Norwegian Ministry
of Climate and Environment

Meld. St. 35 (2016–2017) Report to the Storting (white paper)

Update of the integrated management plan for the Norwegian Sea

Ørnulf Opdahl (born in 1944 in Ålesund) is one of Norway's most distinguished artists. His work is inspired by the ever-changing landscape along the Norwegian coast, and his dramatic depictions of coastal landscapes have caused him to be described as a contemporary Romantic painter.

The Deep Sea was painted during a cruise with the research vessel *G.O. Sars* in 2004. Ørnulf Opdahl accompanied a team of 60 researchers from 13 countries on a two-month expedition to the Mid-Atlantic Ridge as part of the MAR-ECO project. The purpose of the expedition was to enhance understanding of the distribution and ecology of marine animal communities. In previous centuries, before the invention of photography, artists often accompanied scientific expeditions to document their findings.

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Translation from Norwegian. For information only.

Contents

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Recommendation of 5 April 2017 from the Ministry of Climate and Environment, approved in the Council of State the same day.
(White paper from the Solberg Government)

1 Summary

A management plan for the Norwegian Sea was first presented in the white paper *Integrated Management of the Marine Environment of the Norwegian Sea* (Report No. 37 (2008–2009) to the Storting). With this update of the management plan, the Government is maintaining a long-term, integrated marine environmental policy that is intended to facilitate value creation and at the same time protect the marine and coastal environment of Norwegian sea areas.

Purpose of the management plans

The purpose of the management plans is to provide a framework for value creation through the sustainable use of natural resources and ecosystem services and at the same time maintain the structure, functioning, productivity and diversity of the ecosystems. The management plans are thus a tool both for facilitating value creation and food security, and for maintaining the high environmental value of Norway's sea areas.

Norway's management plan system

The foundation for integrated, ecosystem-based management of Norway's sea areas was laid in the white paper *Protecting the Riches of the Sea* (Report No. 12 (2001–2002) to the Storting). The white paper described the vision of maintaining clean, rich seas so that future generations can continue to harvest the wealth of resources that the sea has to offer. Since then, the Storting (Norwegian parliament) has considered and approved integrated, ecosystem-based management plans for all Norwegian sea areas.

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. Activities in each management plan area are regulated on the basis of existing legislation governing different sectors.

Following up the Storting's decisions during its consideration of the white paper *Nature for life – Norway's national biodiversity action plan* (Meld. St. 14 (2015–2016)), the Government intends to revise the management plans at least every twelve years and update them every four years.

Some key developments in marine management

Key developments in Norwegian and international marine management are restructuring in ocean-based industries, global discussions within the UN system on the management of the oceans and ocean resources, and growing recognition of the role of marine ecosystems in the ocean econ-

omy and of how oceans can play a role as part of the solution to global problems.

In 2015, the UN General Assembly adopted the 17 Sustainable Development goals for the period up to 2030. Goal 14 is to 'conserve and sustainably use the oceans, seas and marine resources'. According to the report *The Ocean Economy in 2030*, published by the OECD in 2016, the world's oceans have great potential for boosting economic growth through emerging industries and the further development of established industries. In order to realise the full potential of the oceans, the report points out that it is essential to ensure that they are used responsibly and sustainably.

Ecosystem-based management is based on knowledge about ecosystems, their environmental status and pressures and impacts on them. Since the first management plan for the Norwegian Sea was presented in 2009, a number of steps have been taken to strengthen knowledge about ocean-related topics generally and the Norwegian Sea in particular. However, there is still a considerable needs to expand knowledge about the oceans, for example through mapping of larger areas of the seabed.

In addition to this update of the management plan for the Norwegian Sea, the Government is presenting a white paper on the place of the oceans in Norway's foreign and development policy and an ocean strategy in spring 2017.

Update of the Norwegian Sea management plan

In the 2009 management plan, the state of the Norwegian Sea environment was described as generally good. However, the impacts of climate change and ocean acidification, overfishing of certain fish stocks, the risk of acute pollution, the decline of seabird populations and the need to protect coral habitats were identified as posing considerable challenges.

This update of the Norwegian Sea management plan focuses particularly on topics where new knowledge indicates that new or updated management measures are needed.

The process of updating the management plan has been coordinated by the interministerial Steering Committee for integrated management of Norway's sea areas, which includes all the relevant ministries and is headed by the Ministry of Climate and 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 Forum for Integrated Marine Management, which is headed by the Norwegian Environment Agency, is responsible for compiling the scientific basis for the management plan. The Advisory Group on Monitoring, headed by the Institute of Marine Research, coordinates and reports on monitoring of marine ecosystems.

This update is based mainly on the scientific basis provided by the Forum for Integrated Marine Management, input from a public consultation held in 2015 and a report published by the Advisory Group on Monitoring in 2016. Indicators for assessing environmental status and pressures and impacts in the Norwegian Sea have been developed as part of the follow-up to the 2009 management plan. Results from the monitoring system are part of the basis for assessing progress towards the management goals for this sea area.

New knowledge has been obtained on topics including seabird populations in the Norwegian Sea, coral habitats, important species and habitats in particularly valuable and vulnerable areas, and marine litter.

The 2009 management plan set out general objectives for the management of the Norwegian Sea, and more specific goals concerning conservation and sustainable use. Criteria for good ecological status are being developed in the period up to summer 2017 and this will make it possible to further refine and supplement the goals of the management plan. The 2009 goals have therefore been retained unchanged in this update.

Environmental status and cumulative environmental effects

Characteristic features of the Norwegian Sea are areas of very deep water, the warm Atlantic current (the Gulf Stream) and high biological production and biodiversity. There is a varied benthic fauna as a result of the great variation in water depth. Large coral reef complexes are to be found along the edge of the continental shelf. The northernmost part of the Mid-Atlantic Ridge runs through the Norwegian Sea, and includes areas with a characteristic deep-water fauna associated with mud volcanoes, hydrothermal vents and methane hydrates.

The scientific basis for this update of the management plan concludes that the state of the Norwegian Sea environment is still good, and that the factors posing challenges for management of the area are the same as in 2009. The present document provides updated information on environmental status and trends and on issues it will be

important to address in the management regime for the years ahead. These include the impacts of climate change and ocean acidification, marine litter, the decline in a number of seabird populations and the pollution situation.

The pollution load in the Norwegian Sea originates partly from hazardous substances transported into the area with air and ocean currents, and partly from releases of oil and environmentally hazardous substances from activities within the management plan area. Pollutants spread and are diluted in the large volumes of water, so that the concentrations of oil and environmentally hazardous substances measured in sediments and the water column are low. However, certain hazardous substances bioaccumulate and are found at relatively high levels in particularly vulnerable species at the top of food chains.

Seafood from the Norwegian Sea is generally considered to be safe. The concentrations of persistent, bioaccumulative and toxic substances detected in seafood are generally below the maximum permitted levels, but concentrations of these pollutants in some fish species, edible crab, seabirds and marine mammals give cause for concern. Levels of radioactivity are low and generally show a downward trend, and are not considered to be harmful to marine organisms.

A review of the scientific basis for the designation of particularly valuable and vulnerable areas has been carried out, with a focus on the occurrence of valuable species and habitats and the importance of the areas to the Norwegian Sea as a whole. This has not resulted in any changes in the areas identified or their delimitation compared with the 2009 management plan. In addition, in the period up to the next update of the management plan, it should be assessed whether areas where there are mud volcanoes, hydrothermal vents and methane hydrates meet the criteria for designation as particularly valuable and vulnerable areas.

Various areas in which it is important to improve knowledge about the Norwegian Sea environment have been identified. These include mapping larger areas of the seabed and improving knowledge about the impacts of climate change and ocean acidification on ecosystems; about interactions between fish species; about the causes of the decline in seabird populations; about the sources, inputs and spread of hazardous substances; and about the cumulative effects of underwater noise pollution.

Marine litter and microplastics

The growing problem of marine litter and microplastics is discussed in depth in the present white paper. Plastics make up about 80 % of all marine litter. It takes 450 years for a plastic bottle to break down completely in the sea, while complete degradation of fishing line takes 600 years. During degradation, plastics break down into smaller fragments and eventually to microplastics. Plastic waste and microplastics are transported across large areas by ocean currents and can be found far from their sources.

In 2001, a UN report estimated that about 1 million seabirds, 100 000 marine mammals and unknown numbers of fish and other animals were being injured or killed by marine debris every year. In addition, litter reduces people's enjoyment of the seashore and has negative impacts on outdoor recreation and tourism, and can damage boat motors and fishing gear such as gill nets. Lost gill nets and traps can continue to catch fish long after they have been lost. Plastics and microplastics have been found in many different marine organisms. So far, little further is known about the impacts of plastics and microplastics on ecosystems and food chains. The European Food Safety Authority (EFSA) considers the smallest plastic particles to be of great concern because they can cross cell membranes.

About one fifth of all plastic in the world's oceans originates from marine sources, such as fisheries and shipping. The rest comes from land-based sources. The scale of the marine litter problem is being monitored through Norway's management plan system and the Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention), and as part of the annual ecosystem surveys in the Barents Sea.

The first target under Sustainable Development Goal 14 is to prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution, by 2025. Moreover, one of the objectives of OSPAR's *Marine Litter Regional Action Plan* is to prevent and reduce marine litter, and each of the management plans for Norway's sea areas includes goals for reducing marine litter. These goals are not considered to have been achieved.

