases of red- and black-category substances must have been eliminated by 2005 in cases where there are adequate substitutes. Good documentation is required for the authorities to accept continuation of releases.
- Injection or reinjection of produced water is the most effective method of achieving the zero-discharge targets for naturally-occurring environmentally hazardous substances.
- The solution chosen for eliminating discharges of oil and other naturally occurring hazardous substances must be based on an overall, field-specific assessment that includes the environmental impacts, overall safety issues, reservoir engineering factors and cost issues.
- Provision may be made on the basis of an overall, field-specific assessment for minimising releases of naturally occurring hazardous substances on the priority list.

to eliminate releases of these substances or reduce them to a minimum.

We know that there are illegal releases of oil and litter from ships, but there is little information

on their size and frequency. The impacts of spills vary depending on where and when they happen. The risk of adverse impacts is higher if a spill occurs at a time when organisms are more sensi-

Box 7.2 Effects of produced water

Water in varying quantities – produced water – is always produced along with oil and gas. It contains low concentrations of various substances including oil components, heavy metals, PAHs, alkyl phenols, radioactive substances and production chemicals.

The 10-year research programme «Long-term effects of discharges to sea from petroleum-related activities» (PROOFNY) showed that components in produced water can have a range of negative impacts on health, biological functions and reproduction in individual fish and invertebrates. The research focused on possible endocrine effects, but other effects such as genetic damage, oxidative stress and effects on growth and reproduction were also found. New and improved methods were also developed for measuring biological responses that are both sensitive and are of fundamental importance for the organisms that are affected.

In its summary of the findings of the programme, the Research Council of Norway points out that the ecological significance of the discharges will remain unclarified as long as the effects that have been measured cannot be linked to impacts on populations and communities. However, the overall impression from the PROOFNY programme is that the potential for

long-term environmental damage as a result of discharges of produced water is only moderate, and that concentrations of components that have had adverse impacts are not generally found more than one kilometre from discharge points. This distance corresponds well with both monitoring results and the results of risk assessments. Although no impacts of produced water were found at population level, the possibility that there will be impacts at population and ecosystem level cannot be excluded. Nor is it possible to rule out the risk that weak impacts on individual species may have cumulative ecological effects, even though the probability of this is low.

The operating companies are required by the authorities to carry out both condition monitoring and effect monitoring in the water column. Caged organisms (cod and mussels) are placed at different distances from individual installations along the gradient in pollutant concentrations. Biological impacts of produced water (accumulation of PAHs and/or effects on biomarkers) have only been measured in organisms up to 5–10 km from installations. No effects have been found at population level, but the possibility of such effects cannot be excluded.

tive to the effects of hazardous substances, for example if it affects fetal or early stages of development.

Pollution from petroleum activities reduced

Ordinary petroleum activities, and planned and permitted use and releases of chemicals during these activities, are assessed as having only minor environmental impacts. Considerable volumes of produced water are discharged after treatment, but the negative impacts are restricted to the immediate vicinity of the discharge point, and are only expected within a radius of a few hundred metres. There is still uncertainty about the long-term impacts of discharging treated produced water, including how this contributes to cumulative environmental effects. The Research Council of Norway has published conclusions from 10 years' research, pointing out that although no population-level impacts were identified, the possibil-

ity that there will be impacts at population and ecosystem level cannot be excluded (see Box 7.2).

A great deal of progress has been made towards eliminating the use and discharges of hazardous chemicals added during petroleum drilling and production activities. In line with the zero-discharge targets for the industry (Box 7.1), the quantities of the most hazardous added chemicals used and discharged on the Norwegian continental shelf have been declining (Figure 7.2). The zero-discharge target is considered to have been achieved for added hazardous chemicals. Discharges of substances on the Government's priority list from the offshore petroleum industry constitute only a small proportion of Norway's total releases of these substances, and never more than 4 % of the total releases of a specific substance in Norway. Efforts to reduce the use and discharges of these substances are continuing. However, for safety and technical reasons it will still be necessary to use a certain quantity of these

Table 7.3 Releases of PAHs and oil to water from petroleum activities and land-based sources in Norway. Figures for the whole country. Figures for land-based sources included releases to inland water bodies. Figures for petroleum activities are for oil in oily water (produced water, displacement water, water from jetting operations and drainage water).

Year	PAHs (kg/year)		Oil (tonnes/year)	
	Petroleum activities	Land-based sources	Petroleum activities	Land-based sources
2009	1 625	3 200	1572	113
2010	1 541	2 983	1563	22
2011	1 863	1 982	1589	28

Source: Norwegian PRTR, www.norskeutslipp.no.

substances, and some discharges to the sea will continue in the years ahead.

Discharges of PAHs and oil

Polyaromatic hydrocarbons (PAHs) are natural components of coal and oil and are also formed during the combustion of fossil fuels and wood. Atmospheric inputs are the largest source of PAHs in the management plan area. Monitoring of air and precipitation shows no decrease in inputs since 2008.

Produced water released in connection with petroleum activities is also a major source of PAHs in the management plan area. These releases have not been substantially reduced over the past 10 years. Produced water spreads and is diluted in the water column, and impacts on living organisms are presumed to be restricted to an area within a radius of 5–10 km from the platforms. The impacts on the management plan area as a whole are assessed as minor.

There are also inputs of PAHs from land and with ocean currents, and PAHs are leached from sediments, but the size of inputs from these sources is uncertain. There are no data for operational releases of PAHs and oil from shipping. The quantities released from land-based activities and from petroleum activities are shown in Table 7.3. The highest levels of PAHs are measured in the deep sedimentation areas in the Skagerrak. According to the scientific basis for the management plan, this may have impacts on benthic communities in the area.

In the management plan area, operational discharges from petroleum activities with produced water are the largest source of inputs of oil. In a normal year, these inputs are larger than the combined quantity in spills from both shipping and

petroleum activities. Releases of oil and naturally occurring hazardous substances with produced water have been reduced, but not by as much as the industry's own goal for progress towards the zero-discharge targets. Unless further measures are introduced, oil discharges are expected to continue to rise for several years as the volume of produced water increases.

There is little data on operational discharges of oil from shipping, but estimates of oil in bilge water, based on distance sailed and maximum permitted discharges, indicate that the total quantity released by shipping in all Norway's sea areas was of the order of 0.9 tonnes oil in 2006. This is considerably less than the quantities from petroleum activities and land-based sources.

Long-range transport of pollutants still cause for concern in Norway

Despite considerable cuts in emissions in recent years, hazardous substances are still being released to land and sea by a range of human activities. The most important transport routes for hazardous substances entering the North Sea–Skagerrak area are deposition from the atmosphere, inputs with ocean currents and inputs from land-based activities. Mercury and PCBs, for example, are found everywhere in the environment. These pollutants mainly enter the area with ocean currents and atmospheric transport (Figure 7.3). Inputs from land are also an important source of PCBs in the Skagerrak. These substances are present in marine organisms, and the environmental impacts are assessed as moderate. Measurements at the Birkenes observatory in Southern Norway show no decline in concentrations of mercury or PCBs in air, whereas there has been a downward trend in the concentration

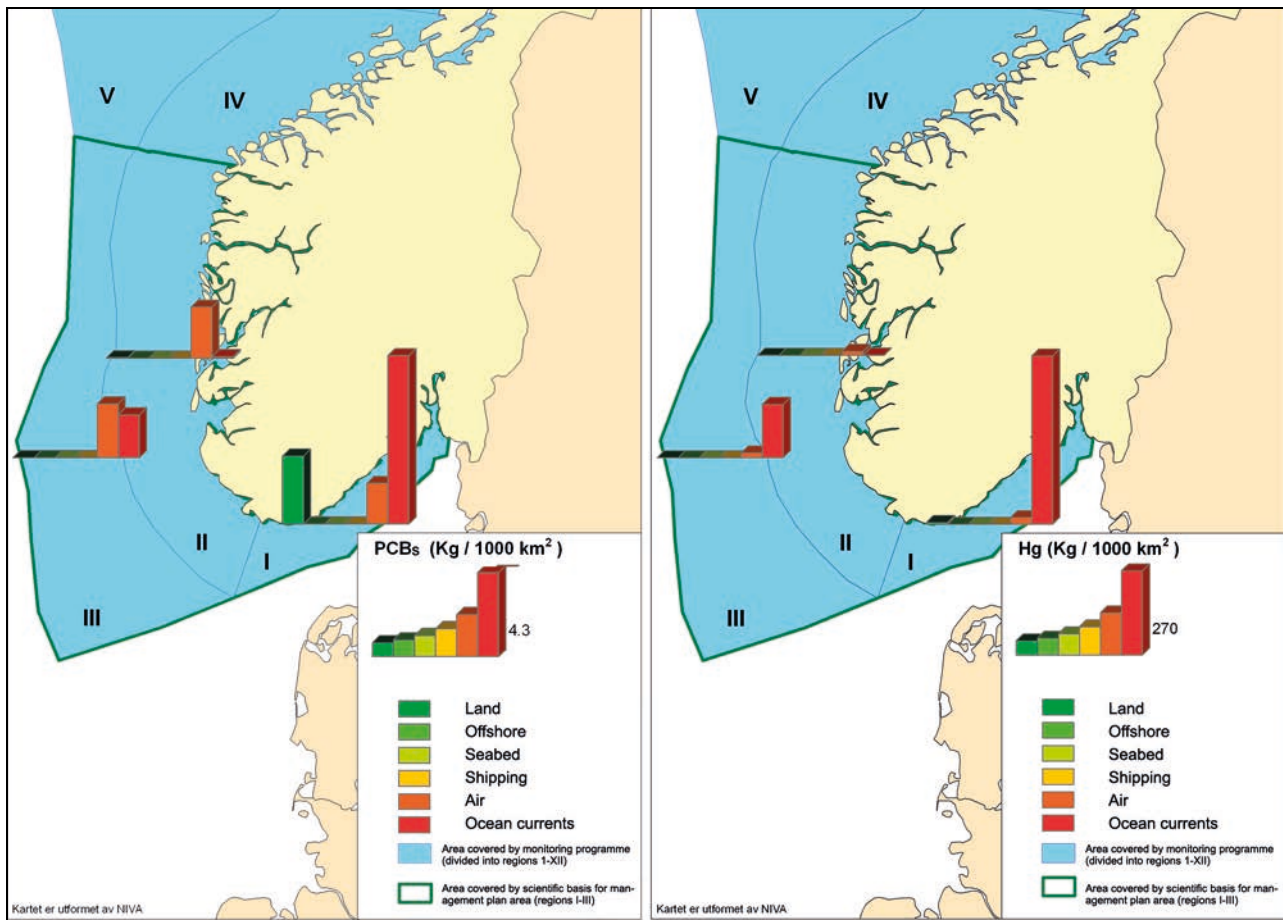


Figure 7.3 Inputs of mercury and polychlorinated biphenyls (PCBs) per 1000 km² sea surface per year. Note that the figures for inputs with ocean currents are not comparable with those for other sources because ocean currents are not a direct source, but redistribute and transport inputs from other sources.

Source: Marine Pollution Monitoring Programme 2010. *Tilførsler og miljøtilstand i Nordsjøen* (North Sea: inputs and environmental status), Climate and Pollution Agency. TA-2810/2011

of mercury in precipitation in the last eight years. Total deposition of mercury in Norway is estimated at 2.5 tonnes per year. Most of this originates from releases in other countries, mainly from the combustion of coal, natural sources and re-emission and remobilisation of mercury. Norway has already introduced a range of measures to reduce its releases of mercury, including a general ban on mercury in consumer products. The high levels of mercury in cod demonstrate how important it is to put in place a global legally binding instrument on mercury in order to reduce inputs of mercury to the management plan area from sources outside Norway.

As new knowledge is acquired, the target of halting releases of hazardous substances by 2020 is being applied to an increasing number of substances. Although the REACH Regulation (the EU/EEA regulatory framework for the registration, evaluation, authorisation and restriction of

chemicals) now provides for better control of chemicals that are on the European market, we still lack knowledge about many substances. Moreover, new chemicals and products that may contain hazardous substances are constantly being produced. To minimise environmental damage, it is important to identify new hazardous substances as early as possible, before any serious health and environmental effects arise.

Radioactive substances

Most radioactive pollution in the management plan area originates from long-range transport. The most important sources of radioactive pollution in the North Sea and Skagerrak today are the remaining fallout from nuclear testing in the 1950s and 1960s, releases from reprocessing plants for spent nuclear fuel in the UK and France, and inflow of water from the Baltic Sea containing radi-

Table 7.4 Known environmental impacts of releases of hazardous substances, oil and radioactive substances during normal activities. From the report *Cumulative Environmental Effects*, part of the scientific basis for the management plan (Climate and Pollution Agency 2012). Stars in the third column refer to the starred comments in the fourth column.

Releases of hazardous substances and other pollutants		Environmental impacts on ecosystem components	Comments
Petroleum	Operational discharges of drill cuttings Drilling fluid Produced water	<i>Minor</i> impacts on plankton, benthic communities, fish (sandeel, Norway pout, saithe, herring, cod, mackerel, haddock), seabirds, marine mammals, shore zone	No impacts under normal circumstances
Shipping	Operational releases to air and sea Illegal releases	<i>Minor</i> impacts on plankton, benthic communities, fish	No impacts under normal circumstances. Illegal releases may have impacts on plankton and organisms associated with the sea surface (seabirds, marine mammals, etc)
Nuclear power	Operational releases to air and sea	<i>Minor</i> impacts on plankton, benthic communities, fish, seabirds, marine mammals	No known impacts from current operational releases under normal circumstances
Offshore renewable energy production	Releases during the construction phase assessed	<i>Minor</i> impacts on birds, marine mammals, benthic communities	Impacts assessed as negligible
Land-based and coastal activities	Inputs of hazardous substances	<i>Minor</i> impacts on plankton, benthic communities, fish <i>Moderate</i> impacts on herring gull, lesser black-backed gull, marine mammals, sea-food safety*	Indirect impacts. Serious knowledge gaps. Difficult to distinguish between long-range transport and national inputs *Dioxins/dioxin-like PCBs in cod liver exceed maximum permitted level for seafood safety; mercury in tusk fillets from the Skagerrak just below this level
Long-range transboundary pollution	Inputs of hazardous substances	<i>Minor</i> impacts on plankton, benthic communities, shore zone, benthic habitats, levels in water/sediment <i>Moderate</i> impacts on fish*, seabirds**, marine mammals**, sea-food safety***, particularly valuable and vulnerable areas****	*Mercury and HCB exceed levels in environmental quality standards **High levels expected because of biomagnification ***Dioxins/dioxin-like PCBs exceed maximum permitted levels ****Seabirds and marine mammals are important ecosystem components in many particularly valuable and vulnerable areas. Ecological relevance unknown

oactive substances originating from the 1986 Chernobyl accident. Releases from petroleum activities are a source of naturally occurring low-level radioactive substances.