Sound waste management is of crucial importance in preventing and reducing marine litter. Before summer 2017, the Government will publish a white paper on waste policy and the circular economy, including new steps to combat marine

litter and microplastics. Clean-up operations are also important, and include the annual retrieval programme for lost fishing gear, the project Fishing for Litter, and voluntary beach clean-up days.

Marine litter is a global environmental problem that can only be dealt with through effective international cooperation. Norway has taken the initiative for global cooperation to combat marine litter through the UN system. Further information on Norway's international efforts to combat marine plastic waste will be presented in the Government's white paper on the place of the oceans in Norway's foreign and development policy in spring 2017.

Ocean-based industries and value creation

The most important ocean-based industries associated with the Norwegian Sea are petroleum activities, fisheries and aquaculture, shipping and tourism.

Fisheries and aquaculture: The four counties bordering on the Norwegian Sea account for a major share of Norway's overall activity in this sector. In recent decades, the number of fishing vessels has been declining, but their average size has risen. The herring fishery is the largest in the management plan area. A little under half of all Norwegian salmonid farming sites are along the Norwegian Sea coastline. In 2014, the fisheries and aquaculture industry in the Norwegian Sea and along its coastline generated a total of NOK 19.9 billion in value added, and provided employment for 14 800 people, not including wider spin-off effects.

Pressure and impacts from the fisheries affect both fish stocks that are harvested and the ecosystem as a whole. Bottom trawling can also have undesirable impacts on benthic communities. Ever since 1999, coral habitats have been closed to bottom trawling, and several areas of the Norwegian Sea have been closed more recently. The closed coral habitats have been designated as marine protected areas. Norway adopted regulations relating to bottom fishing activities in deep-water areas in 2010.

Norway shares most of its fish resources with other countries, so that international cooperation on their management is essential. There are several different forums for international fisheries cooperation in the Norwegian Sea, of which the North East Atlantic Fisheries Commission (NEAFC) is most important.

Shipping: The Norwegian Sea is an important area for freight traffic in Norway, and several of the country's largest ports are along the Norwegian Sea coastline. In 2015, the volume of shipping in the Norwegian Sea corresponded to 31 % of overall traffic in Norwegian waters. Shipping density is highest in the fairways along the coast and in the southern part of the Norwegian Sea. A relatively large proportion of shipping in the Norwegian Sea is in transit, in other words passing through without calling at any ports. Shipping volumes in the Northeast Passage may influence shipping density and traffic patterns in the Norwegian Sea.

In 2014, shipping companies (excluding those in the fisheries, petroleum and tourism sectors) located in the four counties bordering on the Norwegian Sea generated a total of NOK 4.4 billion in value added, and provided employment for 5 000 people, not including wider spin-off effects.

Shipping can have impacts on the environment through operational releases to air and the sea, illegal and acute releases of pollution, the spread of alien organisms and underwater noise. Since 2009, a number of preventive measures have been introduced that have improved maritime safety in the Norwegian Sea, including traffic separation schemes, recommended routes and improvements in vessel monitoring systems. Governmental preparedness and response to acute pollution has been strengthened.

Petroleum activities: It is more than 50 years since petroleum activities began in Norway, and this is now the country's largest industry measured in terms of value added, state revenues, export value and investments. There are currently 16 oil and gas fields in production in the Norwegian Sea, seven of which have started producing since 2009. There has been some decline in total production from the Norwegian Sea in recent years, but the level is expected to remain relatively stable in the years ahead. Parts of the deep-water areas in the western Norwegian Sea are still considered to be frontier areas, where large finds could still be made.

Petroleum activities in the Norwegian Sea involve major current and future investments. Established petroleum activities in the Norwegian Sea account for about one third of all direct employment in the industry in Norway. In 2014, petroleum activities in the Norwegian Sea generated a total of NOK 219.6 billion in value added and direct employment for 42 200 people.

Generally speaking, the petroleum industry can have negative impacts on the environment through operational discharges to the sea and air, acute releases of pollutants, underwater noise from seismic surveys and physical disturbance of the seabed.

Tourism: Tourists are attracted to areas along the Norwegian Sea coast by opportunities for enjoying the outdoors, fishing, eating fresh seafood and observing marine mammals and seabirds. The Norwegian tourism industry has considerable growth potential, which can be related to developments in the tourism industry internationally. In 2014, tourism in the municipalities along the Norwegian Sea coast generated a total of NOK 2.98 billion in added value, and provided employment for 7 230 people, not including wider spin-off effects.

Emerging industries in the Norwegian Sea management plan area include fishing for new species, harvesting the copepod *Calanus finmarchicus*, making use of residual raw materials from the seafood industry, mineral extraction from the seabed and marine bioprospecting.

Use of the Norwegian Sea and spatial management

The marine management plans set out general decisions about spatial management. Greater use of Norway's sea areas will make it a challenging task to strike a balance between the various user interests and environmental considerations.

Expansion of oil and gas activities, a high level of fishing activity and a certain increase in the volume of shipping are the main trends in ocean-based industries in the Norwegian Sea since 2009. The further development of existing industries and the potential for the establishment of new ocean-based industries in the management plan area will increase the need for coordinated spatial management.

Since 2009, four marine protected areas in coastal waters and fjords adjoining the Norwegian Sea have been established under the Nature Diversity Act, and six marine protected areas have been established under the Marine Resources Act. A plan for establishing more marine protected areas under the Nature Diversity Act is being developed.

As part of the management plan system, the first version of a digital mapping tool for Norway's sea areas has been developed. This will provide integrated information on industrial activities, species and habitats and regulatory measures. The mapping tool will give a better overview of decisions and measures relating to Norway's sea areas, both those that are part of the management plan system and those linked to sectoral processes.

The seabed in Norwegian waters is being mapped by the MAREANO programme, which has provided valuable new knowledge on topics including habitats, species and the pressures and impacts of human activity. This can be used to improve the management regime and provide better protection for vulnerable habitat types. Data obtained through MAREANO has confirmed the environmental value of the areas identified as particularly valuable and vulnerable.

Measures for the conservation and sustainable use of ecosystems

The 2009 management plan set out long-term goals for the management of the Norwegian Sea. This update of the management plan describes how the measures presented in 2009 have been implemented and assesses the need to maintain them and to introduce new measures. It presents measures relating to climate change, spatial management, good environmental status and sustainable use, the knowledge base, the exchange of information and experience, and further development of the management plan system.

The 2009 management plan established the overall framework for petroleum activities in the Norwegian Sea (announcement of blocks, exploration drilling and seismic surveying). The Government considers that this framework should be retained, with certain specifications and changes, until the next update of the management plan.

In order to implement the international target for conservation of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, the Government will draw up a plan for further work on marine protected areas. The Government will draw up a national action plan for seabirds as one way of improving the situation for seabird populations. The management plan proposes a number of measures relating to marine litter and pollution. The Government will propose new legislation on seabed mining. Steps will also be taken to obtain more information on habitat types and species in deep-sea areas. The need to protect distinctive and rare species and habitats in deep-sea areas will be assessed. In addition, the management plan proposes a number of measures related to knowledge building and steps to continue international work on integrated marine management.

2 Introduction – integrated, ecosystem-based management

Norway's history is tightly bound up with how its people have used the oceans and managed the huge resources to be found down to the depths of the seas. For hundreds of years, fishing and the transport of fish to other parts of Europe were the activities that made up the backbone of the Norwegian economy. Today, fisheries and aquaculture make Norway one of the world's most important seafood nations. Tomorrow, as yet unknown marine resources may provide new wealth through bioprospecting and the development of new food and medical products.

Norway has managed its oil and gas resources wisely, and has a modern merchant fleet that generates large revenues through sustainable transport of goods. Norwegian seafood is clean and healthy, and this is Norway's main competitive advantage in the stiff competition for market shares in the sector. It is part of Norway's responsibility as a steward of marine areas to maintain healthy ecosystems, clean seas and a clean coastline.

Norwegian society will have to undergo a transformation process in the years ahead. Economic growth in the future must have three important qualities: it must be green, smart, and innovative. Sustainable harvesting of marine resources will be the key to blue economic growth. The Government is pursuing an active policy for its seas and ocean-based industries. With this update of the management plan for the Norwegian Sea, the Government is maintaining a long-term, integrated marine environmental policy that is intended to facilitate value creation and at the same time protect the marine and coastal environment of Norwegian sea areas.

A growing population needs increasing amounts of food and energy. The environmental status of Norway's sea areas is generally good, which gives the country natural advantages when facing global processes of change. There is considerable potential for growth in ocean-based industries, but we still know much less about the sea than we do about land areas. This means that the oceans can offer major opportunities that we are not even aware of. The overall assessments of the marine environment and value creation in the management plans provide a good starting point for growth in existing and emerging industries.

As a maritime nation, Norway has a strong interest in maintaining and further developing its role as a responsible steward of the oceans. Norway's marine management plans are a dynamic tool for knowledge-based, integrated and ecosystem-based management of its sea areas. Climate change and plastic litter are now major threats to the marine environment. The management plans are a useful tool for dealing with these problems as well.

In addition to this update of the management plan for the Norwegian Sea, the Government has presented a white paper on the place of the oceans in Norway's foreign and development policy and an ocean strategy in spring 2017. Together, these documents are a clear expression of the Government's view that it needs to give high priority to the oceans to safeguard Norway's security in the future.

2.1 Norway's system of integrated marine management plans

The purpose of the management plans is to provide a framework for value creation through the sustainable use of natural resources and ecosystem services and at the same time maintain the structure, functioning, productivity and diversity of the ecosystems. The management plans are thus a tool both for facilitating value creation and food security, and for maintaining the high environmental value of Norway's sea areas. The 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.

Activities in each management plan area are regulated on the basis of existing legislation governing different sectors. The different sectoral authorities are responsible for implementing the

measures set out in the management plans. Together with the sectoral legislation, the management plans are also a key tool for meeting Norway's obligation under international law to protect the marine environment of its seas.

The management plans are integrated, meaning that the cumulative effects of all human activities on the marine environment are considered. They are also ecosystem-based, meaning that the management of human activities is based on the limits within which ecosystem structure, functioning, productivity and biological diversity can be maintained.

The foundation for integrated, ecosystem-based management of Norway's sea areas was laid in the white paper *Protecting the Riches of the Sea* (Report No. 12 (2001–2002) to the Storting). The white paper described the vision of maintaining clean, rich seas so that future generations can continue to harvest the wealth of resources that the sea has to offer. Since then, the Storting (Norwegian parliament) has considered and approved integrated, ecosystem-based management plans for all Norwegian sea areas.

Work on the management plans brings together all relevant parts of the public administration (see Figure 2.1). It is coordinated by the interministerial Steering Committee for integrated management of Norway's sea areas, which is headed by the Ministry of Climate and Environment. Other ministries represented in the committee are the Ministry of Labour and Social Affairs, the Ministry of Finance, the Ministry of Justice and Public Security, the Ministry of Local Government and Modernisation, the Ministry of Trade, Industry and Fisheries, the Ministry of Petroleum and Energy, the Ministry of Transport and Communications and the Ministry of Foreign Affairs.

The scientific basis for the management plans is drawn up by two advisory groups: the Forum for Integrated Marine Management and the Advisory Group on Monitoring. The Forum for Integrated Marine Management is headed by the Nor-

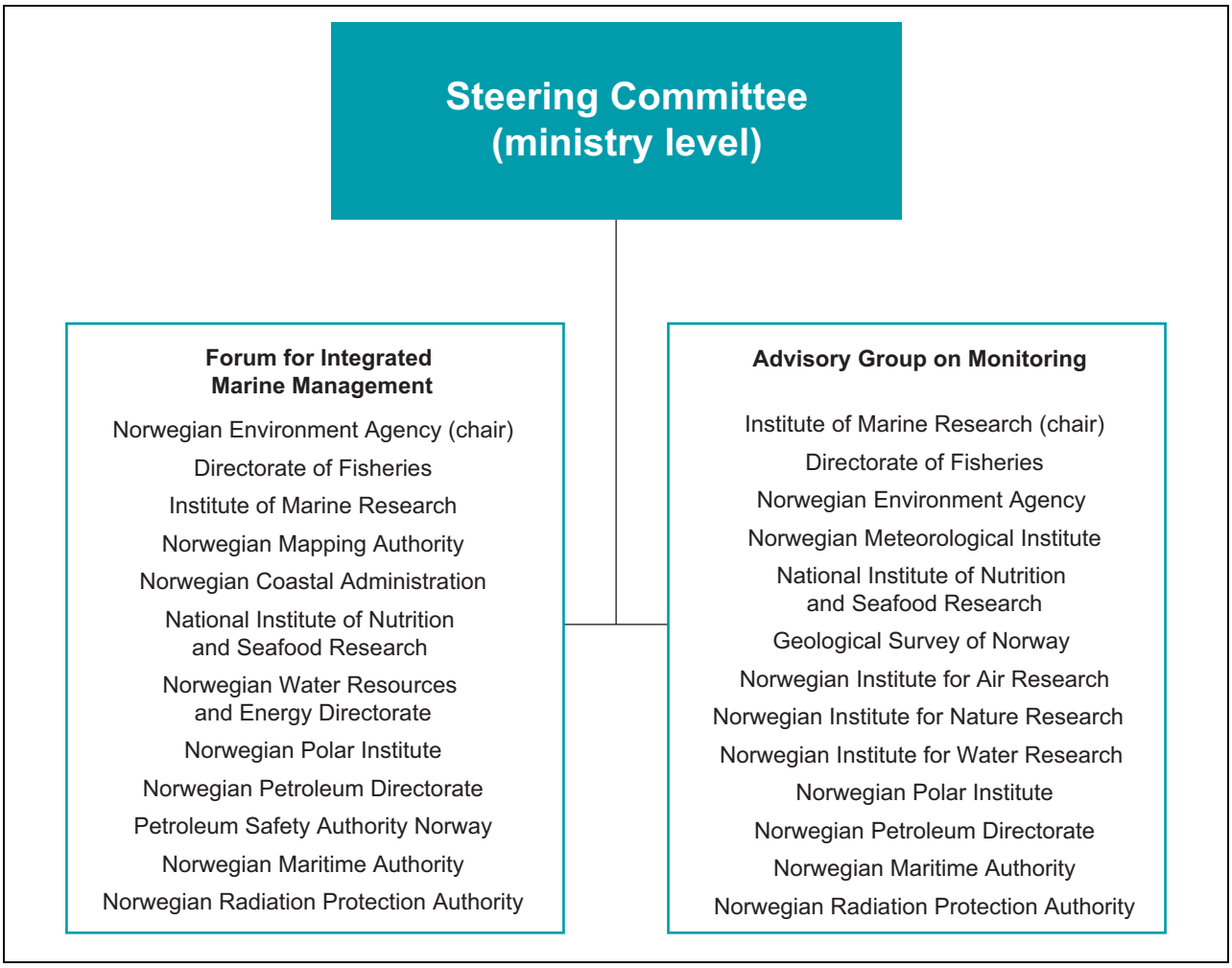

Figure 2.1 Organisation of the management plan work.

Source: Ministry of Climate and Environment

wegian Environment Agency and is responsible for drawing up the overall scientific basis for updating and revising the management plans in cooperation with the Advisory Group on Monitoring. The Advisory Group on Monitoring (headed by the Institute of Marine Research) coordinates monitoring programmes for marine ecosystems in the sea areas covered by the management plans. The work of the two groups is resulting in constant improvement of the knowledge base for management of Norway's marine areas.

Following up the Storting's decisions during its consideration of the white paper *Nature for life – Norway's national biodiversity action plan* (Meld. St. 14 (2015–2016)), the Government intends to revise the management plans at least every twelve years and update them every four years. Fixed intervals for revision and updating will make the marine management plan system more predictable. Work on the scientific basis for revision of the management plan for the Barents Sea–Lofoten area in 2020 has been started.

2.2 Some key developments in marine management

Key developments in Norwegian and international marine management are restructuring in ocean-based industries, global discussions within the UN system on the management of the oceans and ocean resources, and growing recognition of the role of marine ecosystems in the ocean economy and of how oceans can play a role as part of the solution to global problems.

Good environmental status as a basis for value creation and the provision of ecosystem services

The management plans are based on the recognition that value creation based on the sustainable use of marine resources is dependent on good environmental status and on species and habitat diversity in the seas and oceans. There has been growing awareness of this point.

According to the report *The Ocean Economy in 2030*, published by the OECD in 2016, the world's oceans have great potential for boosting economic growth through emerging industries and the further development of established industries. The OECD estimates that more intensive use of the oceans will result in the ocean economy doubling its contribution to the global economy by 2030. The future ocean economy can be part of the solution to national and global challenges related to energy supplies, climate change, transport and food security. In order to realise the full potential of the oceans, it is essential to ensure that they are used responsibly and sustainably. The OECD report presents ocean-based industries and properly functioning marine ecosystems as the two equally important main elements of a model of the ocean economy. Norway's marine policy reflects this approach through an integrated, ecosystem-based management regime that promotes both conservation and sustainable use of ecosystems.

In autumn 2016, an expert committee on green competitiveness appointed by the Norwegian Government delivered a report concluding that there is considerable growth potential in the Norwegian marine industries, provided that they are developed in a biologically sustainable way. A focus on sustainability and the environment will be vital for ensuring competitiveness in the future, and growth in marine industries will depend on finding solutions to any conflicts that arise between different interests. The expert committee emphasised that it will be necessary to build further on the marine management plans and the processes for developing them, in cooperation between the public administration, the research sector and the business sector.

Many of the ecosystem services we obtain from marine ecosystems are public goods. Ecosystem services are the direct and indirect benefits people obtain from ecosystems. Unlike private goods, public goods do not have a market price that provides signals to consumers and decision makers about the value of the goods or the limits on their availability. It is therefore vital to demonstrate and raise awareness of the value of ecosystem services and the costs associated with the loss or degradation of ecosystem services, so that these factors can be included in decisions that will affect the marine environment.

Ecosystem services from the Norwegian Sea include fish and other seafood, energy, climate regulation, degradation of hazardous substances, uptake of carbon dioxide, oxygen production, and opportunities for recreation and enjoying the outdoors. In 2013, an expert commission on ecosystem services published an Official Norwegian Report on the values associated with ecosystem services (NOU 2013:10). The report is an important basis for further work on ecosystem services in connection with the marine management plans and in the Norwegian public administration generally.

The Forum for Integrated Marine Management is working on a more direct approach to eco-

Box 2.1 Management cooperation through OSPAR

Under the OSPAR Convention (Convention for the Protection of the Marine Environment of the North-East Atlantic), parties are obliged to take all possible steps to prevent and eliminate pollution and to take the necessary measures to protect the maritime area against the adverse effects of human activities so as to safeguard human health and to conserve marine ecosystems and, when practicable, restore marine areas which have been adversely affected.