Releases from nuclear activities have dropped since the 1970s and 1980s, as a result of a combination of international cooperation, national regulation and improvements in treatment technology and waste management. The only exception is releases of tritium from the nuclear power industry, for which no treatment options are available. Releases of the radioactive substance technetium-99 from the Sellafield processing plant in the UK were halted in 2007, after persistent pressure from the Norwegian and Irish authorities, when the plant changed over to waste storage on land. This has resulted in a decline in technetium concentrations in the water column and in marine organisms throughout the North Sea.

The petroleum industry releases naturally occurring low-level radioactive substances with produced water. The content of radioactive substances in produced water depends on geological conditions and therefore varies from one area to another. Two installations on the Troll field are the most important sources. According to the zero-discharge goals, discharges of naturally occurring radioactive substances are to be gradually reduced so that the concentrations in the environment are close to the natural background levels by 2020. The lack of treatment technology has meant that releases have remained more or less at the same level in recent years.

Radioactive substances accumulate to different degrees in marine organisms and the food chain. For the management plan area generally, no ecological impacts are expected from the current levels of radioactivity, but this conclusion is based on limited knowledge. Nor is it expected that consumption of seafood will result in doses of radioactivity exceeding the limit values for human consumption. There is a pressing need for further investigation of the uptake, accumulation and possible impacts of radioactive pollution of the marine environment.

Projections for 2030

Since long-range transport accounts for a large proportion of the inputs of hazardous substances to the management plan area, future trends will depend strongly on developments in the international regulation of their release. Over the next 20

years, it is likely that inputs and levels of already regulated substances will decline, but inputs of some unregulated and new substances will rise until steps are taken to regulate them. An important element of uncertainty is what effects climate change will have on inputs, metabolism and uptake of hazardous substances. It may weaken the effect of international regulation; for example, hazardous substances stored in sediments may be mobilised, making the impacts on marine organisms more severe.

7.3.3 Impacts of acute pollution

The scientific basis includes analyses of various scenarios for accidents that may result in spills of oil, chemicals or radioactive waste. The type of spill and when and where it occurs play a major role in determining its potential environmental impacts. The level of uncertainty in assessments of environmental risk is relatively high, both because of gaps in our knowledge and because only a limited selection of scenarios has been analysed for each sector.

Table 7.5 summarises the assessments of the environmental impacts of the spills that have been analysed. The results are based on the Expert Group's assessment, using the same three-point scale (minor–moderate–major) for the impacts of all pressures. These assessments should be considered in conjunction with the discussion of consequence assessments for acute pollution from petroleum activities (Chapter 6.2.3), which are more detailed and use methodology for estimating the risk of environmental consequences on the basis of pre-defined categories for population mortality and recovery time.

Projections for 2030

No significant changes in the probability of accidents that may result in spills are expected in the period up to 2030. The activity level in the petroleum industry is expected to remain fairly stable. Maritime safety measures should be able to compensate for the increase in the volume of maritime transport. Nevertheless, 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 location of commercial activities will also influence the level of environmental risk.

Table 7.5 Environmental impacts of acute pollution. Based on the report *Cumulative Environmental Effects* (Climate and Pollution Agency 2012).

Spills (oil, chemicals, radioactive pollution)		Environmental impacts on ecosystem components	Comments
Petroleum	Spills from five representative discharge points assessed	<i>Minor</i> impacts on plankton, benthic communities, fish (sandeel, Norway pout, saithe, herring, cod, mackerel, haddock), common guillemot, razorbill, cormorant, common eider, common seal <i>Moderate</i> impacts on kittiwake, grey seal, shore zone <i>Major</i> impacts on little auk and shag	Impacts on seabirds vary from minor to major depending on the size and location of the spill, the time of year and physical conditions (e.g. light, wind strength, temperature, current conditions, coastal topography) A spill in the Tampen or Troll area would have the greatest impact
Shipping	Maritime accident scenarios in three locations assessed	<i>Minor</i> impacts on plankton, benthic communities, fish, marine mammals <i>Major</i> impacts on seabirds (little auk, shag)	Impacts on seabirds vary from minor to major depending on the size and location of the spill, the time of year and physical conditions (e.g. light, wind strength, temperature, current conditions, coastal topography)
Nuclear power	Three different scenarios assessed	Impacts on plankton, benthic communities, fish, seabirds and marine mammals can vary from <i>minor</i> to <i>moderate</i> depending on the scenario	Three different spill scenarios were assessed in the impact assessments

7.3.4 Impacts of nutrients and organic matter

Eutrophication in coastal waters and fjords can be caused by runoff from agricultural areas, inputs from industry and municipal waste water treatment, or discharges of nutrients from fish farming. In addition, nutrients are transported from the southern part of the North Sea and Baltic Sea to the Norwegian coast with ocean currents. In accordance with its international obligations, Norway has over the past 20–30 years implemented a range of measures to reduce Norwegian discharges of nutrients. National inputs of nutrients to the Skagerrak coast have been reduced since 1990. Other countries around the North Sea have

also taken action to reduce discharges, and this has benefited Norway as well. However, along the Skagerrak coast nutrient inputs from land are still influencing the eutrophication status of fjords and inner coastal waters. In these areas, further measures are needed to achieve the target of good chemical and ecological status by 2021. Along the coast of Western Norway, there has been a rise in anthropogenic inputs of nutrients, largely as a result of an increase in discharges from the aquaculture industry (Figure 7.4). Calculations for two fjords (Hardangerfjorden in Hordaland and Boknafjorden in Rogaland) indicate that these discharges are not so large that they have a significant bearing on eutrophication status at regional level. Measurements of nutrients in both fjords

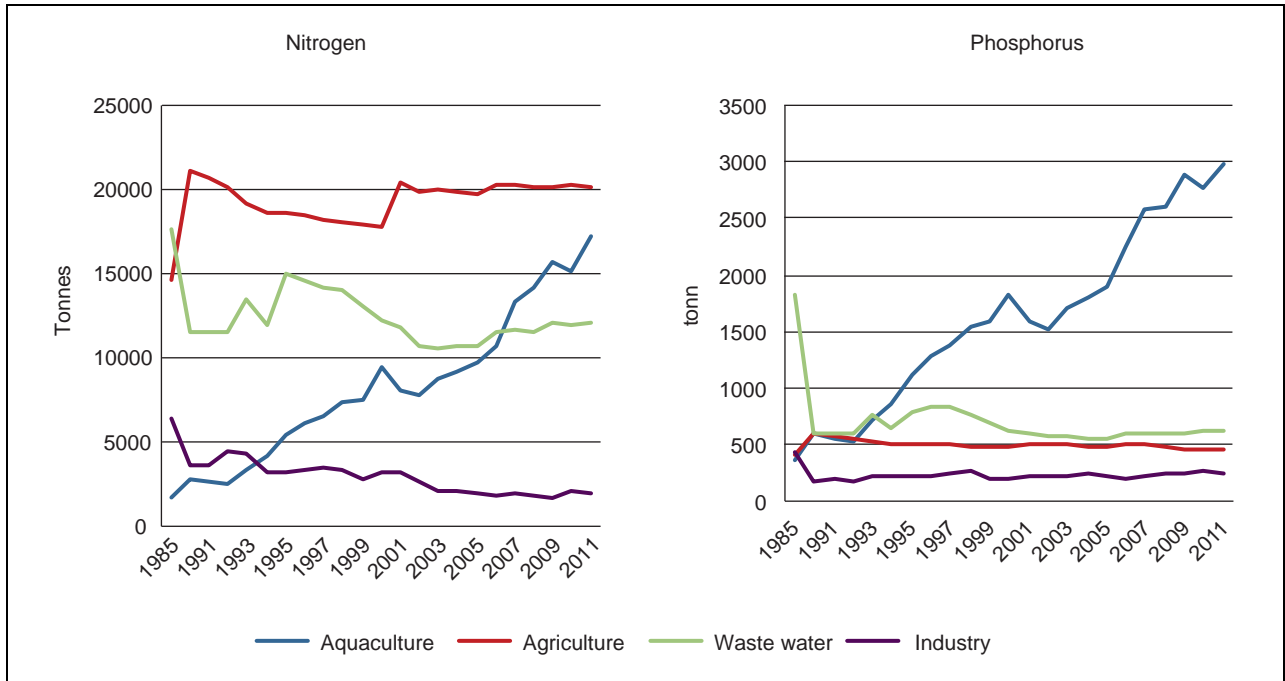


Figure 7.4 Norwegian discharges of nutrients to the North Sea and Skagerrak 1985–2011.

Source: Climate and Pollution Agency

Table 7.6 Environmental impacts of nutrients and organic matter. Based on the report *Cumulative Environmental Effects*, part of the scientific basis for the management plan (Climate and Pollution Agency 2012), with supplementary information. Stars in the third column refer to the starred comments in the fourth column.

Discharges of nutrients and organic matter		Environmental impacts on ecosystem components	Comments
Aquaculture	Discharges of nutrients and organic matter	<i>Minor</i> impacts on benthic communities	Local impacts in the immediate vicinity of installations
Land-based and coastal activities	Run off from land and inputs from municipal waste water treatment and agriculture	<i>Minor</i> impacts on plankton, benthic communities, fish (sandeel), seabirds (auks, kittiwake), shore zone, ecological relationships <i>Moderate</i> impacts on seabirds* (gulls, shag, common eider)	*Indirect impacts on seabirds as a result of changes in food supplies. Difficult to distinguish between long-range transport and national inputs
Long-range transboundary pollution	Inputs from the continent and the Baltic Sea assessed	<i>Minor</i> impacts on plankton, benthic communities, fish, shore zone, benthic habitats, ecological relationships <i>Moderate</i> impacts on seabirds*	*Indirect impacts on seabirds as a result of loss of kelp forests, unknown impacts on marine mammals and particularly valuable areas

suggest that levels are low enough that in most cases, water quality can be characterised as «very good» according to the Climate and Pollution Agency's criteria for water quality. However, knowledge of environmental status along the coast of Western Norway is still inadequate.

In the outer zone of coastal waters and the open sea, the *direct* impact of nutrients and organic matter is minor, and the state of these waters is considered to be very good (Table 7.6). In the areas closest to the coast, the impacts of nutrient inputs can include sediment deposition in sugar kelp forests and in soft-bottom areas in fjords. This can result in habitat degradation in nursery areas for fish and in poorer food availability for seabirds, and thus have indirect impacts in the management plan area.

Projections for 2030

Over the next 20 years, climate change may result in higher inputs of nutrients because of an increase in precipitation and more flooding. Interactions between a rise in temperature and nutrients are presumed to have had impacts on sugar kelp (see Chapter 3.3.3). As climate change con-

tinues, more effects of this kind are expected. More precipitation in the form of rain in winter may increase runoff and erosion from agricultural areas, resulting in higher inputs of nutrients and particulate matter to river systems and from there to coastal waters.

7.3.5 Marine litter

Marine litter is considered to be a global problem and one that is growing in scale, largely because the amounts removed from the world's oceans are so small. Most activities in or associated with the management plan area contribute to the problem, even though the disposal of waste at sea is banned by both national and international law, and clean seas are in the best interests of both industries and individuals. Under Norway's Pollution Control Act, there is a general ban on disposing of waste in such a way that it causes littering, which applies both on land and at sea.

The IMO International Convention for the Prevention of Pollution from Ships (MARPOL) prohibits all discharges of waste from ships. Illegal discharges from ships – and perhaps to an even greater extent, illegal discharges from ships out-

Box 7.3 Marine litter and injury to the fauna

Marine litter is a threat to the marine environment and can cause considerable harm to animal life in the sea:

- Internal effects: If animals confuse litter with food and ingest it, this can result in the uptake of hazardous substances from plastics, suffocation, or damage to the stomach and gut; litter may also block the respiratory system or oesophagus and prevent normal digestion.
- External effects: if animals become entangled in nets or other objects, they may suffocate, drown, die of hunger because they are unable to hunt or feed, be physically injured, with possible complications such as infections, or their growth may be hampered.
- Ghost fishing: lost or dumped fishing gear can continue to catch fish and other animals for long periods.
- Marine litter can put further pressure on species that are already in difficulty, such as auks and other threatened bird species.

- Marine litter may be one of several factors that in combination cause serious cumulative environmental effects.



Figure 7.5 Shag entangled in a fishing net

Photo: Morten Ekker

Table 7.7 Environmental impacts of marine litter. Based on the report *Cumulative Environmental Effects* (Climate and Pollution Agency 2012).

Marine litter		Environmental impacts	Comments
Fisheries	Lost fishing gear	Concentrations of marine litter in the North Sea and Skagerrak are the highest recorded in the Northeast Atlantic.	Quantities of lost fishing gear in management plan area not investigated. Scale and impacts assessed as minor.
Shipping	Illegally discarded marine litter	Various sectors contribute to the problem in the management plan area, and there are inputs of litter from other countries' sea areas. We have only limited knowledge of the exact scale and sources of marine litter in Norway. This makes it difficult to assess the environmental impacts of litter from individual sectors. The impacts on seabirds are assessed as <i>moderate</i> , based on findings of considerable quantities of plastics in the stomachs of fulmars.	Applies in the event of illegal discharges.
Land-based and coastal activities			Assessed as having minor impacts.
Long-range transboundary pollution			Assessed as having minor impacts on all ecosystem components, but moderate impacts on seabirds. Impacts on ecological relationships and in particularly valuable areas are unknown.

side the North Sea – are sources of marine litter, which can drift for long distances. However, most marine litter originates from land. Waste that is dumped illegally or carelessly near beaches and rivers can be swept into the water, for example during spring floods. Industrial waste and landfill waste can be transported by wind and surface runoff to coastal and marine waters. Particulate matter from road traffic (including asphalt and rubber particles) is also transported by runoff and stormwater. Long-range transport of marine litter from other areas is believed to account for a considerable proportion of the total quantity in the management plan area. The large rivers that drain into the southern part of the North Sea also contribute to the problem.

End-of-life and discarded leisure craft may become a serious environmental problem in the future. Calculations show that far more boats are dumped illegally than the number delivered to approved waste facilities. Leisure craft contain a range of environmentally harmful components that can pose a considerable risk of pollution. In addition, dumping boats illegally means that the

materials and energy resources they contain are not properly used. The number of leisure craft is expected to rise considerably in the future, and the environmental problems will increase if end-of-life craft are not dealt with in an environmentally sound way.