The OSPAR Commission can adopt decisions (which are legally binding) or recommendations, and issues guidelines or guidance. Previously, OSPAR's main area of work was controlling releases of hazardous substances and other pollutants both from land-based industry and from ocean-based activities. In recent years, the emphasis has shifted to measures to safeguard marine ecosystems and biodiversity. One important measure is the establishment of an ecologically coherent and representative network of marine protected areas. This network also includes areas beyond national jurisdiction. OSPAR has also adopted a list of threatened and/or declining species and habitats in the North-East Atlantic that are in need of extra protection.

The OSPAR Commission's work is based on an ecosystem approach to management. This means among other things that management must be based on the best available scientific knowledge and advice. OSPAR has established a set of indicators that are used to assess environmental status in its Joint Assessment and Monitoring Programme (JAMP). The results are used in publishing joint assessments of environmental pressures and environmental status and trends in the North-East Atlantic, which are required under the OSPAR Convention.

The OSPAR Commission has overall responsibility for implementation of the Convention, and consists of representatives of all the parties to the Convention: Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the UK and the EU (represented by the European Commission).

system services to be included in future updates of the management plans. Some aspects of the use value of several ecosystem services provided by the Norwegian Sea are included in the figures for value added used in the management plan, for example for the seafood and tourism industries (see Chapter 5). However, the value of ecosystem services that are not included in figures for value added in the traditional sense has not been quantified.

UN Sustainable Development Goals for the oceans and international cooperation

Integrated marine management has been attracting increasing attention internationally. One key trend is the growing recognition that marine resources offer part of the solution to major global problems, and at the same time the oceans are under pressure from human activities.

In 2015, the UN General Assembly adopted the 17 Sustainable Development Goals for the period up to 2030. Goal 14 is to 'conserve and sustainably use the oceans, seas and marine resources'. This goal is supplemented by 10 targets on matters including marine debris, other marine pollution, ecosystem-based management, sustainable fishing, conservation of marine areas and knowledge building.

Norway has large and highly productive sea areas, which provide natural advantages when addressing global trends such as population growth and growing needs for energy and safe food. Oceans and marine resources extend across national borders, and so do the pressures and impacts of human activity. This means that management of Norway's own marine areas is closely linked with Norway's regional and global role as a maritime nation.

The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) is a legally binding international agreement and an important forum for developing marine nature management in the North-East Atlantic (see Box 2.1).

The Government's goal is for Norway to continue to be at the forefront of international efforts to promote sustainable use and value creation and ensure that the oceans are clean and healthy. This is why the Government recently presented the

Figure 2.2 The tube-dwelling anemone *Cerianthus vogti* is characteristic of deep-seabed habitats in cold water.

Photo: MAREANO

first white paper on the place of the oceans in Norway's foreign and development policy. It is a core Norwegian foreign policy interest to ensure ocean health and productivity for future generations, and the white paper includes an account of action to achieve this. The world's dependence on clean and productive oceans, the fundamental importance of the Law of the Sea and the forces shaping international ocean policy are the backdrop for the white paper, which discusses Norway's options and responsibilities in international marine management and in the development of ocean-based industries. The white paper also points out that Norway's integrated marine management plans have made it a pioneer in integrated, ecosystem-based management. Sharing experience and knowledge gained from its system of integrated marine management plans is one important way in which Norway can contribute to international marine management.

The system of marine management plans also plays a part in fulfilling Norway's duty under the UN Convention on the Law of the Sea to protect the marine environment in its sea areas. This duty is closely linked to the extensive rights Norway has under the Convention to utilise living marine resources and other resources on the continental shelf under its jurisdiction.

International marine management and the place of the management plans in an international context are further discussed in the white paper on the place of the oceans in Norway's foreign and development policy.

Knowledge development

Ecosystem-based management is based on knowledge about ecosystems, their environmental status and pressures and impacts on them. Since the first management plan for the Norwegian Sea was presented in 2009, a number of steps have been taken to strengthen knowledge about ocean-related topics generally and the Norwegian Sea in particular.

More knowledge provides a better basis for environmental management and for industrial development and value creation. The seabed in Norwegian waters is being mapped through the MAREANO programme. In this way, new knowledge has been acquired, the presence of valuable species and habitats has been confirmed, and many new finds have been made, for example of benthic communities such as coral reefs and sponges.

New information on seabirds in the Norwegian Sea has been acquired through the SEAPOP mapping and monitoring programme, including

the SEATRACK module. For the Jan Mayen area and coastal waters, analyses of existing information have been carried out and more knowledge has been obtained about human activity and environmental conditions

The monitoring system that has been established as part of the marine management plans makes it possible to follow environmental status in the Norwegian Sea systematically. Through the research programme MARINFORSK (and the earlier programme *Havet og kysten*) under the Research Council of Norway, more knowledge is being built up about marine ecosystems and the impacts of human activity, and this is also providing a better basis for sustainable value creation based on marine resources and ecosystem services. The seas and oceans are one of the priority areas for the Government's long-term plan for research and higher education 2015–2024.

The overall result is that there is now a more robust knowledge base for management of the Norwegian Sea than has previously been the case. However, there is still a considerable need to improve basic knowledge about the seas, for example by mapping larger areas of the seabed.

2.3 The present update of the management plan for the Norwegian Sea

This update of the Norwegian Sea management plan focuses particularly on topics where new knowledge indicates that new or updated management measures are needed. It does not include a full review of all the measures that were presented in the 2009 management plan.

This white paper is based mainly on the scientific basis provided by the Forum for Integrated Marine Management and input from a public consultation held in 2015. The Management Forum's report has been published on the website www.havforum.no, and includes information on environmental status, pressures and impacts, and activities and value creation in the Norwegian Sea. Another key document is the status report published by the Advisory Group on Monitoring in 2016. The scientific basis has also been supplemented with relevant information obtained at a later date and input from the various interests involved.

In the 2009 management plan, the state of the Norwegian Sea environment was described as generally good. However, the impacts of climate change and ocean acidification, overfishing of certain fish stocks, the risk of acute pollution, the decline of seabird populations and the need to protect coral habitats were identified as posing considerable challenges.

The scientific basis for this update includes new knowledge that has been obtained on topics including seabird populations in the Norwegian Sea, coral habitats, species and habitats in particularly valuable and vulnerable areas, and marine litter.

Marine plastic litter is a rapidly growing problem and is having increasingly serious impacts on the oceans. Because of the scale of the problem and the national and international attention it is attracting, this issue is discussed separately in Chapter 4 of the present white paper.

Indicators for assessing environmental status and pressures and impacts in the Norwegian Sea have been developed as part of the follow-up to the 2009 management plan. Results from the monitoring system and other relevant monitoring programmes are part of the basis for assessing progress towards the management goals for this sea area. The first results from using the set of indicators were reported in 2012. Many of the indicators are based on time series of measurements that have been maintained for many years. The set of indicators covers important aspects of the ocean climate, the status of various species in the Norwegian Sea ecosystem, and pollutants. Chapter 3 presents the result of the monitoring programme using these indicators.

For most of the indicators, monitoring involves annual measurements at selected sites in the Norwegian Sea. However, the set of indicators and the reporting and monitoring routines have weaknesses, and the system needs to be further developed. The updated information on environmental status in the Norwegian Sea in this white paper includes the most recent results from the Advisory Group on Monitoring available at the time of publication. The indicators for the Norwegian Sea are listed in Appendix 1.

2.4 Goals for management of the Norwegian Sea

The 2009 management plan set out general objectives for the management of the Norwegian Sea, and more specific goals concerning conservation and sustainable use (see Box 2.2).

The marine management plans are an important tool for achieving national targets for marine biodiversity, and particularly for ensuring sustain-

able use so that ecosystems achieve good status and deliver ecosystem services. The management plans are also important in the overall national implementation of UN Sustainable Development Goal 14 on the oceans and seas.

Goals that are not linked to one specific sea area are generally formulated in a very similar way in all the management plans. The wording of several goals was updated in the North Sea-Skagerrak management plan (Meld. St. 37 (2012–2013)). Further harmonisation of the goals in the different management plans will be considered.

An expert committee has been appointed to develop recommendations for scientific criteria for good ecological status, and will deliver its report in June 2017. The committee was appointed as part of the follow-up to the white paper on Norway's national biodiversity action plan. The recommended criteria for good ecological status for marine waters will be part of an overall system using a common framework to describe ecological status in all Norway's ecosystems. The Advisory Group on Monitoring will then develop scientific criteria for good ecological status in marine waters as part of its work on the management plans.

This process will make it possible to further refine and supplement the goals of the management plan. Since the work is still under way, the goals from 2009 are not being updated in this update of the management plan. When the goals are updated, this must also be done in a way that reflects Norway's national biodiversity targets. The 2016 white paper on maritime safety and the preparedness and response system for acute pollution (Meld. St. No. 35 (2015–2016)) includes the Government's new goals in this area, and these will be used as a basis for updating relevant goals in the management plans.

Some of the environmental goals set out in the 2009 management plan have not been achieved. Chapter 7 presents the Government's proposals for continued action and new measures to achieve the goals.