Lost fishing gear, both commercial and non-commercial, is one important type of marine litter. Some lost gear ends up as beach litter, but a large proportion is believed to remain in the sea. Lost nets and traps can continue to catch fish and other animals long after they have been lost, a problem known as ghost fishing. There have been no comprehensive surveys of the scale of ghost fishing in the management plan area. From time to time, marine litter is caught in trawls, or fishing vessels retrieve marine litter in other ways. At present, there is little or no incentive to ensure that litter is collected and brought ashore by fishing or other vessels. Facilities for delivering litter that has been retrieved from the sea vary widely from one port to another.

Every year, considerable numbers of seabirds, marine mammals and fish are injured or killed by

marine litter because they ingest it or come into contact with it in other ways (see Box 7.3). Table 7.7 gives an overview of the impacts of marine litter. In addition, litter can have negative economic and social impacts such as the cost of clean-up operations, damage to boats, loss of fishing gear and reduction of the amenity value of outdoor recreation areas. The coastline adjacent to the management plan area is intensively used for outdoor

recreation and important for people's well-being. Litter along beaches is an aesthetic problem and can hinder people's use of the area. It is estimated that about 15 % of all marine litter is washed up on land, while about 15 % remains afloat in the sea and as much as 70 % eventually sinks to the seabed. However, there have been few studies to verify these figures.

Box 7.4 Beach clean-up and retrieving marine litter

Many people are concerned about the problem of marine litter in Norway. Litter is visually intrusive and reduces the quality of the coastline for outdoor recreation. Many volunteers, associations and organisations are involved in voluntary beach clean-up campaigns that remove large quantities of litter from selected areas. An annual beach clean-up day is organised throughout the country by the voluntary organisation Hold Norge rent (Keep Norway Clean), which coordinates efforts in different geographical areas. In addition, the Norwegian Nature

Inspectorate and the county governors organise systematic efforts to clear litter from protected areas and public beaches. The intermunicipal outdoor recreation boards and other organisations are also involved in beach clean-up, monitoring of litter and information work. The Directorate of Fisheries conducts an annual retrieval programme that removes substantial amounts of lost gear and other fisheries-related litter from the sea. The programmes cover waters from Møre og Romsdal and northwards.



Figure 7.6 Annual beach clean-up day, April 2012. From the Hvaler archipelago. This beach is included in the OSPAR beach litter monitoring programme.

Photo: Intermunicipal outdoor recreation board for the Oslofjord

Table 7.8 Environmental impacts of physical loss and damage. Based on the report *Cumulative Environmental Effects*, part of the scientific basis for the management plan (Climate and Pollution Agency 2012), with supplementary information. Stars in the third column refer to the starred comments in the fourth column.

Physical loss and damage		Environmental impacts	Comments
Petroleum	Drill cuttings on the seabed Installations Pipelines	<i>Minor</i> impacts on benthic communities, fish (sandeel, Norway pout, saithe, herring, cod, mackerel, haddock)	There is some uncertainty about the impacts of large piles of drill cuttings previously deposited after drilling using oil-based drill cuttings.
Fisheries	Bottom trawling	<i>Minor</i> impacts on corals and sponges <i>Moderate to major</i> impacts on benthic communities*	*Moderate to major impacts in areas that are trawled frequently. Minor impacts on the management plan area as a whole
Offshore renewable energy production	Occupation and disturbance of areas of seabed by installations and burial of pipelines. Artificial reef effects.	<i>Minor</i> impacts on benthic communities and habitats, corals, plankton, current conditions	A wind farm with fixed installations occupies areas both on the surface and on the seabed. The scale of pressures and impacts is very uncertain and dependent on the technology used. No coral reefs registered in the areas assessed for offshore wind power. Strategic impact assessment concluded that impacts on fish would generally be minor except in the areas Southern North Sea I, Stadthavet and Frøya-banken. Impacts can be reduced by remedial measures or avoiding parts of the areas assessed

In general, knowledge of the scale of the marine litter problem is inadequate; for instance, little is known about the relative importance of international and national sources. In the scientific basis for the management plan, the impacts of marine litter from each of the relevant sectors are assessed as minor, with the exception of long-range transport of litter, which is assessed as having moderate impacts on seabirds. This conclusion is based on findings of considerable quantities of plastics in the stomachs of fulmars, and the fact that we have not achieved OSPAR's ecological quality objective for the quantity of plastics in the stomachs of dead seabirds (see Table 7.7).

The overall conclusion is that marine litter is a substantial environmental problem in the management plan area and that further measures are needed to learn more about the scale of the problem, to reduce the quantities of marine litter entering the environment, and to remove as much as possible of the litter that is already present.

7.3.6 Physical pressures

The following types of pressures on the seabed were assessed during the impact assessments: occupation of areas, deposition of material, sealing of the seabed, sediment deposition, and bottom trawling. There is normally no dredging or dump-

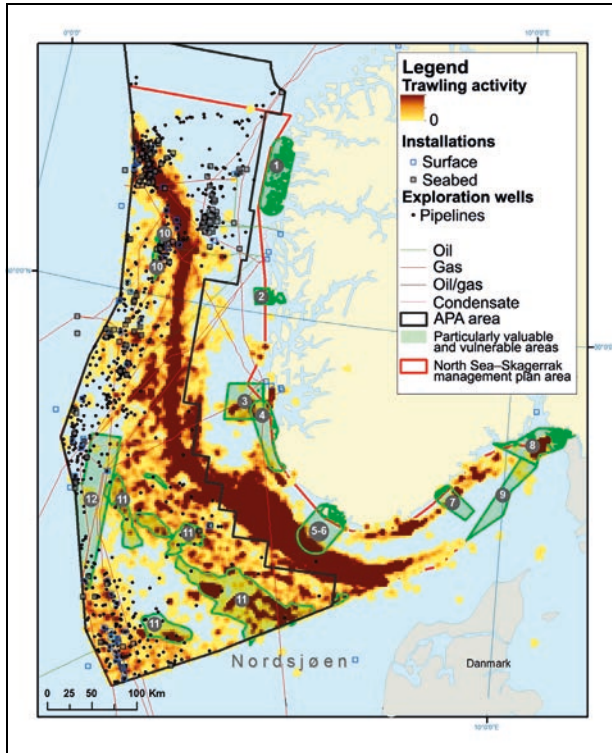


Figure 7.7 Activities and installations in the management plan area with impacts on the seabed (bottom trawling, petroleum installations, exploration wells, pipelines).

Source: Directorate for Nature Management, Norwegian Petroleum Directorate and Directorate of Fisheries.

ing of dredged material in the management plan area. Installations on the seabed gradually become overgrown with marine organisms and their foundations may function as artificial reefs. There has been little investigation of their impacts. Table 7.8 provides an overview of the impacts of physical loss and damage.

Large parts of the management plan area are influenced by activities with impacts on the seabed (Figure 7.7). Bottom trawling is the most widespread activity, and its impacts are assessed as varying from moderate to major in areas that are frequently trawled. There has been a great deal of bottom trawling in the North Sea and Skagerrak for over 100 years. This has impacts on large soft-bottom areas in relatively shallow waters and particularly along the sloping sides of the Norwegian Trench. Trawling can damage or destroy important habitats and alter the structure of benthic communities. The effects of bottom trawling are greatest the first few times an area is trawled. With repeated trawling, species that are not resilient to the activity are expected to disappear gradually. The impacts of the removal and

destruction of molluscs and sessile organisms persist for a long time precisely because these organisms grow very slowly. However, benthic communities that are resilient to trawling will become established in areas that are trawled repeatedly, and will be fairly stable as long as trawling continues.

According to the impact assessment for the petroleum industry, the impacts of physical loss and damage to the seabed are minor and limited to small areas. Discharges of drill cuttings from oil and gas activities affect only a small proportion of the continental shelf. The total contaminated area around installations on the Norwegian part of the shelf in the North Sea amounts to about 90 km². The total area around installations in the North Sea where there are impacts on the benthic fauna is estimated at about 10 km². This area is largely affected by previous discharges of oil-contaminated drill cuttings, as shown by elevated concentrations of hydrocarbons and changes in the species composition of the sediment fauna. However, laboratory experiments have shown that discharges of drill cuttings with water-based drilling fluids can also have impacts on the benthic fauna, although this is limited to about 250 metres of the installations. Less is known about the impacts of drill cuttings on vulnerable benthic communities and fish species that live in and on the sediments, such as sandeels.

A number of other activities also occupy or disturb areas of the seabed, but on a smaller scale. Offshore wind power development could result in both habitat loss and habitat gain. However, wind power development would not be expected to have substantial negative impacts on benthic communities in any of the areas assessed in the strategic impact assessment.

Impacts on particularly valuable and vulnerable areas

Bottom trawling takes place in a number of particularly valuable and vulnerable areas – the Karmøyfeltet and Siragrunnen bank areas, the Skagerrak transect, the Outer Oslofjord, and «sandeel habitat south» in the southernmost part of the management plan area (see Figure 3.15). Any activities that occupy parts of these areas could reduce the amount of suitable habitat for sandeels, which are a key species in the ecosystem.

There are now strict restrictions on bottom trawling in Norway's territorial waters. The fishing industry is likely to make increasing use of

gear types that have less impact on the seabed than those in use today.

7.3.7 Impacts of noise

In recent years, underwater noise and its impacts have received growing attention both in Norway and internationally. Many marine organisms use sound as their primary form of communication, whether to find a mate, search for food, avoid predators or for navigation. Activities that generate underwater noise can affect these functions. Sources of underwater noise may generate either impulse noise (blasting, pile-driving, seismic surveys, sonar) or continuous low-frequency noise (ship propellers, wind turbines, cables, drilling). Water carries sound well, and sound travels four times as fast in water as in air. Because sound is transmitted so efficiently under water, the geo-

graphical area influenced by sound pollution can be very large.

Both marine mammals and fish are influenced by noise. Different species respond differently, and some life cycle stages are more sensitive than others. Fish, for example, are most vulnerable during spawning and spawning migrations. Noise is now believed to be a greater problem for marine mammals than was previously thought. Responses such as strong avoidance, changes in communication patterns and a sudden halt in feeding can occur even at low noise levels.

Table 7.9 provides an overview of the impacts of noise.

None of the sectors report major impacts from the noise generated by their activities. Direct impacts are assessed as local only, but behavioural changes as a result of scare effects of noise are believed to occur over longer distances. Noise has impacts on both marine mammals and fish.

Table 7.9 Environmental impacts of noise (from the report *Cumulative Environmental Effects* (Climate and Pollution Agency 2012))

Noise pollution		Environmental impacts	Comments
Petroleum (seismic)	Seismic and sonar	<i>Minor</i> impacts on plankton, fish (sandeel, Norway pout, saithe, herring, cod, mackerel, haddock)	
Petroleum	Pile-driving, propeller noise, etc	<i>Minor</i> impacts on plankton, fish (sandeel, Norway pout, saithe, herring, cod, mackerel, haddock)	
Shipping		<i>Minor</i> impacts on marine mammals (propeller noise)	Limited knowledge base
Offshore renewable energy production		<i>Minor</i> impacts on marine mammals, plankton	Establishment of offshore wind farms may cause noise pollution, especially during construction. Little is known about the impacts, and they have only been assessed for marine mammals and plankton. Impacts on fish not assessed
Land-based and coastal activities	Disturbance during the breeding season	<i>Moderate</i> impacts on seabirds (gulls, cormorant/shag and common eider)	Applies to coastal seabirds that are disturbed by people during the breeding season

Table 7.10 Environmental impacts of climate change and ocean acidification up to 2100 (from the report Cumulative Environmental Effects (Climate and Pollution Agency 2012))

Global CO ₂ emissions		Environmental impacts	Comments
Climate change	Changes in ocean temperature, salinity, stratification, ocean circulation, current patterns, precipitation patterns	<i>Major</i> impacts on all ecosystem components	High level of uncertainty in the assessment of the severity of the impacts
Ocean acidification	Ocean acidification	<i>Major</i> impacts on plankton, benthic communities, benthic habitats, fish. <i>Indirect impacts (major impacts)</i> on seabirds and ecological relationships	High level of uncertainty in the assessment of the severity of the impacts

Larvae near sources of sound can be injured. Little is known about the effects of low-frequency noise on communication between marine mammals. Because a general increase in human activity is expected in the management plan area in the years ahead, underwater noise levels are also expected to increase.

Knowledge of the cumulative effects of noise pollution in the North Sea and Skagerrak is limited.

7.3.8 Global emissions of CO₂ and other greenhouse gases

Climate change caused by global greenhouse gas emissions has impacts on the marine environment. CO₂ emissions also result in ocean acidification. Both climate change and ocean acidification may result in large-scale changes in marine ecosystems. Table 7.10 gives an overview of the impacts of climate change and ocean acidification in the period up to 2100.

Climate change

The climate in the North Sea–Skagerrak area is changing. In the IPCC's Fourth Assessment Report, published in 2007, most of the global temperature rise in the past 50 years is attributed to anthropogenic emissions. Because greenhouse gases have global impacts, the impacts of local emissions on the management plan area have not been assessed. On the other hand, the impacts of global warming were treated as a very important issue in the impact assessments. A variety of observed changes in the distribution of fish,

plankton and benthic organisms, and also regime shifts, can be linked with climate change, although it is so far difficult to determine how much of the observed climate change in the management plan area is anthropogenic.

In future, anthropogenic climate change will probably outweigh natural fluctuations. In that case, changes in sea temperature, stratification, ocean circulation and current patterns in particular may affect the entire management plan area in varying degrees.

The causal relationships behind the anthropogenic changes are expected to become clearer, and climate change is likely to have far-reaching impacts on plankton, benthic organisms, fish, seabirds and marine mammals in the management plan area. For example, new species from further south may become established here, while more northerly species are displaced northwards. One possible effect of such changes is mismatches in time and space between prey species and the predators that feed on them, with effects along the entire food chain.