Box 2.2 Goals for management of the Norwegian Sea

General objectives for management of the Norwegian Sea

The Government has set the following general objectives for management of the Norwegian Sea:

- management of the Norwegian Sea will promote sustainable use of the area and its resources to the benefit of the region and the country in general;
- the management regime will take special account of the need to protect vulnerable habitat types and species;
- the management regime will ensure that activities in the area do not threaten the natural resource base and will thus safeguard opportunities for future value creation;
- the management regime will supplement necessary new legislation by further developing and strengthening the capacity for cooperation between Norwegian and foreign law enforcement bodies;
- the management regime will facilitate economically viable commercial activities and as far as possible promote value creation and employment in the region;
- 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;
- harvesting of living marine resources will promote value creation and secure welfare and business development to the benefit of the country as a whole;
- living marine resources will be managed sustainably through the ecosystem approach;
- petroleum activities will 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;
- the development of offshore renewable energy production will be facilitated, taking into account environmental considerations and other activities;
- 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;
- the Norwegian Sea will continue to be a source of high-quality seafood for international markets.

Goals for the protection and sustainable use of the Norwegian Sea

The Government has set the following goals for the protection and sustainable use of the Norwegian Sea:

Management of biodiversity

- Management of the Norwegian Sea will ensure that diversity at ecosystem, habitat, species and genetic levels, and the productivity of ecosystems, are maintained. Human activity in the area will not damage the structure, functioning or productivity of ecosystems.

Management of particularly valuable and vulnerable areas and habitat types

- Activities in particularly valuable and vulnerable areas will be conducted in such a way that the ecological functioning and biodiversity of such areas are not threatened.
- Damage to marine habitats that are considered to be endangered or vulnerable will be avoided.
- In marine habitats that are particularly important for the structure, functioning and productivity of ecosystems, activities will be conducted in such a way that all ecological functions are maintained.

Species management

- Naturally occurring species will exist in viable populations and genetic diversity will be maintained.
- Management of living marine resources will be based on the principles of sustainable harvesting.

Box 2.2 continue

- 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 Norwegian Sea will be avoided
- The introduction of alien species through human activity will be avoided.

Marine protected areas in the Norwegian Sea

- A number of marine protected areas will be established in the Norwegian Sea by 2010 as part of the OSPAR network of Marine Protected Areas.
- A representative network of marine protected areas will be established in the coastal and sea areas of the Norwegian Sea at the latest by 2012.

Pollution in general

- Releases and inputs of pollutants to the Norwegian Sea area will not result in injury to health or damage the productivity of the natural environment and its capacity for self-renewal. Activities in the area will not result in higher levels of pollutants.

Hazardous substances and radioactive substances

- The environmental concentrations of hazardous and radioactive substances will not exceed the background levels for naturally occurring substances and will be close to zero for man-made synthetic substances, and releases and inputs of hazardous or radioactive substances from activities in the Norwegian Sea will not cause these levels to be exceeded.

Operational discharges

- 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.

Marine litter

- Litter and other environmental damage caused by releases and waste from activities in the Norwegian Sea will be avoided.

Safe seafood

- Fish and other seafood will be safe and will be perceived as safe by consumers in the various markets.
- Activities in the Norwegian Sea will not result in higher levels of pollutants in seafood.

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. Activities that involve a risk of acute pollution will be managed with this objective in mind.
- Maritime safety measures and the oil spill preparedness and response system will be designed and dimensioned to effectively keep the risk of damage to the environment and living marine resources at a low level.

3 State of the Norwegian Sea environment

In the 2009 management plan, the state of the environment in the Norwegian Sea was described as generally good. However, the impacts of climate change and ocean acidification, overfishing of certain fish stocks, the risk of acute pollution, the decline of seabird populations and the need to protect coral habitats were identified as posing considerable challenges. The scientific basis for this update of the management plan concludes that the state of the Norwegian Sea environment is still good, and that the factors posing challenges for management of the area are still the same. This and the following chapter present updated information on environmental status and trends and on issues it will be important to address in the management regime for the years ahead. These include the impacts of climate change and ocean acidification, marine litter, the decline in a number of seabird populations and the pollution situation. This chapter also includes an account of environmental conditions in the deep-water areas of the Norwegian Sea.

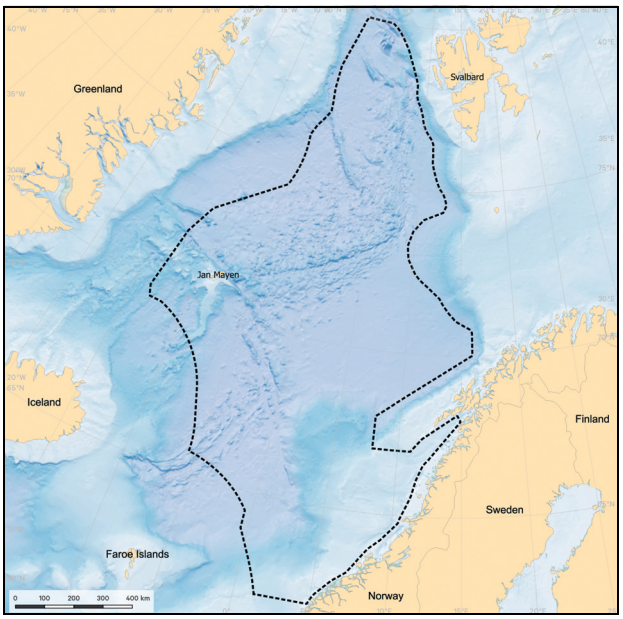

Figure 3.1 The management plan area.

Source: Norwegian Environment Agency

3.1 General information about the Norwegian Sea

The Norwegian Sea stretches from Stad at 62 °N to the Fram Strait northwest of Svalbard. The management plan area (see Figure 3.1) covers about 1.12 million km^2, including the area known as the 'Banana Hole'. About 800 000 km^2 of this is under Norwegian jurisdiction.

Characteristic features of the Norwegian Sea are areas of very deep water, the warm Atlantic current (the Gulf Stream) and high biological production and biodiversity. It includes two deep-water basins where the water depth reaches between 3 000 and 4 000 metres, and shallower waters above the inner part of the continental shelf near the coast. The average depth of the area as a whole is 1800 metres. The inflow of warm, saline Atlantic water to the Norwegian Sea is about 8 million tonnes per second – eight times the total flow of all the world's rivers. The Norwegian Sea is rich in species and supports large populations of fish, marine mammals and seabirds. There is a varied benthic fauna as a result of the great variation in water depth. Large coral reef complexes are to be found along the edge of the continental shelf. The northernmost part of the Mid-Atlantic Ridge runs through the Norwegian Sea, and includes areas with distinctive environmental conditions. Petroleum activities, shipping and fisheries and aquaculture generate substantial value added in the management plan area. The Norwegian Sea may also become an important area for the development of emerging ocean-based industries. The management plan does not establish a framework for activities in the coastal zone, which comes within the geographical scope of the Planning and Building Act.

3.2 Environmental monitoring and new knowledge about the ocean climate and biological conditions

Sound knowledge about status and trends for the ocean climate and biodiversity is a vital basis for

Box 3.1 The continental shelf in the Norwegian Sea

According to a recommendation made by the Commission on the Limits of the Continental Shelf on 27 March 2009, the part of the Norwegian shelf that stretches beyond 200 nautical miles from mainland Norway, Svalbard and Jan Mayen covers approximately 235 000 km^2.

In September 2006, Norway, Iceland and Denmark/the Faroe Islands signed a negotiation protocol on the procedure for delimiting the continental shelf in the southern part of the 'Banana Hole', a high seas area in the Norwegian Sea. This will be followed up with formal delimitation agreements now that the Commission has also made recommendations concerning this area to Iceland and Denmark/the Faroe Islands.

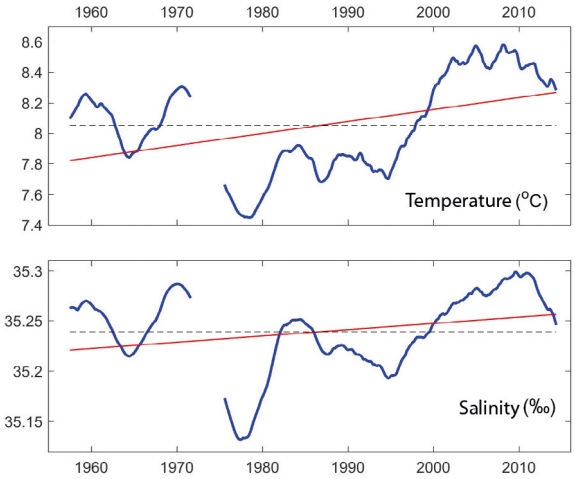

Figure 3.2 Temperature and salinity in the southern part of the Norwegian Sea. The blue lines show the five-year mean and the red lines indicate the long-term trend.

Source: Institute of Marine Research

managing marine ecosystems. A coordinated system has been established for monitoring environmental conditions in the Norwegian Sea. The next part of this chapter discusses status and trends for physical and biological conditions. The monitoring system uses indicators for ocean acidification, temperature, salinity and nutrients in seawater, and transport of Atlantic water into the Norwegian Sea. Furthermore, there are indicators for the biomass and species composition of plankton and for spawning stocks and fishing pressure for several commercial fish species. There are also indicators for breeding populations of selected seabird species and the population trend for hooded seal (as a representative of marine mammals). The indicator for threatened species shows population trends and is based on the Norwegian red list. There is also an indicator for the occurrence and distribution of alien species. Appendix 1 gives a complete list of the indicators. The harp seal stock in the West Ice and selected seabirds around Jan Mayen are monitored as part of the environmental monitoring programme for Svalbard and Jan Mayen (MOSJ).