Climate change may also have impacts on pollution status by altering pollution levels, the spread and inputs of hazardous substances and the risks they pose. However, it is difficult to predict how great these effects and their significance will be. In the worst case, levels of a number of hazardous substances, both old and new, may rise. Such changes have already been observed for some hazardous substances in the Arctic. Climate change may also affect the toxicity of hazardous substances, the extent to which they accumulate in food chains and how vulnerable organisms are to these substances. Temperature

Box 7.5 Ocean acidification and its impacts on calcifying organisms

An equilibrium always forms between CO₂ in surface sea water and atmospheric CO₂. When CO₂ dissolves in water, it forms carbonic acid, which makes the seawater less basic. Acidity is expressed as pH. A pH of 7 is neutral, solutions with a pH less than 7 are acidic and solutions with a pH greater than 7 are basic or alkaline. Since the industrial revolution, global surface ocean acidity has increased by 30 %. This means that the concentration of positive, acidic hydrogen ions (H⁺) ions has risen by 30 %, and that average pH has dropped from 8.2 to 8.1. The water is still on the basic side of neutral, but has become more acidic. In the decades ahead, a further reduction of 0.1–0.2 pH units is expected. Calcium carbonate forms when calcium and carbonate ions precipitate out of seawater. As the concentration of hydrogen ions rises, the concentration of carbonate ions decreases. If it falls below a critical level, the seawater becomes undersaturated in carbonate,

and solid calcium carbonate can gradually dissolve.

Calcifying organisms mainly use calcium carbonate in the form of calcite or aragonite to build their shells and skeletons, and require a certain degree of supersaturation of these compounds in seawater for the process to function properly. Measurements show that there has already been some decline in the degree of calcite and aragonite saturation. Coldwater corals and a number of bivalves contain aragonite, the most soluble form of calcium carbonate. So does *Limacina helicina*, a sea snail that plays an important role in the marine food web. Crustaceans and echinoderms with calcium carbonate skeletons contain calcite, which is less soluble than aragonite, as do many groups of planktonic organisms. Ocean acidification may also have negative effects on sensitive biological processes such as reproduction, and on early life stages such as eggs and larvae.

changes may also affect inputs, transport and effects of nutrients. Higher precipitation may increase runoff and leach nutrients from land more rapidly, and result in remobilisation of nutrients from the environment. There are complex interactions behind such effects, and our knowledge of these issues is inadequate at present. It is difficult to predict either trends or impacts precisely and reliably. Climate change may also increase vulnerability to other pressures.

Ocean acidification

Measurements show that globally, the average pH of ocean surface water has dropped by about 0.1 pH units. During the present century, pH is expected to drop more and more rapidly. This will also result in changes in saturation levels of calcium minerals, which are vital «building blocks» for many marine organisms. No impacts of ocean acidification have as yet been demonstrated in the management plan area. However, the expected future changes in pH entail a risk of major impacts on individual species – both directly as a result of lower pH and indirectly as a result of changes in saturation levels of calcium minerals. This could in turn result in major changes in food supplies for

other marine species. In addition, it is uncertain whether a lower pH may have other impacts by affecting nutrient cycles and the bioavailability of micronutrients and hazardous substances.

7.4 Cumulative environmental effects on specific ecosystem components

7.4.1 Cumulative environmental effects on phyto- and zooplankton

State

In the sea, as on land, plant growth (primary production) is the basis for all other biological production. Changes in primary production or the conditions for primary production will have impacts on all higher trophic levels in marine food chains. Many of the factors that affect the phytoplankton are also important for the production, species composition and distribution of the zooplankton. Changes in the zooplankton biomass available can affect the entire food chain.

In the past 20 years, the species composition of the phyto- and zooplankton in the management plan area has changed, partly as a result of rising sea temperature.

Causes and impacts

Shipping, petroleum activities, fisheries and long-range pollution have little impact on phytoplankton production in the North Sea and Skagerrak, nor is acute pollution expected to have measurable impacts.

Inputs of nutrients and organic matter from land-based and coastal activities may have major impacts on some coastal ecosystems, and this could have indirect impacts on the management plan area.

There are wide variations between seasons and between years in the species composition and biomass of phytoplankton. Important natural factors that influence the phytoplankton include nutrients, light, temperature, salinity, mixing of the water masses, grazing and sedimentation.

Climate change could influence several of these factors and thus result in changes that propagate upwards in food chains. We are already seeing changes in the quantity and composition of the plankton and their production cycle, which are largely attributed to climate change.

Projections

Towards the year 2100, continued ocean acidification and climate change, rising sea temperatures and increasing runoff of nutrients and organic matter from land may have major impacts on the distribution of various plankton species. This could in turn have far-reaching effects on all trophic levels in the food chain.

Global cuts in CO₂ emissions will be an important factor in the future, as will international cooperation under the EU directive on national emission ceilings for certain atmospheric pollutants and the Gothenburg Protocol (which restricts emissions of gases that contribute to acidification and eutrophication).

Despite reductions in releases of phosphorus and nitrogen both in Norway and internationally, certain coastal waters and fjords with shallow sills are still at risk of eutrophication, with excessive production of phytoplankton (high primary production). Changes in coastal ecosystems may be intensified by climate change, and would have indirect impacts on the management plan area. Integrated management in line with the Water Framework Directive will be an important management instrument in future, both in Norway and in the EU.

7.4.2 Cumulative environmental effects on benthic communities and habitats

State

The species composition of benthic communities is an important indicator of environmental quality.

Monitoring of coastal waters shows that the state of hard- and soft-bottom benthic communities in the outer zone of coastal waters is good and, and benthic communities in the Outer Oslofjord are showing a positive trend, whereas the kelp forests closest to the coast are showing a negative trend. However, our knowledge of habitat types and benthic communities in the management plan area is limited. This complicates assessments of the cumulative environmental effects on the benthic fauna and benthic communities, including assessments for particularly valuable and vulnerable areas.

Causes and impacts

Data and analyses from monitoring in the North Sea and Skagerrak indicate that there are several reasons for the changes in benthic communities. Eutrophication and sediment deposition have a marked influence on the benthic fauna and benthic communities near the coast. Elsewhere, inputs of nutrients and hazardous substances are considered to have only minor impacts. Fisheries, particularly bottom trawling, put considerable pressure on benthic communities in parts of the management plan area.

Oil and gas activities affect benthic communities and species, but to a limited extent. Discharges of drill cuttings from exploration and production drilling and other mechanical disturbance of the seabed have only local impacts. The impact of anti-fouling systems has been greatly reduced through new measures implemented by IMO.

Oil spills are not generally expected to have major impacts on benthic communities, but there may be local impacts. The potential consequences depend on the distance from a spill to shallow coastal waters, and whether there is a possibility of direct contamination of the seabed (for example if a ship is grounded). Accidents involving releases of radioactive material could have long-lasting impacts on benthic communities.

Habitat fragmentation and degradation is considered to be a serious threat to biodiversity today, in marine environments as elsewhere. There is particular concern about burrowing and sessile organisms and fish that are associated with sediment, such as sandeels. Such species are often

dependent on very specific bottom conditions, and are therefore vulnerable to pressures that change the quality of the substrate or influence ocean currents. Fishing with bottom gear, fixed installations, mooring systems and pipelines laid on the seabed can all cause such changes. There is little documentation of quantities of marine litter on the seabed, but this can be a considerable problem for the benthic fauna and other animals that live near the seabed.

One of the world's largest known inshore cold-water coral reef complexes, the Tisler reef, is in Ytre Hvaler national park. Restrictions on bottom trawling have been introduced to protect the coral habitats here. It is considered important to obtain more information on the state and occurrence of vulnerable, habitat-forming benthic organisms such as corals and sponges in the management plan area.

Projections

Projections indicate that direct and indirect pressures and impacts related to climate change and ocean acidification will have a strong influence in the period up to 2030 and 2100, and that there may be major impacts on benthic communities. Sugar kelp forests and coral reefs are two of the habitat types that are vulnerable to temperature changes. Kelp forests are important for biodiversity, for example as nursery areas for fish larvae and feeding areas for several species of seabirds. Coral reefs are complex habitats that also support high levels of biodiversity. Both corals and other calcifying organisms will be vulnerable to increasing acidification.

The situation for benthic communities by 2030 will depend on activity levels and the management measures that are implemented. In areas where there are particularly valuable and vulnerable benthic communities, developments will depend on the cumulative environmental effects and on the requirements that apply to activities in and around such areas. Fisheries management measures could be an important factor for benthic communities that are currently trawled frequently.

7.4.3 Cumulative environmental effects on fish stocks

State

In the past 10 years, there has been concern about poor recruitment to several of the most important fish stocks in the North Sea. Several marine fish

species are classified as threatened on the Norwegian Red List. Inputs of hazardous substances have resulted in worryingly high levels of some substances in certain fish species.

Causes and impacts

The state of a particular stock is determined by the sum of a whole range of pressures and impacts. In addition to heavy fishing pressure, the background reports for this white paper have identified environmental changes, especially changes in temperature and in zooplankton communities, as important factors.

If a fish stock is weakened and vulnerable, even relatively minor negative pressures and impacts may have disproportionately strong effects.

High levels of certain hazardous substances have been measured in a few fish species from the North Sea and Skagerrak (see Chapters 3.2.2 and 7.3.2). We know too little about the effects of long-term exposure and the combined effects of exposure to mixtures of different pollutants, and about new substances. Physical conditions such as temperature, salinity stratification, suspended particulate matter, food supplies and ocean acidification are very important for the early life stages of fish. Climate change may also influence survival in early life stages, growth and sexual maturity. Many fish species are able to move away from areas where conditions are suboptimal, and a northward shift in the distribution of several gadid species has already been observed. However, species such as sandeels that are closely associated with particular habitats cannot adapt in this way, and are therefore vulnerable to climate change and other more direct pressures within their distribution range.

Projections

The projections indicate that climate change and ocean acidification will be the factors that have most impact on fish in the years ahead. Climate change has already resulted in more frequent observations of commercially important species such as anchovy, pilchard, John dory, rudderfish, surmullet and Atlantic pomfret in the North Sea. Anchovy and pilchard in particular, both of which are pelagic schooling species, may become important for the fishing industry and for the North Sea–Skagerrak ecosystem. At the same time, a warmer climate may displace species that are cur-

rently common in the North Sea away from the area.

Several of the fish stocks in the management plan area are managed jointly by Norway and the EU, and they cooperate on the management of a number of other species. Successful fisheries management in the future will depend on agreement between Norway and the EU on joint management measures, and on their implementation in practice. It will be crucially important for the EU to introduce a ban on discards.

7.4.4 Cumulative environmental effects on seabirds

State

A number of seabird populations in the North Sea and Skagerrak 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, and to both coastal and pelagic seabirds (those that feed out at sea). Several species are listed as threatened on Norway's Red List for 2010.

Causes and impacts

The scientific basis distinguishes 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.

Levels of hazardous substances are highest in species at higher trophic levels. Along the Norwegian coast, gulls and great skuas have been found to contain the highest levels of persistent organic pollutants. Large gulls, which also visit landfills and urban areas, are likely to be more vulnerable to contamination with hazardous substances through their food than purely fish-eating species or pelagic feeders. Hazardous substances can have greater impacts on reproduction and survival during periods when little food is available than when there are abundant food supplies. Discharges of nutrients from agriculture, municipal waste water treatment, aquaculture and industry near the coast can have indirect impacts on coastal seabirds, since they can result in eutrophication, which in turn has impacts on ecosystem

components such as kelp forests and reduces food supplies for seabirds.

Seabirds are particularly vulnerable to marine litter, because they can mistake fragments of plastic for food and ingest them.

There is a great deal of pressure on the coastline adjoining the management plan area; it is heavily used by leisure craft and for outdoor activities such as camping and bathing, which can disturb seabirds during the breeding season and reduce breeding success, particularly in coastal species. Disturbance during the breeding season can make the adult birds leave their nests, which may then be robbed by other birds, particularly crows and gulls.

Seabirds are highly vulnerable to oil spills. Important factors in addition to the size of a spill, are its timing and location in relation to the seabird distribution. There is a high level of uncertainty in estimates of the consequences of spills. A small spill may kill more birds than a major spill if it coincides in time and space with large numbers of seabirds. After the grounding of the *Full City* in the Outer Oslofjord in 2009, it was estimated that 2000–2500 seabirds died. Of these, 1500–2000 were common eider. However, this mortality had little effect at population level.

Hunting of a few seabird species is permitted. In the management plan area, it is largely common eider and cormorant that are hunted, including about 9000 eider a year along the Skagerrak coast. Seabird populations that are registered as declining are not hunted. Hunting pressure has been gradually reduced over many years in Nordic waters, and this has greatly reduced its importance as a threat to seabird populations. There are no indications that the current level of harvesting has any significant effect on populations in the Norwegian part of the North Sea and Skagerrak.

Seabirds are also taken as accidental bycatches, particularly in gill nets. Too little is known about the scale of these bycatches at present. This issue is attracting considerable attention internationally, and in autumn 2012, the EU published an action plan for reducing incidental catches of seabirds.

Seabird numbers in the North Sea are largely a result of high primary and secondary production of phyto- and zooplankton, and large stocks of small pelagic fish species such as herring, sprat and sandeels. The food preferences of seabirds include a wide range of prey species, and preferences may vary considerably through the year, between years and between regions. In the breeding season, a number of seabird species forage up

Box 7.6 Particles of plastic in seabird stomachs

Fulmars forage exclusively at sea, feeding on floating dead fish and fish waste from fishing vessels as well as live fish. They often confuse floating fragments of plastic with food and ingest them. These fragments may be of a shape or size that makes it difficult for them to pass through the digestive system. The effects depend on how where the blockage occurs. Fragments stuck high in the oesophagus can choke a bird, while further down or in the stomach they may reduce food intake or the ability to ingest food. In the longer term, this can damage

the digestive system or kill the bird. Persistent organic pollutants can bind to the surface of small plastic particles, adding to the accumulation of such substances in marine food chains.

In a study of beached seabirds found at Lista near the southern tip of Norway, 98 % of the birds were found to have plastic particles in their stomachs. On average, each stomach contained 46 plastic particles, with a total weight of 0.33 grams. This is equivalent to a large dinner plateful of litter in a human stomach.



Figure 7.8 Fragments of plastic from seabird stomachs and a fulmar in flight

Photo: Jan van Fraeneker

to about 100 km out to sea from their colonies. It is the younger year classes of herring that are particularly important seabird prey, especially in the open sea, while sandeels and sprat are suitable throughout their life cycle because of their limited size. Sprat and sandeels are especially important for a range of coastal seabird populations. Herring and sprat are important food species for common guillemots, razorbills and kittiwakes in the North Sea for much of the year, but gadids such as poor cod, Norway pout and young year classes of saithe also make up a substantial part of the diet of wintering auks. During the breeding season, sandeels are a particularly important food species for gulls, including kittiwakes, and auks. There is no fishery for coastal stocks of sandeels.