3.2.1 The ocean climate

Temperature and salinity

Long-term trends for the Norwegian Sea show rising temperature and salinity, based on time series from the late 1950s to the present (Figure 3.2). However, there are also large natural fluctuations in both temperature and salinity in the area. The temperature of the Norwegian Sea has risen markedly from the mid-1990s onwards as a result of large-scale changes in the strength of the ocean currents in the northern Atlantic. These changes mean that the Atlantic water flowing into the Norwegian Sea in the past 15 years has been warmer and more saline than previously. In 2016, the mean temperature of the Atlantic water layer in the Norwegian Sea was the highest ever measured. However, colder and fresher Atlantic water has been flowing into the southern part of the Norwegian Sea from 2014 to 2016. As this water flows northwards, both temperature and salinity are expected to decline. There is a close relationship between the temperature of the Atlantic water and its salinity, so that relatively warm and saline conditions occur at the same time.

The general trend of a changing climate is superimposed on natural variability in the ocean climate, and it is difficult to distinguish between them in the short term. Although measurements both in the atmosphere and in seawater are showing global-scale warming, there is reason to believe that natural variability will continue to be the dominant factor in Norway's sea areas for the next 10 to 20 years.

Since 1979, the extent of the sea ice has decreased by about 8 % per decade in the north-

Box 3.2 Impacts of ocean acidification on ecosystems

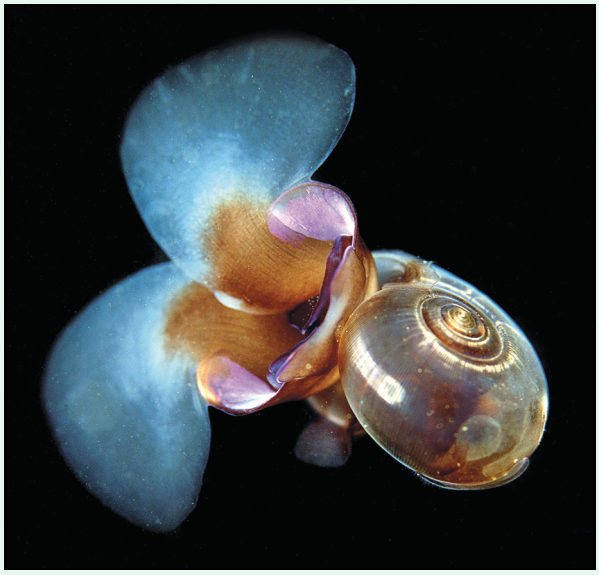

Figure 3.3 Ocean acidification can cause serious problems for species with calcareous shells like this sea snail (or 'sea butterfly') *Limacina helicina*

Photo: Erling Svensen

Laboratory studies of the impacts of ocean acidification have demonstrated adverse effects on calcifying organisms. Their calcareous shells or skeletons can begin to dissolve, but organisms can counteract this by continuing to build the shell or skeleton and increasing the energy allocated to this purpose. Some organisms are also affected directly by low pH levels, for example through effects on their metabolism. The biological availability of important micronutrients such as manganese and iron can also be altered by lower pH levels.

Ocean acidification has been shown to have adverse impacts on calcifying plankton, mollusc and echinoderm larvae and sea butterflies. Non-calcifying plankton may also be adversely affected. Large copepods such as *Calanus finmarchicus*, which is a key species in the Norwegian Sea, do not appear to be much affected by ocean acidification. Ocean acidification combined with changes in water temperature may negatively affect shrimps, krill, sea urchin larvae and cold-water corals, but there are still very few long-term studies of this.

Some work has also been done on commercially important species, and some studies indicate that cod larvae are vulnerable to ocean acidification. Early stages in the life cycle of lobsters and scallops are also vulnerable. However, no long-term or multi-generational studies of these species have been carried out.

ern part of the Norwegian Sea as a result of rising ocean and atmospheric temperatures.

Climate change and ocean acidification

According to the IPCC's Fifth Assessment Report (2013–2014), the oceans have absorbed about 30 % of all anthropogenic CO_2 emissions and more than 90 % of the energy accumulated within the climate system in the period 1971–2010. The cold northern seas are more vulnerable to ocean acidification than warmer waters, partly because the capacity to absorb CO_2 from the air is greatest at lower temperatures. Freshwater input from melting ice and runoff from land also weaken the buffering capacity of seawater and thus the extent to which it can counteract acidification.

Monitoring of ocean acidification in the Norwegian Sea has shown considerable variability in acidity levels (pH) and carbon content over time and from one area to another. However, since the 2009 management plan was published, it has been documented that the rising CO_2 content of the atmosphere is resulting in measurable acidification of the seawater in the Norwegian Sea. Monitoring of water chemistry parameters relevant to ocean acidification has been stepped up since 2011, and has improved our knowledge of acidification and natural variability in the Norwegian Sea. An analysis of historical data has confirmed that acidification is taking place more rapidly than the global average in parts of the Norwegian Sea. In the surface water of the Norwegian Basin, pH has dropped by 0.13 units over the past 30 years. Globally, pH has dropped by an average of 0.1 units from the pre-industrial level to the current average of 8.1 (this corresponds to a 30 % increase in the concentration of hydrogen ions).

So far, the biological impacts of ocean acidification have not been systematically monitored.

3.2.2 Plankton

From just after 2000 to 2009, the quantity of zooplankton (biomass) declined throughout monitored areas of the Norwegian Sea. The lowest level measured was in 2009, when zooplankton biomass was about 40 % of the long-term average for 1995–2014. After 2009 there was some increase in biomass again, followed by a new drop in 2015. Observations of more southerly plankton species in the Norwegian Sea increased up to 2011, but decreased again from 2011 to 2015.

More knowledge is still needed about the impacts of different environmental pressures on zooplankton biomass, including climatic and oceanographic factors, any changes in phytoplankton production, and grazing by other zooplankton species and fish. There is also little information about how much climate change, ocean acidification, pollution and other anthropogenic pressures contribute to the cumulative environmental effects on zooplankton.

Phytoplankton play an important role in the oceans as food for zooplankton. In addition they absorb CO_2 through photosynthesis, thus removing it from the atmosphere.

3.2.3 Kelp forests

Kelp forests are an important habitat for many marine organisms in the coastal zone, and have a high biomass. They are important nursery areas for fish (cod, saithe, pollack, lumpsucker, wrasses and cottids). A number of seabirds, including cormorants and shags, eider and black guillemot, are associated with kelp forests throughout the year. Kelp forests and other marine macrovegetation (in Norway seaweed and eelgrass) are sometimes referred to as 'blue forests'. 'Blue carbon' is the term used for the carbon captured and stored by marine biological material.

For a good many years, kelp forests along the Norwegian coast suffered from overgrazing by sea urchins. The situation is now improving. Kelp forests are recovering in the outer zone of coastal waters as far north as Bodø, but grazing by sea urchins is still a problem in many part of the fjords.

In Norway, kelp trawling for *Laminaria hyperborea* takes place along the coast from Stad in Sogn og Fjordane to Nord-Trøndelag, regulated through county management plans. There is also some trawling under experimental licences in the southern part of Nordland.

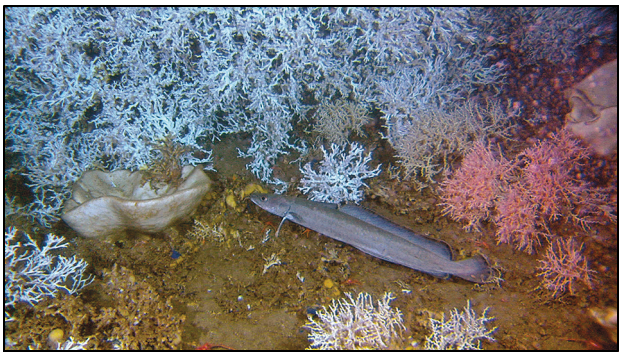

Figure 3.4 A ling on a reef with large intact colonies of corals at Storneset off the coast of Møre og Romsdal.

Source: MAREANO

3.2.4 The seabed and benthic fauna

There is a highly diverse benthic fauna on the mid-Norwegian continental shelf and continental slope, including large coral reef complexes. Stony corals form reefs that grow very slowly and that may be extremely old. Coral reefs are important because they attract a wide variety of species and form species-rich communities.

Coral reefs, coral gardens and sponge communities

Coral reefs, coral gardens and sponge communities are all formed by sessile animals that live on the seabed and form habitats for other animals (see Box 3.3). They often grow in colonies and form complex physical structures with cavities and crevices in which many different invertebrates and fish can settle and shelter. Reefs formed by the cold-water coral *Lophelia pertusa* can be up to 50 metres in height. Gorgonians, soft corals and sponges may grow on the reefs, and there are often many different species of crabs, other small crustaceans, starfish, brittlestars, basket stars and polychaetes that live within the reef structure, where they provide food for fish such as tusk, ling, saithe and redfish. Redfish larvae also find shelter within coral reefs.