Marine ecosystems are complex, and in most cases the decline of a seabird population is probably due to several factors. Developing an understanding of these complex interactions is a challenging task. The importance of indirect impacts of climate change on seabird populations varies

geographically and between species. As the temperature of seawater rises, organisms such as the copepod *Calanus finmarchicus*, herring and mackerel respond by altering their distribution patterns. Seabird populations that have already been negatively affected by changes in food supplies are more vulnerable to direct pressures.

A reduction in the availability of prey species has been identified as one of the reasons for the decline in several seabird populations in recent years. The fisheries can have indirect impacts on seabirds through changes in the species composition and quantities of potential prey species. The report *Action plan for seabirds in Western-Nordic areas*, published by the Nordic Council of Ministers in 2010, contains a review and assessment of pressures and impacts on seabirds in the North-east Atlantic, based on information from national and international experts. The report highlights three pressures that are important for many seabird species in large parts of the study area. These are climate change/rising sea temperatures, com-

petition with fisheries and oil pollution. The report identifies food shortages caused by competition between seabirds and fisheries as an important cause of the problems many seabird populations are experiencing in areas where fisheries and seabirds compete for the same species. However, seabirds and fisheries do not necessarily compete for the same fish resources at the same time and in the same place. There is often a time lag, and competition may be indirect. We still need more knowledge to understand the mechanisms involved and quantify the relationships. A working group of seabird experts and marine scientists has been established to investigate the links between the decline in many seabird populations and their food supplies, and suggest measures to improve food availability for seabirds.

Projections

Large-scale climate change will have far-reaching impacts on the species composition, numbers and temporal and spatial distribution of seabirds in the North Sea and Skagerrak. Signs of change have already been documented for both seabirds and fish in the region. In the breeding season, seabirds have a limited radius of action when foraging because they have to return to their eggs or young, and they are therefore particularly sensitive to changes in the availability of prey species, regardless of the reason behind such changes.

If wind farms are established near the coast or offshore in the management plan area, there could be conflicts with seabirds in the areas Frøyagrunnene and Olderveggen, because these overlap with feeding areas for red-listed species such as puffin, common guillemot, kittiwake, common tern and black guillemot in the breeding season. Wind farms could also cause problems for migratory species. There is some uncertainty about the impacts of wind farms in the other areas proposed for wind power developments. The main impacts for seabirds are expected to be direct mortality as a result of collisions with turbines, degradation and fragmentation of habitats, and disturbance (particularly during the construction period) that may cause birds to avoid or move away from the area.

Threats to seabird populations are not delimited by national borders, and this complicates the pattern of threats facing seabirds, which also vary through the year. Pressures outside the management plan area may thus have strong effects on populations that breed within it.

7.4.5 Cumulative environmental effects on marine mammals

State

Whale populations in the North Sea and Skagerrak are stable. Protection has had a positive impact on seal populations, but the common seal is still listed as vulnerable in the 2010 Norwegian Red List.

Causes and impacts

Pressures known to affect marine mammals in the North Sea and Skagerrak are hazardous substances, marine litter, and noise from sonar and propellers. Marine mammals are taken as bycatches, primarily in gill nets. Since they are top predators, marine mammals 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. Knowledge from other sea areas indicates that natural mortality, infections and lower fertility can be linked to hazardous substances. The spill scenarios that have been assessed show that oil spills from petroleum activities could have up to moderate consequences for seals (grey seals).

Projections

In addition to the long-term impacts of pollution by hazardous substances, the situation for marine mammals may deteriorate in future as a result of climate change, and as an indirect result of ocean acidification. However, there is considerable uncertainty attached to these assessments.

7.4.6 Cumulative environmental effects on coastal waters and the shore zone

Many of the people who live along the Skagerrak and North Sea coast have close ties with the sea and coastal zone, and use these areas for recreation and outdoor activities, commercial fisheries and recreational fishing. At the same time, human activity is having marked environmental impacts in the area. Hazardous pollutants have been and still are a major problem in many coastal and fjord areas. They may originate from industrial emissions, releases from urban areas or remobilisation of earlier releases, for example pollutants leached from sediments in ports and harbours where they have accumulated. The Norwegian Food Safety Authority has therefore issued a general advisory

to the whole population against the consumption of liver from private catches of fish taken inside the baseline. In addition, there are advisories against the consumption of fish and/or shellfish from specific areas of a number of harbours and fjords.

Marine litter drifts in the Norwegian coastal current. As a result of wind, current and geographical conditions, it is more likely to accumulate in some localities along the coast than others, and there is an exchange of litter between open waters and the shore zone. The future impacts of marine litter are assessed as moderate.

Other activities that influence the environment in coastal waters and the shore zone are outdoor recreation and tourism, and generally the presence of people – all positive for the human population, but with negative impacts on seabirds, which are easily disturbed during vulnerable periods of the breeding season. The American mink, an alien species in Norway, has spread to many islands and coastal areas, and takes birds' eggs during the breeding season. Lobsters are locally threatened by trapping, and there is heavy fishing pressure on coastal cod. The shore zone is particularly vulnerable to brackish-water invasive alien species that are spread by shipping in harbour areas. Low temperatures have previously limited the spread of a number of introduced species in Scandinavian waters, but warmer seawater may weaken this barrier to the spread of both algae and animals.

During normal operations, petroleum activities and shipping are not expected to have environmental impacts on the shore zone. The same applies to the fisheries. However, acute oil pollution in coastal waters could have serious negative impacts on the shore zone. Higher concentrations of nutrients and organic matter could have direct impacts on kelp forests and seaweed communities, depending on the topography and current conditions. The impacts on the management plan area in the future are assessed as moderate. In addition to warmer water as a result of climate change, higher inputs of nutrients and sediment deposition have been identified as probable reasons why there is little re-establishment of sugar kelp forests along the Skagerrak coast of Norway. This situation is assessed as having moderate impacts on fish-eating seabirds that feed in kelp forests. Changes in species composition and habitats in the shore zone can influence biological production, erosion and the deposition of material in this zone.

If wind farms are established in coastal waters and the shore zone in the future, their impacts are likely to vary from one locality to another.

7.5 Costs of environmental degradation

There is a considerable body of knowledge about the state of the environment in the North Sea and Skagerrak. There is also a good deal of information about the ecosystem services supplied by Norwegian sea areas, although there are many gaps in our knowledge. However, we know very little about the loss of benefits (in other words, the costs) to society associated with the degradation of some marine ecosystems and ecosystem services.

Ecosystem services are the benefits – goods and services – that people obtain from ecosystems. The potential for value creation and earnings in sectors such as fisheries, aquaculture and travel and tourism in future will be closely linked to the state of the environment. Opportunities for value creation based on genetic resources and the use of marine resources in pharmaceuticals, the chemical industry and biotechnology will also be influenced by changes in the state of the environment and the quality of the ecosystem services it provides.

In addition to these well known and recognised ecosystem services, there are many others that are less obvious, including processes such as water purification and waste treatment, maintenance of ecosystem stability and climate regulation (see Box 7.7). Most ecosystem services are public goods. They are not traded in markets and therefore have no market price. Thus, the cost of damage to such services does not appear in company budgets or ordinary accounts, at any rate not in the short term. This increases the risk of their degradation, which can undermine the basis for future prosperity. One of the main purposes of the management plan is to coordinate different interests and weigh up their importance so as to ensure that ecosystem services that are not traded in markets are also managed sustainably, so that their economic value and ecological importance are maintained.

In the case of *fish and shellfish*, environmental degradation means that we cannot harvest as much as would be possible if the state of the environment was improved. Analyses indicate that environmental degradation costs the Norwegian fisheries sector substantial sums every year. The

Box 7.7 Which ecosystem services do the seas provide?

The term «ecosystem services» has in a short time come into widespread use as a way of describing the importance of ecosystems for human well-being. They are generally divided into four categories: supporting, regulating, provisioning and cultural.

Supporting services

Marine primary production, in the form of phytoplankton and marine plants, is an example of a supporting service, and is the basis for the rest of the marine food web and biodiversity. Supporting services underpin practically all other ecosystem services. Maintaining these services is therefore crucial to maintaining ecosystem sustainability. To a certain degree, their economic value is reflected in the market value of provisioning services.

Regulating services

These include services and functions such as climate regulation, mitigation of eutrophication, regulation of hazardous substances, biological regulation and sediment retention. For example, seawater and marine algae and phytoplankton act as a large carbon sink, and this is an important factor regulating global warming (see the estimates presented in Box 7.8).

Provisioning services

The provisioning services are the best known and most directly recognisable. In the case of the sea the most obvious examples are fish and

shellfish, but marine ecosystems also provide products that could be used in for example the pharmaceutical and biotechnology industries.

Cultural services

Cultural services include leisure and recreation opportunities, which are an important part of the basis for the tourism industry. They also include aesthetic value, cultural heritage and contribution to the sense of place, all of which are of fundamental value to people but also difficult to express in monetary terms.

It is generally possible to find market values for fish and other products derived from provisioning services. However, it is important to realise that such figures do not necessarily give a good picture of the ecosystem's contribution to the end products, the value of which also includes labour and other types of factor inputs in production. Turnover figures for the tourism industry reflect the value of some cultural services, but by no means all of them. Other monetary values have to be derived by estimating people's willingness to pay for the services. It is also possible to estimate the value of some regulating services, and Box 7.8 presents the example of the cost of the loss of kelp forests in terms of reduced carbon capture. However, we still have no way of expressing many ecosystem services in monetary terms, and despite methodological developments this will continue to be the case in the future. But the fact that we do not have prices and monetary values does not make these ecosystem services any less important for economic activity and human well-being.

loss of the sugar kelp forests can result in considerable reductions in catches of both commercial and non-commercial species.

Blooms of toxic algae and oil spills can kill fish in *fish farms*. The seafood industry is dependent on a good international reputation, which is not necessarily linked directly to the actual state of the environment. Any negative incidents can jeopardise the industry's reputation and have adverse effects on sales and earnings. The costs are difficult to predict.

It is also difficult to estimate the value of *genetic resources* and resources that can be used

by the biotechnology industry, because these are option values – values related to their possible future use.

As described in Chapter 4, there is substantial value creation and employment in the *travel and tourism industry* in the North Sea and Skagerrak counties. Much of the activity is related to the sea and coastal areas, but it is nevertheless difficult to assess the extent to which poorer environmental status results in a loss of production value and income.

One negative environmental trend in recent years has been the loss of sugar kelp forests in the

Box 7.8 Estimates of the cost of lost carbon fixation by sugar kelp

An analysis of CO₂ uptake in marine habitats by the Norwegian Institute for Water Research estimated that one square metre of kelp forest fixes 3.6 kg of CO₂. Using the figures in the table below, the reduction in CO₂ fixation as a result of the loss of kelp forests in the North Sea and Skagerrak is estimated at 4.6 million tonnes. Given a CO₂ price of NOK 320 per tonne, the cost of the current decline of sugar kelp is estimated at about NOK 1 470 million. This result is sensitive to the CO₂ price chosen. The price of allowances in the EU Emissions Trading System is currently lower than the figure used here. An Official Norwegian Report (NOU 2012:16 *Cost-Benefit Analysis*) recommends using a carbon price path that uses the price in the EU ETS as a starting point, but gradually rises to the level needed to achieve the two-degree target for global warming.

Further losses of kelp forest would release even more CO₂, whereas regrowth of kelp forest

in areas where it has been lost would result in fixation of the quantity of CO₂ estimated above. This carbon is stored only once, and the value calculated is therefore for regrowth of all kelp forest today. For calculations of regrowth in the future, it is necessary to use a discount factor and make assumptions about the future CO₂ price path.

Permanent regrowth of the kelp forests would fix the CO₂ permanently. The turf or filamentous algae that replace kelp forest do fix some CO₂ during the summer (estimated at 5 % of the amount stored in kelp forest), but release the same amount in autumn when they die and are broken down. The table below shows the loss of CO₂ fixation in biomass and an estimate of its value, given the estimated loss of kelp forest area in the North Sea and Skagerrak today.

Area of kelp forest lost	1 251 km ²
Loss of primary production	11 million tonnes
Loss of CO ₂ fixation	4.6 million tonnes
CO ₂ price per tonne	NOK 320
Cost of the loss of CO ₂ fixation (non-recurring)	NOK 1 470 million

Source: Vista Analysis, 2012.

North Sea and Skagerrak. As well as providing a habitat for many marine animals, sugar kelp acts as a sink for large quantities of carbon. Calculations based on a CO₂ price of NOK 320 per tonne show that the area of kelp forest that has been lost today corresponds to a reduction in greenhouse gas fixation valued at about NOK 1 470 million (see Box 7.8). In addition, there is no sedimentation of dead kelp material where kelp forests have been lost, and the cost of this is estimated at a further NOK 24–64 million per year. Such calculations are very sensitive to the carbon price that is used.

Losses such as a reduction in fish production, the number of recreation days or the capacity for

carbon fixation are annual losses that are repeated every year as long as the degraded state of the ecosystem persists and its capacity to provide ecosystem services is reduced. If ecosystem status gradually improves, the costs of environmental degradation will be gradually reduced until good ecosystem status is achieved. If ecosystem status deteriorates further, the annual losses may increase. These matters are difficult to assess at present, but it is nevertheless of interest to examine the importance of good environmental status and ecosystem services for value creation, since this will have implications for decision-making processes.

8 Goals for management of the North Sea and Skagerrak

In this white paper, the Government presents a set of goals for management of the North Sea and Skagerrak. They are intended to reflect relevant national and international goals for the environment and value creation and the purpose of this management plan. They are designed to give clear guidance for the work of improving the environmental status of the North Sea and Skagerrak as a basis for conservation and sustainable use of the area and for value creation and coexistence between industries. The goals apply to all activities in the management plan area.

Purpose

The purpose of this management plan is to provide a framework for the sustainable use of natural resources and ecosystem services derived from the North Sea and Skagerrak and at the same time maintain the structure, functioning, productivity and diversity of the area's ecosystems.

Knowledge-based management

Management of the North Sea and Skagerrak must be based on the best available knowledge. The management regime will be further improved by systematically building up new knowledge about ecosystems, ecosystem services, the state of marine ecosystems and pressures and impacts on these ecosystems.

8.1 Biodiversity and ecosystems

The state of the North Sea and Skagerrak environment has been improved in recent decades, but still gives cause for concern and is unsatisfactory in many ways. These waters are naturally rich and productive, but the different types of pressures on the environment entail considerable management challenges. The Government will continue efforts to improve environmental status in the management plan area, in order to maintain biodiversity and ensure the continued provision of ecosystem services as a basis for harvesting.

One of Norway's environmental targets is to maintain or restore the structure, functioning, productivity and diversity of marine ecosystems so that they provide a basis for value creation through the sustainable use of natural resources and ecosystem services. This means that we accept that human activities leave a «footprint» and that marine areas too are affected by them, but at the same time, activities must be carried out in a way that limits the pressures they cause, to avoid any significant degradation of the environment or of the basis for ecosystem services. In other words, the aim is not to achieve a «natural state», but a state that allows ecosystems to function normally and ensures that they are resilient and productive.

Improving the state of the environment in the North Sea and Skagerrak is expected to increase ecosystem resilience to environmental pressures. Increasing ecosystem resilience and preventing fragmentation of habitats will be a good basis for enhancing ecosystem services and long-term opportunities for harvesting from the management plan area.

Most pressures on the North Sea and Skagerrak can be dealt with using national policy instruments, but in other cases international cooperation is needed. This applies for example to long-range transboundary pollution, climate change, ocean acidification and management of fish stocks. By means of targeted efforts, the Government intends to reduce cumulative environmental effects on the North Sea and Skagerrak to a level that permits positive trends in the state of the environment and the basis for sustainable use.

The Government has set the following goals for biodiversity and ecosystems and sustainable use in the North Sea-Skagerrak management plan area, to be achieved by 2020.

Achieving good environmental status

- Management of the North Sea and Skagerrak will ensure that diversity at ecosystem, habitat, species and genetic levels, and the productivity of ecosystems, are maintained and enhanced.

Human activity in the area will not damage the structure, functioning or productivity of ecosystems.

Particularly valuable and vulnerable areas and habitats

- The management regime will take special account of the need to protect vulnerable habitat types and species in particularly valuable and vulnerable areas. Activities will be conducted with special care and in such a way that the ecological functioning and biodiversity of such areas are not threatened.

Management of habitat types and species

- Naturally occurring species will exist in viable populations that provide for sufficient reproductive capacity and long-term survival.
- Species that are essential to the structure, functioning and productivity of ecosystems will be managed in such a way that they are able to maintain their role as key species in the ecosystem concerned.
- Populations of endangered and vulnerable species and species for which Norway has a special responsibility will be maintained or restored to viable levels. Unintentional negative pressures on such species as a result of activity in the North Sea and Skagerrak will be avoided.
- The establishment of marine protected areas in Norway's coastal and marine waters will contribute to an internationally representative network of marine protected areas.

Sustainable harvesting and use

- Living marine resources will be managed sustainably through an ecosystem approach based on the best available knowledge.
- Harvesting will not have significant adverse effects on other parts of the marine ecosystem or its structure.
- Bycatches of marine mammals and seabirds will be minimised.
- Living marine resources will be harvested making use of the best available techniques for different types of gear to minimise negative impacts on other ecosystem components such as marine mammals, seabirds and benthic communities.

Alien organisms

- The introduction and spread of alien organisms through human activity will be avoided.

8.2 Value creation, commercial activities and society

Ecosystem services and resources in the management plan area provide a basis for substantial value creation and revenue. The goals for value creation in the North Sea and Skagerrak are listed below.

- Management of the North Sea and Skagerrak will promote sustainable use of the area and its resources.
- Management of the North Sea and Skagerrak will facilitate economically viable commercial activities and as far as possible promote value creation and employment in the region.
- Management of the North Sea and Skagerrak will ensure that activities in the area do not threaten the natural resource base and will thus safeguard opportunities for future value creation.
- Management of commercial activities in the area will be coordinated to ensure that the various industries are able to coexist and that the overall level of activity is adjusted to take account of environmental considerations.

Fisheries and seafood

- Harvesting of living marine resources will promote value creation and secure welfare and business development to the benefit of the country as a whole.
- Harvesting activities and natural resource use that provide a high long-term yield within sustainable limits will be facilitated.
- The North Sea and Skagerrak will be a source of safe seafood.

Petroleum activities

- Petroleum activities will continue to promote value creation and secure welfare and business development to the benefit of the country as a whole.
- Steps will be taken to facilitate the profitable production of oil and gas on the basis of health, environment and safety requirements and standards that are adapted to environmental

considerations and the needs of other industries.

Offshore renewable energy

- The development of offshore renewable energy production will be facilitated, taking into account environmental considerations and other activities.

Maritime transport

- Favourable conditions will be provided for safe, secure and effective maritime transport that takes account of environmental considerations and promotes value creation in the region.

8.3 Pollution, marine litter and the risk of acute pollution

Clean seas are an essential basis both for achieving good environmental status and for the possibility of harvesting from ecosystems that produce safe seafood. Despite considerable efforts to reduce levels of hazardous substances and other pollutants in the North Sea and Skagerrak, there are still challenges to be dealt with as regards hazardous substances. Climate change and ocean acidification are new pressures, and so far we know little about their impacts. However, they are expected to result in large-scale changes in marine ecosystems. Concentrations of marine litter in the North Sea and Skagerrak are among the highest recorded in the Northeast Atlantic, and litter quantities need to be reduced. Inputs of nutrients are resulting in local eutrophication problems, mainly close to the coast and in fjords. The pollution-related goals for the North Sea and Skagerrak are listed below.

Climate change and ocean acidification

- When marine ecosystems are used as carbon sinks, the need to maintain biodiversity and natural ecosystem functions will be taken into account.
- The cumulative effects of human activities on habitats and species that are affected by climate change or ocean acidification (e.g. coral reefs) will be minimised, in order to maintain ecosystem functioning as fully as possible.

Inputs of nutrients, sediment deposition and organic matter

- Anthropogenic inputs of nutrients, sediment deposition and inputs of organic matter will be limited in order to avoid significant adverse impacts on biodiversity and ecosystems in the management plan area.

Pollution

- Environmental concentrations of hazardous and radioactive substances will be reduced to background levels for naturally occurring substances and will be close to zero for man-made synthetic substances. Releases and inputs of hazardous or radioactive substances from activity in the management plan area will not cause these levels to be exceeded.
- Releases and use of substances that pose a serious threat to health or the environment in Norwegian waters will be continuously reduced with a view to eliminating them by 2020.
- Releases and inputs of pollutants to the North Sea and Skagerrak will not result in injury to health or damage the productivity of the natural environment and its capacity for self-renewal.
- Operational discharges from activities in the area will not result in damage to the environment or elevated background levels of oil or other environmentally hazardous substances over the long term.
- Activities in the North Sea and Skagerrak will not result in higher levels of pollutants in seafood.
- Activities entailing a noise level that may affect species' behaviour will be limited to avoid the displacement of populations or other effects that may have negative impacts on the marine ecosystem.

Marine litter

- Inputs of litter that have negative impacts on coastal waters, the sea surface, the water column or the seabed will be reduced.

Risk of acute pollution

- The risk of damage to the environment and living marine resources from acute pollution will be kept at a low level and continuous efforts will be made to reduce it further.

- Maritime safety measures and the oil spill preparedness and response will be designed and dimensioned to effectively keep the risk of damage to the environment and living marine resources at a low level.

8.4 Monitoring progress towards goals

As part of the scientific basis for the management plan, a proposed set of indicators was drawn up for use in a coordinated system for monitoring the North Sea and Skagerrak ecosystem. The indica-

tors were selected to coincide with national and international environmental targets, and include state, pressure and impact indicators. In most cases, the indicators are already in use or data are available that can be used, but some further development will be required, for example of reference values and action thresholds. The proposal will be used as a basis by the Advisory Group on Monitoring in its work on the establishment of an integrated monitoring system for the North Sea and Skagerrak. The monitoring results will be used in assessing progress towards the goals.

9 Measures for the conservation and sustainable use of ecosystems

The Government's goal is for Norway to be a pioneer in developing an integrated, ecosystem-based management regime for marine areas.

The purpose of this management plan is to provide a framework for the sustainable use of natural resources and ecosystem services derived from the North Sea and Skagerrak and at the same time maintain the structure, functioning, productivity and diversity of the area's ecosystems. The management plan is thus a tool for both facilitating value creation and maintaining the high environmental value of the area.

Intensively used and economically important

The North Sea–Skagerrak area is Norway's most intensively used sea area and one of the most heavily trafficked in the world. Norwegian society derives major assets from its use. The bulk of Norway's oil and gas production and thus value creation by the industry takes place in the North Sea. In addition, the North Sea is biologically productive. There are major fisheries in the area, which is fished by both coastal and deep-sea fishing vessels. Moreover, the Skagerrak is particularly important for small-scale fisheries, and is also the sea area of Norway that is most heavily used for outdoor recreation. The high level of activity combined with a number of potentially conflicting interests places considerable demands on the management regime.

Access to the sea and opportunities to stay by the seaside and enjoy activities such as boating, swimming and fishing are important to many people. Opportunities to enjoy the seaside are strongly dependent on a clean, rich and productive marine environment – a living sea means a living coast.

Concern about the state of the environment

Since the 1970s, much has been done to improve the environmental status in the North Sea and Skagerrak, and particularly to reduce the pollu-

tion load. Nevertheless, the state of the environment still gives cause for concern and is unsatisfactory in many ways. These waters are naturally rich and productive, but the different types of pressures on the environment entail considerable management challenges. Concentrations of hazardous substances are higher in the North Sea and Skagerrak than in Norway's other sea areas, and the concentration of marine litter is higher than anywhere else in the Northeast Atlantic. Water quality is good in the coastal current, but eutrophication and sediment deposition may affect water quality in near-coastal waters and fjords. Moreover, a number of seabird populations have declined and certain fish stocks are in poor condition. Climate change and ocean acidification are creating new challenges that will require a long-term approach to management of the North Sea and Skagerrak. This means that we need to take steps to improve environmental status and ecosystem resilience, and strengthen the basis for continued value creation through use and harvesting of the North Sea and Skagerrak.

International responsibility and national action

The North Sea and Skagerrak are shared between eight countries. Due to the direction of the ocean currents and prevailing winds, pollution from other countries is carried into Norwegian waters. Cooperation with the other North Sea countries and the combined efforts of all these countries are therefore of crucial importance for achieving good environmental status.

With the publication of the present white paper, the Government has drawn up integrated, ecosystem-based management plans for all Norwegian sea areas. These plans are an important tool for ensuring a good balance between conservation of the environment and sustainable use in marine areas. The Government will therefore continue and further develop the system of management plans, and make it more effective

9.1 Overall framework for commercial activities

The rich resources, ecosystems and ecological goods and services provided by the North Sea and Skagerrak, combined with their geographical location and intensive use, make these areas an engine of the Norwegian economy. The management plan is an important tool for ensuring that the area it covers continues to contribute to prosperity in the long term. The management plans clarify the overall framework and encourage closer coordination and clear priorities for management of Norway's sea areas. They increase predictability and facilitate coexistence between industries that are based on the use of these sea areas and their natural resources.

The management plans are intended to be rolling plans that are updated at regular intervals. The Government has decided that the management plan, and the spatial framework for petroleum activities, in the Norwegian Sea will be updated for the first time in 2014 at the latest. After this, an overall revision will be carried out in 2025 for the period up to 2040. The management plan for the Barents Sea–Lofoten area was first presented in 2006 and updated in 2011. It will be updated again during the next parliamentary period. On the basis of the overall needs that are identified through assessments, a process will be started well before 2020 with a view to an overall revision of the Barents Sea–Lofoten management plan in 2020, with a time frame up to 2040. The Government will continue the development of an integrated ecosystem-based management regime for the North Sea and Skagerrak. On the basis of the overall needs that are identified in this sea area through assessments, a process will be started well before 2030 with a view to an overall revision of the North Sea–Skagerrak management plan in 2030, with a time frame up to 2050.

A flexible digital mapping tool could simplify the work of updating and revising the management plans and also provide general guidelines for spatial management (thus avoiding potential conflicts between activities) in Norway's sea areas. It should also make the process of updating the management plans more efficient and give interested parties more opportunity to take part in the planning process. In other words, such a tool would be useful both during work on the management plans and for subsequent communication of the scientific basis and the conclusions drawn from it.

The Government will:

- Continue to use the system of management plans for sea areas. An overall framework for petroleum activities will be established in the management plan for each sea area.
- Organise a system of rolling management plans with regular updates.
- Update the management plan and the spatial framework for petroleum activities in the Norwegian Sea in 2014 at the latest. The intention is to carry out an overall revision of the management plan in 2025 for the period up to 2040.
- Update the management plan for the Barents Sea–Lofoten area during the next parliamentary period. On the basis of the overall needs that are identified through assessments, a process will be started well before 2020 with a view to an overall revision of the plan in 2020, with a time frame up to 2040.
- Continue the development of an integrated ecosystem-based management regime for the North Sea and Skagerrak. On the basis of the overall needs that are identified through assessments, a process will be started well before 2030 with a view to an overall revision of the plan in 2030, with a time frame up to 2050.
- Develop a digital mapping tool that can be used to present and compile mapping data for updating the management plans and disseminating information about them, in close cooperation between the Forum for Integrated Marine Management and BarentsWatch. The mapping tool will be made available through BarentsWatch.

9.2 Framework for petroleum activities in the North Sea and Skagerrak

Each of the management plans establishes the overall framework for petroleum activities in the sea area in question.

The management plans clarify where petroleum activities will be permitted within areas that have already been opened and within a specific time frame. The framework for activities in areas that have been opened may include environmental and fisheries-related requirements, spatial restrictions and restrictions on when drilling is permitted, and applies to new production licences regardless of whether they are issued during numbered licensing rounds or through the system of awards in predefined areas (APA).

Environmental requirements are applied to all phases of oil and gas activities, from decisions on whether to open areas, via exploration, assessment of whether a field should be developed, the production phase (in specific licences and annual amendments to the licences), and to shutdown and decommissioning of installations.

The North Sea differs from Norway's other sea areas in the scale of oil and gas activities. In 2010, the North Sea fields accounted for about two-thirds of production on the Norwegian shelf. Oil and gas production in this area has a 40-year history, which means that the geology of most of the area is known, there are fewer technical challenges and there is a well developed or planned infrastructure.

The present management plan will provide a good basis for sound resource management and a predictable regulatory framework for the oil and gas industry. Petroleum activities are already in progress or planned in large areas of the North Sea, and these activities must coexist with the fisheries and comply with general environmental requirements. Comprehensive legislation has been established to ensure this. The current legislation lays down strict requirements for the industry, and a wide range of measures has been implemented to ensure that fisheries interests and environmental concerns are taken properly into account.

The following framework for petroleum activities will apply until the first update of the North Sea–Skagerrak management plan.