Since 2012, new knowledge on the distribution of various habitat types and vulnerable biotopes, including sponge communities, coral reefs, coral gardens and sea pen communities, in the management plan area has been acquired through the mapping and monitoring programme MAREANO. The programme has also provided information on the positions and outer limits of many registered coral reefs, and confirmation of the presence or absence of reefs at other sites (see Figure 3.5). An

Box 3.3 Facts about corals

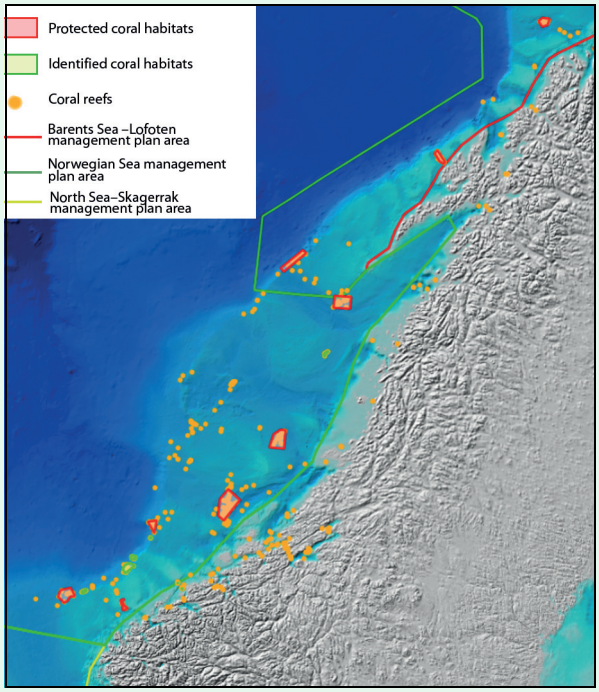

Figure 3.5 Coral habitats in the Norwegian Sea.

Source: MAREANO

The anthozoans are a large and diverse group of invertebrates that includes various types of corals – stony corals, gorgonians, soft corals and sea pens – and also sea anemones. Stony corals are the only reef-building group. The most widespread and best known of the cold-water reef-building corals is *Lophelia pertusa*. The density of reefs of this species is probably higher in the Norwegian Sea than anywhere else in the world. Gorgonians resemble large bushes or trees, and the largest species in Norwegian waters is *Paragorgia arborea*, which can grow to more than 3 metres in height. Soft coral are smaller and softer, and most of them are found in tropical waters. *Drifa glomerata* and *Alcyonium digitatum* (dead man's fingers) are two Norwegian representatives of this group.

Investigations of sediments from the continental shelf area of the Norwegian Sea have shown that there are large areas containing animals with calcareous shells or fragments of such shells. This may include smaller coral reefs and areas of coral rubble.

Sponges may grow either individually or to form large sponge communities. The latter are habitats for a wide variety of animal species that in turn provide food for fish and seabirds. Large sponge communities are quite common in shallow bank areas.

updated knowledge base on coral habitats needs to maintained as a basis for the conservation and management of these habitats. New information has been obtained on bottom conditions in the Møre banks and Eggakanten areas. Another two of the particularly valuable and vulnerable areas that have been identified, the Iverryggen reef and the Froan archipelago and Sula reef, have been investigated more thoroughly (see Chapter 3.4 for more information). From 2012 to 2015, 91 new coral reefs were discovered in the Norwegian Sea, but we still lack a full overview of their distribution and numbers.

Studies of the seabed in connection with planning of petroleum activities have also revealed many coral habitats on the continental shelf in the Norwegian Sea. The data that have been collected on them are being systematised.

Studies in coastal areas have shown that the distribution of many benthic organisms has shifted northwards in response to higher water temperatures. Of the roughly 1600 marine benthic species found in more southerly Norwegian waters, 565 were found to have expanded northwards by an average of 750–1000 kilometres in the period 1997–2010. In addition, well over 100 species have moved into Norwegian waters from

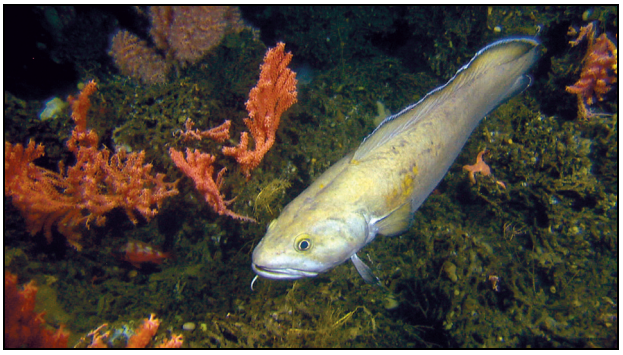

Figure 3.6 A tusk near the cold-water coral *Lophelia pertusa* and the sea fans *Primnoa resedaeformis* and *Anthothela grandiflora*.

Photo: MAREANO

more temperate areas between 1997 and the present.

Fishing with bottom trawls and other gear that is towed along the seabed is the commercial activity that has the greatest impact on the benthic fauna.

Damage to coral habitats from fishing operations was identified as a problem in the 2009 management plan, and is still considered to be an important issue. The MAREANO programme has registered trawl tracks on the seabed down to a depth of 823 metres, and has documented damage to vulnerable habitats.

Bottom trawling affects large areas and has direct impacts on the seabed. Bottom trawling has been carried out for many years, and this is one reason why it is difficult to determine precisely when damage to coral habitats occurred. In some cases, new damage has been observed that is believed to have occurred within the past five years. Other damage is clearly older. Since there is no monitoring of registered coral habitats, it can be difficult to document changes in the pressure from bottom trawling. However, there is reason to believe that bottom trawling is putting less pressure on these habitats now than a few decades ago. The number of trawling hours by Norwegian vessels in the Norwegian Sea has been considerably reduced since the 2009 management plan was published, see Table 5.3. Regulatory measures were introduced in 1999 in the Sea-water Fisheries Regulations and the Bottom Fishing Regulations, and appear to have reduced the impacts of bottom fishing on coral reefs. In addition, trawl types that cause less damage to the seabed are being tested. As a precautionary measure, bottom trawling has also been prohibited in deep-water areas unless a special permit is obtained.

Pressures and impacts of petroleum activities on vulnerable benthic animals are further discussed in Chapter 5.3.3.

It is still not clear what impacts climate change and ocean acidification will have on coral habitats and other calcifying organisms in the Norwegian Sea. Levels of hazardous substances are generally low in sediments, and their effects on the benthic fauna have been reassessed as minor rather than moderate as previously. Monitoring of shrimps (*Pandalus borealis*) in the Norwegian Sea started in 2012, and the results show that mercury levels are somewhat higher than the Environmental Quality Standard (EQS). Organisms at higher trophic levels in marine food chains that feed on shrimps may be at risk of accumulating mercury. Mercury levels in shrimps are well under the maximum permitted level in foodstuffs.

3.2.5 Valuable species and habitats in the deep sea

There are large deep-water areas under Norwegian jurisdiction in the Norwegian Sea. They include the northernmost part of the Mid-Atlantic Ridge, which is the geologically most active area in Norway. It runs through deep parts of the Norwegian Sea, and includes areas with distinctive environmental conditions and ecosystems and habitat types about which little is known. This deep-water area has large underwater mountains and rift valleys.

Areas where there are hydrothermal vents and associated deposits of metal sulphides and methane hydrate (methane trapped in ice crystals) are habitats for very specialised organisms that form distinctive marine ecosystems along the Mid-Atlantic Ridge. These ecosystems are based on chemosynthesis, which means that organisms use chemical compounds in the water as a source of energy, rather than sunlight. Hydrothermal vents can be active for thousands of years. When they are no longer active, the ecosystem in the area changes from the distinctive chemosynthetic system to a normal benthic fauna. Organisms living in extreme deep-sea environments have unique adaptations to enable them to survive in the extreme conditions. Microorganisms and biomolecules can be harvested for industrial and

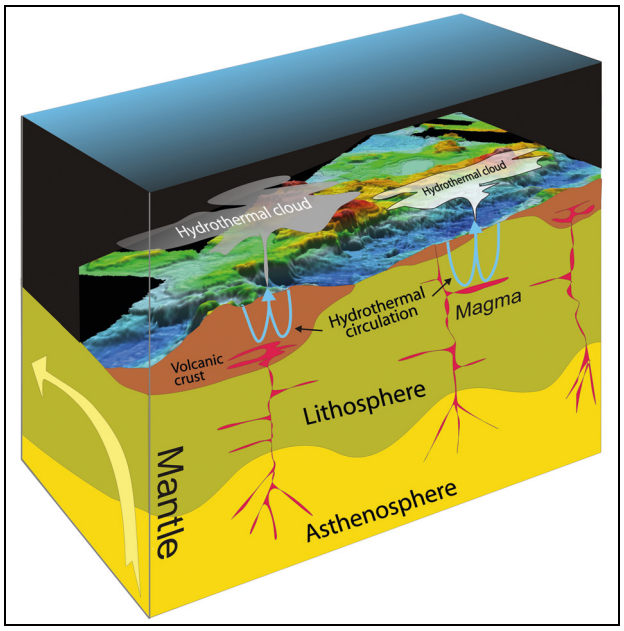

Figure 3.7 Geodynamic processes in the deep sea.