The Government will:

Skagerrak

- Assess the future need for new knowledge about oil and gas resources and the environment in the Skagerrak. No petroleum activities will be initiated in the area until such an assessment has been made.

North Sea coastal zone

- In a zone stretching 25 km outwards from the baseline, licensees must ensure adequate preparedness and response capacity for coastal waters and shoreline clean-up that is not based on municipal and government resources.
- Given the risk-based approach of the health, safety and environment legislation, stricter requirements may be set for preparedness and response in coastal waters.

Sandeel habitat (south) and Viking Bank

- Exploration drilling in the areas of sandeel habitat and in a zone surrounding them must be carried out in a way that minimises disturbance to spawning, and there must be no discharges of drill cuttings, to ensure that the quality of these areas is not reduced by sediment deposition from drilling activities.
- Any field developments in these areas must use solutions that keep changes to benthic conditions in the areas of sandeel habitat to a minimum.
- Other fisheries-related requirements will be maintained.

Other

- In connection with numbered licensing rounds, and when licences are issued through the system of awards in predefined areas (APA), the authorities will take into account all available new knowledge about the effects of produced water and drill cuttings and other impacts on the environment and living marine resources.

9.3 Framework for offshore wind power

A report on proposed areas for impact assessments in connection with offshore wind power development was published in 2010, and identified six suitable areas in the North Sea. As a follow-up to the report, a strategic environmental assessment has been carried out. This recommends giving priority to opening four of the six areas (Frøyagrundene, Utsira North, Southern North Sea I and Southern North Sea II). Limited grid capacity will probably mean that it is only possible to open one of the areas in the southern part of the North Sea in the foreseeable future. Consultations have been held on the strategic environmental assessment, and the deadline for comments was April 2013.

Impacts on the natural environment have been taken into account in selecting the recommended areas for offshore wind power. The strategic environmental assessment therefore assesses the impacts on seabirds, fish, marine mammals and benthic communities. In addition, a range of business and public interests will be affected by offshore energy production. The impacts on the oil and gas industry, shipping, fisheries, outdoor rec-

reation and the landscape, the cultural heritage, and travel and tourism have been assessed. Thus, a broad-based approach has been taken in evaluating suitable locations for offshore wind projects.

The Government will:

- follow up the strategic environmental assessment for offshore wind power with a view to opening up areas for licensing.

9.4 A changing climate

Climate change and ocean acidification are expected to result in major changes in ecosystem structure and functioning, but we know little about the impacts of such changes.

Expected changes will have to be identified so that appropriate steps can be taken to address negative impacts and adapt to climate change. One important adaptation measure is to limit other pressure from human activities and strengthen ecosystem resilience.

«Blue carbon» is the term used for the carbon captured and stored in marine biological material, in the same way as carbon is captured for example by forests on land. There is growing interest in the use of marine vegetation types, particularly kelp ecosystems, to sequester carbon.

The Government will:

- Build up knowledge about the impacts of climate change and ocean acidification, including rising sea temperature and the spread of alien organisms (species or populations that do not occur naturally in the North Sea and Skagerrak), and on the combined effects of ocean acidification interacting with other pressures such as climate change, pollution and other human activities in the area.
- Build up ecosystem resilience to withstand climate change and ocean acidification.
- Build up knowledge about carbon uptake in marine vegetation types.

9.5 Measures for achieving good environmental status and ensuring sustainable use

The state of the environment in the North Sea and Skagerrak is still assessed as giving cause for concern in various ways. The Government therefore

considers that there is a need to improve environmental status and ecosystem resilience, and to strengthen the basis for continued value creation through use and harvesting of the North Sea and Skagerrak

9.5.1 Reducing eutrophication and pollution by hazardous substances

The use and release of persistent, bioaccumulative and toxic substances poses a serious long-term threat to the marine environment. Despite wide-ranging measures and years of international cooperation, there are still considerable inputs of such substances to the management plan area. Levels of some substances are so high that there is cause for concern, both as regards seafood safety and for marine organisms in the North Sea and Skagerrak. In addition, more and more new synthetic pollutants are being discovered in this area. Little is known about the impacts of these substances and how they may interact. Many of them are only slowly biodegradable and tend to bioaccumulate, and some of them are suspected to be endocrine disruptors. It will be necessary to maintain strict regulation and continually reduce the use and releases of priority substances in order to achieve the target of eliminating releases and use of substances that pose a serious threat to health or the environment by 2020.

Eutrophication a problem in coastal waters and fjords

Eutrophication and sediment deposition as a result of inputs of nutrients and organic matter are primarily a problem in coastal waters and fjords. The inner coastal waters all along Norway's Skagerrak coastline have been identified as a Problem Area with respect to eutrophication. The eutrophication status of the outer zone of coastal waters the open sea is considered to be good. Rising sea temperatures combined with higher inputs of nutrients and more sediment deposition are probable explanations for the loss of sugar kelp from much of the Skagerrak coast.

The Government will:

- Follow up relevant measures in the management plans drawn up under the Water Management Regulations to reduce environmental problems caused by pollution loads in the coastal and marine environment from Norwegian releases of persistent, bioaccumulative

and toxic substances, nutrients and particulate matter.

- Continue remediation operations for contaminated sediments in fjords and harbour areas.
- Continue screening studies to detect new hazardous substances and develop new methods to make it easier to recognise the potentially most dangerous pollutants.
- Build up knowledge about the cumulative environmental effects of persistent, bioaccumulative and toxic substances and radioactive substances in the management plan area.
- Reinforce efforts to develop a stricter international regime governing persistent, bioaccumulative and toxic substances in products.
- Work towards international regulation of new persistent, bioaccumulative and toxic substances, for example through the Stockholm Convention.

9.5.2 Strengthening preparedness and response to acute pollution

Norway's aim is to maintain a preparedness and response system for acute pollution that is appropriately dimensioned to the risk level, and that protects and helps to maintain a clean, rich and productive marine environment. In the event of a spill, the primary aim is to avoid environmental damage and secondarily to limit the scale of any damage. In the event of an incident involving a risk of environmental damage, steps must be taken to avoid pollution. At sea, this generally means taking steps to prevent oil from being discharged into the sea. If this is not possible, the main aim is to minimise the scale of the pollution and any subsequent environmental damage.

The preparedness and response system is being continuously developed, among other things on the basis of lessons learned from accidents and government clean-up operations. To provide an effective emergency response system, adequate resources must be available for use during operations. The availability of sufficient material and personnel is also important for preparedness and response in coastal waters and along the shoreline. Experience gained during oil spill response operations in Norway shows that operations management and close coordination between the actors involved is of crucial importance when dealing with acute pollution.

The Government will:

- Commission five new multi-purpose offshore vessels equipped with modern oil spill recovery equipment, in addition to *OV Utvær*, which was put into service in autumn 2012.
- Regularly assess progress in implementing the environmental risk and preparedness and response analysis drawn up by the Norwegian Coastal Administration.
- Build up the municipalities' capacity to provide assistance during governmental oil spill response operations.
- Ensure the efficiency of the governmental oil spill response system through exercises, training and better coordination.
- Contribute to research and development in the field of oil spill preparedness and response.

9.5.3 Combating marine litter

Marine litter injures seabirds, which mistake small pieces of plastic for food and eat them. Seabirds and marine mammals also become entangled in rope and cables and other large items of litter. Lost gill nets and other fishing gear continue to catch fish long after they have been lost, a problem known as ghost fishing. Litter on beaches and coastal islands and skerries is an aesthetic problem, and reduces the quality of these areas for outdoor recreation. Marine litter can also cause financial losses for shipping and fisheries. More systematic work is needed to deal with the problem of marine litter.

Voluntary organisations, neighbourhood associations, school classes and individuals put a great deal of effort into clearing litter from beaches and coastal islands and skerries. It is important that the central government and local authorities provide appropriate legislation and facilitate the continuation of voluntary efforts in this area. International cooperation is also needed to reverse the negative trend and reduce new inputs of marine litter.

The Government will:

- Support voluntary clean-up operations, awareness-raising activities and local engagement in efforts to deal with marine litter, for example by supporting continuation of the annual beach clean-up day organised by the voluntary organisation *Hold Norge rent* (Keep Norway Clean).

- Provide a legal basis to ensure that fishing and other vessels do not incur extra costs when they deliver litter collected from the sea.
- Consider amendments to the legislation to allow municipalities to use waste management fees to fund clean-up of marine litter and prevent littering in selected public places.
- Continue the annual retrieval programme for lost fishing gear and other equipment.
- Consider arrangements to prevent illegal dumping of leisure craft at sea and their abandonment along the coast.
- Maintain monitoring of reference beaches where litter is monitored and collected in accordance with OSPAR's methodology for marine beach litter surveys.
- Strengthen international cooperation, for example by advocating the development of a strategic plan for reduction of marine litter by OSPAR.

9.5.4 Ensuring sustainable harvesting of fish stocks

The North Sea and Skagerrak are traditionally important fishing grounds. Sandeels are a key species in the North Sea ecosystem, and are an important part of the diet for other fish species and for seabirds.

Steps need to be taken to rebuild some of the fish stocks in the management plan area, and it is also necessary to maintain sustainable levels of stocks that are in good condition. The Government also intends to build up more systematic knowledge about benthic habitats and the pressure fisheries exert on these habitats, and to reduce pressure on the seabed and benthic organisms.

The Government will:

- Continue the development of ecosystem-based management of living marine resources.
- Further develop the sandeel management regime to build up and safeguard viable spawning stocks in all historically important sandeel areas.
- Continue rebuilding fish stocks that are in poor condition, particularly North Sea cod.
- Encourage research on the development of selective fishing gear to reduce environmental impact.
- Safeguard Norwegian fisheries interests in the North Sea and Skagerrak through continuous

efforts to make Norwegian fisheries inspection at sea more effective.

- Work to improve the effectiveness of control of landings and sales of fish from the management plan area.
- Continue the system of opening and closing fishing grounds to protect juvenile fish.
- Further develop systematic monitoring of the fisheries.
- Continue the long-term survey of elasmobranchs such as sharks and skates and rays in the North Sea.
- Evaluate the results of the new area-based management plan for sandeels as part of the annual regulatory cycle for the fisheries.
- Take part in international efforts to ensure the sustainability of the overall harvest from the North Sea.
- Follow up the new agreement with the EU on a discard ban in the Skagerrak, in close collaboration with the EU.
- Strengthen cooperation with the EU in general to ensure sustainable management of the resources of the North Sea and Skagerrak. Special attention will be paid to reducing/eliminating discards of catches and further developing management strategies for the fisheries sector in accordance with the precautionary principle.

9.5.5 Safeguarding seabird populations

Many of the Norwegian seabird populations have shown a severe decline for a number of years. Numbers of species such as common gull, black-legged kittiwake, common tern, Atlantic puffin and common guillemot have dropped substantially. However, populations of some species, such as northern gannet and great cormorant, have risen, and the population of common eider is relatively stable. Pressures on seabirds include climate change, changes in food supplies and human activity. Nest predation by mink is a contributory factor in the decline of some species. Another issue that is attracting considerable attention internationally is bycatches of seabirds in the fisheries. In autumn 2012, the EU published an action plan for reducing incidental catches of seabirds. A working group of seabird experts and marine scientists has been established under the mapping and monitoring programme for seabirds, SEAPOP, to investigate the links between the decline in many seabird populations and their food supplies, and suggest measures to improve food availability for seabirds. Seabirds are vulnerable to a

range of pressures from human activity, and are also strongly influenced by natural fluctuations in environmental conditions. Given the threats to seabird populations, it is necessary to take steps to improve their protection.

The Government will:

- Continue the mapping and monitoring programme for seabirds, SEAPOP, in all Norway's sea areas.
- Further develop systematic monitoring of the most important seabird populations.
- Further develop knowledge about the links between the decline in many seabird populations and their food supplies, and identify possible measures to improve food availability for seabirds.
- Intensify efforts to reduce the mink population along the shoreline and on coastal islands and skerries.
- Continue to survey the scale of bycatches of seabirds by fishing vessels and review methods and technological solutions for reducing bycatches of seabirds and the extent to which they are being used.
- Consider the introduction of specific requirements relating to gear and catch methods in fisheries or areas where bycatches of seabirds are a problem.

9.5.6 Marine protected areas

Ytre Hvaler national park was established in 2009 and covers an area of 354 km², of which only 14 km² is land and the rest is sea and seabed. It was established to protect the rich marine environment, both for its intrinsic value and to maintain an attractive area and outdoor recreation opportunities for future generations. Ytre Hvaler is Norway's first marine national park. Several other protected areas along the coast also include adjoining areas of sea, but so far no other purely marine protected areas have been established. The establishment of Ytre Hvaler national park has raised awareness of the importance of protecting the marine environment. The establishment of a network of marine protected areas will safeguard important marine ecosystems.

Work on the marine protection plan will be continued. A proposal to establish three marine protected areas under section 39 of the Nature Diversity Act (Saltstraumen in Nordland, Tautraryggen in Nord-Trøndelag and Framvaren in Vest-Agder) is under consideration, and the dead-

line for comments on the proposal was in April 2013.

Marine protection in areas beyond national jurisdiction

Cooperation on marine protected areas is also a focus area under a number of international agreements such as the Convention on Biological Diversity and the OSPAR Convention. Between 2006 and 2009, the North East Atlantic Fisheries Commission (NEAFC) closed several areas beyond national jurisdiction to bottom fishing to prevent damage. In 2010, OSPAR's ministerial meeting in Bergen decided to establish six marine protected areas in areas beyond national jurisdiction. OSPAR and NEAFC are cooperating on identifying ecologically or biologically important areas, and this will be an important basis for further international work on marine protection. Marine protected areas are also an important topic of discussion in the UN General Assembly.

The Government will:

- Continue its work on Norway's marine protection plan.
- Aim to establish up to three marine protected areas under the Nature Diversity Act in the course of 2013.
- Play an active part in international cooperation (UN General Assembly, Convention on Biological Diversity, OSPAR, etc) to identify important marine areas with a view to their protection.

9.5.7 Knowledge building

The Government will continue to build up knowledge about environmental conditions, value creation and commercial activities in the North Sea and Skagerrak in the period leading up to the first update of the management plan. An important element of this work will be to clarify what is meant by good environmental status in the North Sea and Skagerrak and further develop indicators as a basis for establishing an integrated monitoring system. As in the other sea areas, this will be important for monitoring environmental trends and assessing progress towards goals.

This system will make it possible to evaluate the costs and benefits of possible additional measures that could be introduced to achieve good environmental status in the management plan area. Any such evaluation will also take into

account the expected effects of action taken by the other North Sea countries to achieve good environmental status, including measures to implement the EU Marine Strategy Framework Directive.

The values associated with coastal and marine areas can be demonstrated by initiating pilot projects in selected areas to investigate factors that can strengthen ecosystem services. For example, establishing small protected areas for lobsters has been successful and has resulted in a larger lobster population both within and outside the reserves. The aim is to obtain empirical knowledge as a basis for better management and improvement of environmental status.

Systematic mapping of the seabed through the MAREANO programme is also important.

The Government will:

- Further develop indicators for assessing environmental status in the North Sea and Skagerrak and establish an integrated monitoring system for the state of the environment in this sea area.
- On the basis of the monitoring results, determine:
 - which other environmental problems need to be addressed in the years ahead;
 - national and international action that can help to achieve good environmental status;
 - the costs and benefits of different measures.
- Consider whether to initiate pilot projects to obtain empirical knowledge as a basis for improving management and environmental status, and determine the economic assets and potential that may result from better environmental status.
- Continue the MAREANO programme for mapping of the seabed in Norwegian waters.

9.6 Simplifying the organisation of the management plan work

The main elements of the organisation of the management plan work were set out in the first management plan for the Barents Sea–Lofoten area in 2006. In 2010, during the first update of the plan, various aspects of the management plan were evaluated externally, including its organisation. In addition, the Forum for Integrated Management

of the Barents Sea–Lofoten Area was asked to evaluate the work.

Some of the recommendations have already been followed up. They were incorporated when the mandates of several advisory groups (Forums for Integrated Management of the Barents Sea–Lofoten Area and the Norwegian Sea, Advisory Group on the Monitoring of Sea Areas and Forum on Environmental Risk Management) were revised in 2011. Another recommendation was that a single management forum should be established for the three sea areas.

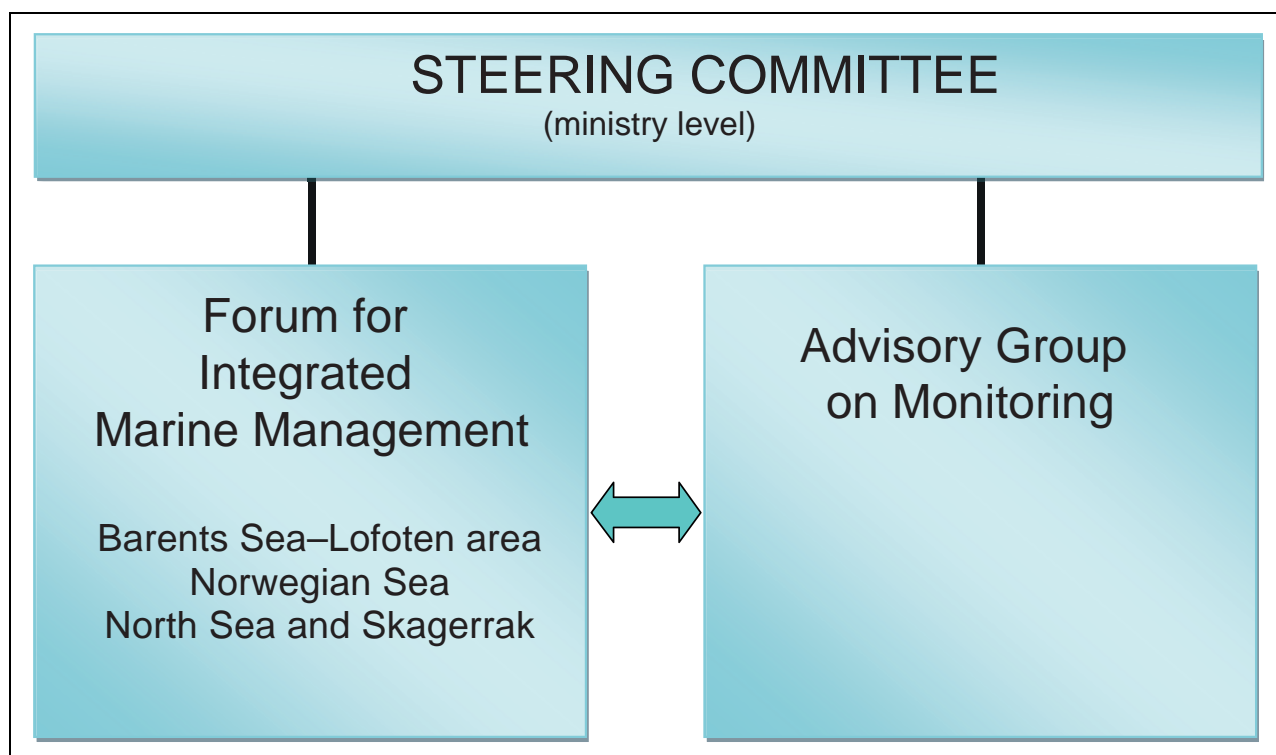
With the publication of the present management plan, the Government has drawn up management plans for all Norwegian sea areas. From now on, the plans will only need to be updated and revised. This, together with experience gained from earlier work, will make it possible to simplify structures and working methods, making the management plan work more effective.

Merging the management forums for the three sea areas to form one Forum for Integrated Marine Management will make the management plan process more effective, reduce the workload for the agencies involved and ensure good coordination of work on all the sea areas. The Forum for Integrated Marine Management will be headed by the new Norwegian Environment Agency, which will also act as secretariat. The management forum will be responsible for coordinating the scientific aspects of integrated ecosystem-based management of Norway's sea areas. The forum will include representatives of directorates and advisory institutions under the relevant ministries.

The Forum on Environmental Risk Management has been an important arena for further development of risk and environmental risk assessment relating to activities in Norway's sea areas. Value creation is another cross-cutting issue that is highlighted in the present management plan. It now seems logical to incorporate work on these topics into the mandate of the Forum for Integrated Marine Management, as a way of making work on the management plan more effective. The Advisory Group on Monitoring will be maintained under the leadership of the Institute of Marine Research.

The Government will:

- Establish a joint Forum for Integrated Marine Management for Norway's sea areas.
- Maintain the Advisory Group on Monitoring.



Figur 9.1 Organisation of the management plan work – new system

Kilde: Ministry of the Environment

9.7 Strengthening international cooperation on the North Sea and Skagerrak

Internationally, Norway is considered to be a driving force in international cooperation on the marine environment and international fisheries management processes and to pursue an active marine environment policy. Regional environmental cooperation within OSPAR and cooperation on fisheries management within NEAFC, cooperation with the European Commission, Nordic cooperation and scientific advice (particularly that provided by the International Council for the Exploration of the Sea (ICES)), will be of crucial importance for achieving and maintaining good environmental status in the North Sea and Skagerrak.

Work in other forums, such as the International Maritime Organization (IMO), and cooperation on emergency preparedness and response under the Bonn and Copenhagen agreements and bilateral cooperation with individual countries, are also important. The management plan for the North Sea and Skagerrak will help to provide a firmer basis for Norway's contributions to international cooperation.

The Government will:

- Continue and strengthen cooperation in existing international forums to achieve and maintain good environmental status in the North Sea and Skagerrak.

10 Economic and administrative consequences

This white paper largely discusses the further development of existing policy instruments, and also some specific new measures. Management of Norway's sea areas will be based on the best possible knowledge, and the intention is to strengthen the knowledge base for ecosystem-based management of the Barents Sea–Lofoten area through mapping, monitoring and research.

The economic and administrative consequences of the measures proposed in the white paper can be predicted with varying degrees of accuracy, but as the proposals are implemented, the consequences for public and private actors will be assessed in the usual way as set out in the Instructions for official studies and reports and the preparation of legislation.

Follow-up of measures that require allocations will be considered by the Government in the ordinary budgetary processes, and presented in the budget propositions of the ministries concerned. Follow-up of measures in the years to come will depend on economic developments and the budget situation.

Simplification the organisation of work on the management plans is expected to result in more effective use of resources. The development of a digital mapping tool to present information on the management plans should make the information more accessible to the public administration and users in the business sector and other interest groups. The remaining measures are not expected to have administrative consequences of any significance.

The Ministry of the Environment

r e c o m m e n d s :

that the Recommendation from the Ministry of the Environment concerning Integrated Management of the Marine Environment of the North Sea and Skagerrak (management plan) dated 26 April 2013 should be submitted to the Storting.

Appendix 1

Scientific basis for the management plan

Key background reports for the management plan for the North Sea and Skagerrak have been published at the following address:

http://www.miljodirektoratet.no/no/Tema/Vann_og_hav/Nordsjoen/Forvaltningsplan-for-Nordsjoen-Skagerrak/Rapporter-fra-faggruppa/

Synthesis reports

Cumulative Environmental Effects. (Summary in English TA 2928/2012) Report from the Expert Group for the North Sea and Skagerrak. TA-2907/2012

Conflicting interests and the need for coordination. (Summary in English TA 2929/2012) Report from the Expert Group for the North Sea and Skagerrak. TA-2908/2012

Analysis of population, economic activity and ecosystem services. (Summary in English TA 2931/2012) Report from the Expert Group for the North Sea and Skagerrak. TA-2910/2012

Proposed indicators for a monitoring programme. (Summary in English TA 2926/2012) Report from the Expert Group for the North Sea and Skagerrak. TA-2906/2012

Priority knowledge needs. (Summary in English TA 2930/2012) Report from the Expert Group for the North Sea and Skagerrak. TA-2909/2012

Vulnerability of particularly valuable areas. (Summary in English TA 2927/2012) Report from the Expert Group for the North Sea and Skagerrak. TA-2858/2011

Sectoral studies

Helhetlig forvaltningsplan for Nordsjøen og Skagerrak: Sektorutredning for fiskeri og havbruk. (Integrated management plan for the North Sea and Skagerrak: impacts of fisheries and agriculture) Directorate of Fisheries. TA-2831/2011.

Helhetlig forvaltningsplan for Nordsjøen og Skagerrak: Konsekvenser av fornybar energiproduksjon i Nordsjøen. (Integrated management plan for the North Sea and Skagerrak: impacts of renewable energy production in the North Sea) Norwegian Water Resources and Energy Directorate. TA-2829/2011.

Helhetlig forvaltningsplan for Nordsjøen og Skagerrak: Sektorutredning for klimaendringer, havforsuring og langtransportert forurensning. (Integrated management plan for the North Sea and Skagerrak: impacts of climate change, ocean acidification and long-range transport of pollutants. Summary in English) Climate and Pollution Agency. TA-2833/2011.

Helhetlig forvaltningsplan for Nordsjøen og Skagerrak: Sektorutredning for land- og kystbasert aktivitet. (Integrated management plan for the North Sea and Skagerrak: impacts of land-based and coastal activities. Summary in English) Climate and Pollution Agency. TA-2832/2011.

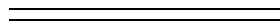
Helhetlig forvaltningsplan for Nordsjøen og Skagerrak: Sektorutredning for petroleumsvirksomhet. Integrated management plan for the North Sea and Skagerrak: impacts of petroleum activities) Norwegian Petroleum Directorate. TA-2828/2011.

Konsekvenser av skipstrafikk i Nordsjøen og Skagerrak. (Impacts of maritime transport in the North Sea and Skagerrak) Norwegian Coastal Administration. TA-2830/2011.

Background documents

Tverrsektoriell vurdering av konsekvenser for sjøfugl. Grunnlagsrapport til en helhetlig forvaltningsplan for Nordsjøen og Skagerrak. (Cross-sectoral assessment of impacts on seabirds. Background report for the integrated management plan for the North Sea and Skagerrak) Norwegian Institute for Nature Research. TA-2839/2011.

- Framtidbilder for sektorene i 2030. (Scenarios for the different sectors in 2030) Report from the Expert Group for the North Sea and Skagerrak. TA-2785/2011.
- Faglig grunnlag for en forvaltningsplan for Nordsjøen og Skagerrak: Arealrapport. (Scientific basis for the management plan for the North Sea and Skagerrak. The environment, natural resources and pollution) Report from the Expert Group for the North Sea and Skagerrak. *Fisken og havet*, no. 6, 2010.
- Prognoser for skipstrafikk i Nordsjøen. (Projections for shipping in the North Sea) DNV for the Norwegian Coastal Administration, 2011. Reference number: 13NBY1D-2.
- Statusbeskrivelse for Nordsjøen – utseilte distanser og driftsutslipp for skip. (North Sea status report – distances sailed and operational discharges from ships) DNV for the Norwegian Coastal Administration, 2011. Reference number: / 2011-0469.
- Analyse av sannsynlighet for akutt forurensning fra skipstrafikk i forvaltningsplanområdet Nordsjøen. (Analysis of the probability of acute pollution from shipping in the North Sea-Skagerrak management plan area) DNV for the Norwegian Coastal Administration, 2011. Reference number: 2011-1037/12NA8X8-3.
- Miljørisiko ved akutt oljeforurensning fra skipstrafikken langs kysten av Fastlands-Norge for 2008 og prognoser for 2025. (Environmental risk associated with acute oil pollution from shipping along the coast of mainland Norway in 2008 and projections for 2025.) DNV for the Norwegian Coastal Administration, 2011. Report number: 2011-0850.
- Tilførselsprogrammet 2010: Overvåking av forurensning av norske farvann med spesiell fokus på Nordsjøen. (Marine Pollution Monitoring Programme 2010: acidification in Norwegian waters, particularly the North Sea) Norwegian pollution monitoring programme. TA-2809/2011.
- Tilførselsprogrammet 2010: Overvåking av tilførsler og miljøtilstand i Nordsjøen. (Marine Pollution Monitoring Programme 2010: North Sea: inputs and environmental status) Norwegian pollution monitoring programme. TA-2810/2011.
- Kunnskap om marint søppel i Norge 2010. (Knowledge about marine litter in Norway in 2010) Climate and Pollution Agency and Directorate for Nature Management. TA-2753/2011.
- Forslag til scenarier relatert til akutt utslipp til sjø fra petroleumsvirksomhet i Nordsjøen og Skagerrak i perioden 2010 til 2030. (Proposed scenarios for modelling the consequences of spills from the petroleum industry in the North Sea and Skagerrak in the period 2010 to 2030) Proactima for the Petroleum Safety Authority Norway, 2011. Report number: PS-1070011-RE-06.
- Helhetlig forvaltningsplan for Nordsjøen og Skagerrak – Oljedrift. (Integrated management plan for the North Sea and Skagerrak – oil drift) DNV for the Norwegian Petroleum Directorate, 2011. Report number: 2011-0217.



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