Source: University of Bergen

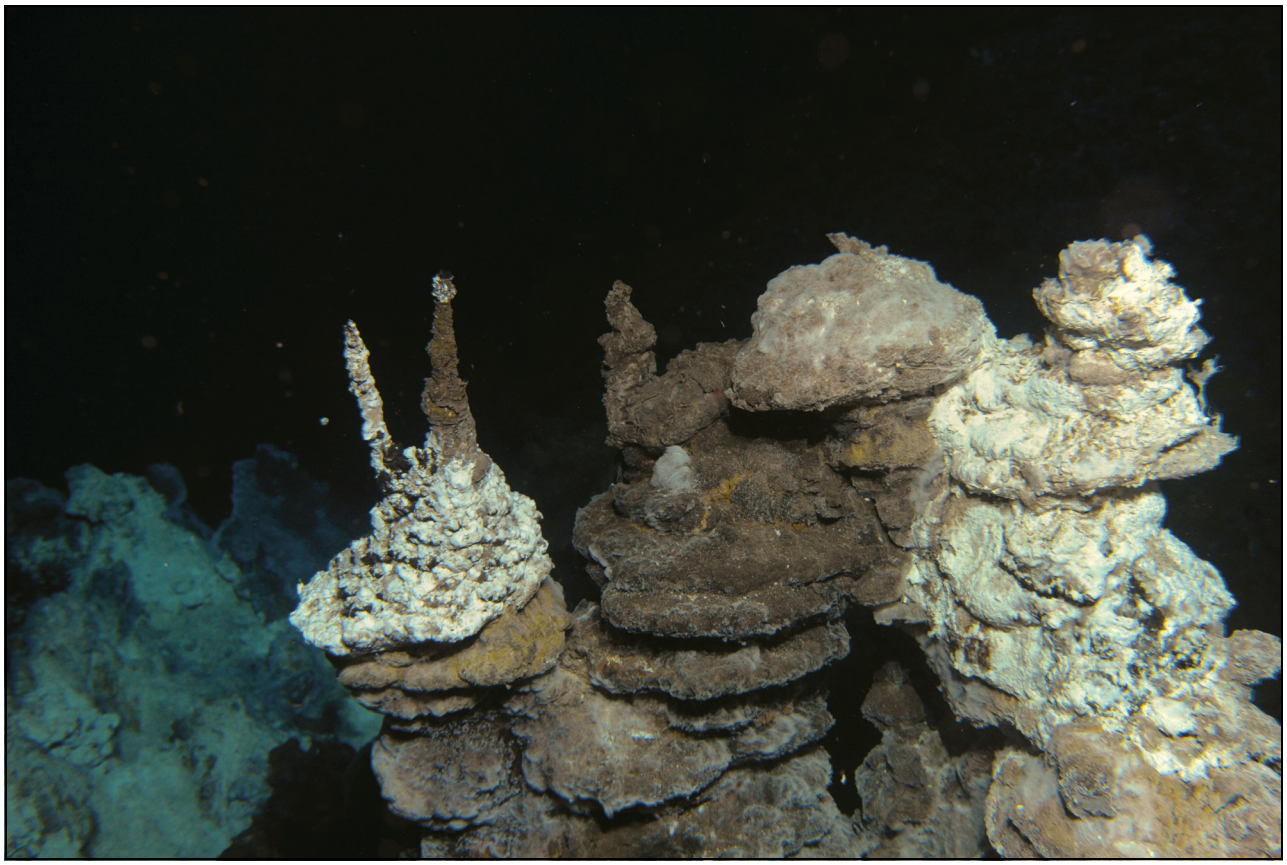

Figure 3.8 These 'black smokers' on the Mid-Atlantic Ridge between Jan Mayen and Bjørnøya are hydrothermal vents formed by the deposition of metal-rich sulphide minerals.

Photo: University of Bergen

medical uses (bioprospecting) from hydrothermal vent fields.

Mineral deposits are largely associated with inactive vent fields, and it is these areas that are of most interest for commercial exploitation of rare metals. Extensive deposits of manganese crust have also been found in the Norwegian Sea. Manganese crust is rich in a number of metals. The crust is deposited from seawater on bare rock, and contains rare, important elements that may be of great economic value.

So far, only limited research has been carried out in deep-water areas, and there has been little focus on the management of these areas.

Hydrothermal vents and the formation of mineral deposits

So far, seven active and two inactive hydrothermal vent fields have been discovered at depths of between 140 and 2400 metres in the Norwegian Sea. They contain metal deposits that are formed where there is an outflow of geothermal water from the seabed. When this hot, mineral-rich water mixes with cold seawater, minerals are precipitated out and form chimney-like structures. Geothermal water gushes out from the top of the vents. It contains large quantities of black or white mineral particles that make the hot water resemble smoke, and which gave rise to the names 'black smokers' and 'white smokers'.

The extent of our knowledge about the biology of the vent fields varies. Dense assemblages of sea anemones and sea squirts have been found on the Seven Sisters field. The fauna of the three Jan Mayen vent fields includes a small species of snail that grazes on the extensive bacterial mats, large sea anemones, several species of carnivorous sponges, calcareous sponges, hydroids and large numbers of sea lilies. The Jan Mayen vent fields are the best surveyed thus far. They are situated about 70 km north-east of Jan Mayen itself.

Little is known about the biology of the Ægirs kilde vent field, but a species of eelpout and various amphipods have been photographed. The Loki's Castle vent field was discovered in 2008 and contains the largest mineral deposits so far found in the Norwegian Sea. This is also the first site in

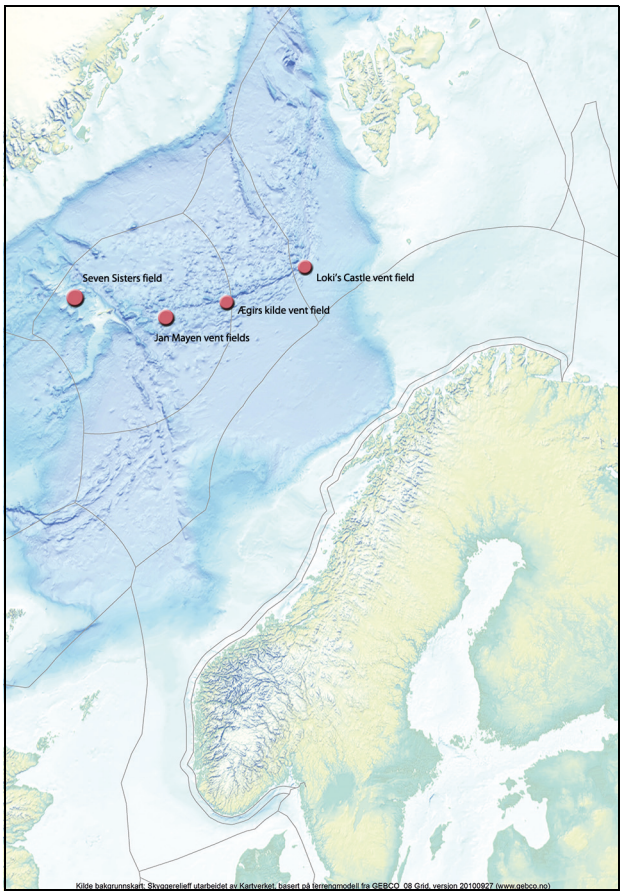

Figure 3.9 Known active hydrothermal vent fields in the Norwegian Sea.

Source: Source: University of Bergen

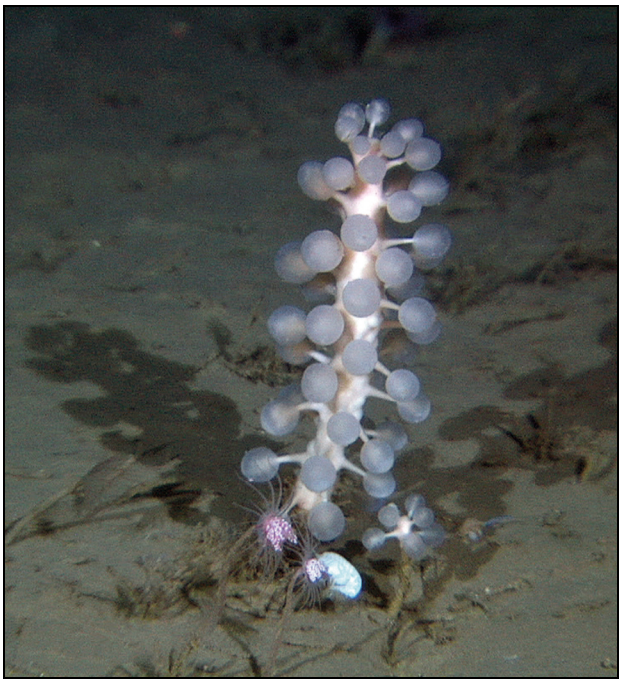

Figure 3.10 Carnivorous sponges have been found on the Jan Mayen hydrothermal vent fields. *Chondrocladia grandis*, is common in soft-bottom habitats in deep waters in the Norwegian Sea. This specimen was photographed at a depth of 770 metres near the edge of the continental shelf off Møre og Romsdal.

Photo: MAREANO

Norway's deep-water areas where species have been found that are specifically adapted to the high temperatures around hydrothermal vents, including species that are endemic to the area.

There are rare habitat types and highly specialised organisms and species in areas around hydrothermal vents. It is important to investigate such areas before, during and after any commercial activities take place. Baseline studies are also needed in surrounding areas to look at the prospects of recolonisation by the original fauna.

Box 3.4 The Loki's Castle vent field

The fauna of the Loki's castle vent field is unusual even by comparison with other deep-water areas. Both the hard-bottom and the soft-bottom fauna are closely adapted to the environmental conditions. On the vent chimneys themselves, a new species of amphipod has been found, and snails and polychaetes are abundant at the base of the chimneys. The soft-bottom areas are covered with large white bacterial mats and tubeworms, snails, amphipods and polychaetes. An overview of the fauna of the area is being prepared.

Methane hydrates

Methane hydrates consist of methane trapped in ice crystals in the seabed, and are only stable at high pressure and low temperature. They are found on the continental shelf and the continental slope in association with natural gas seeps. Methane hydrates can provide a source of energy, and there is therefore interest in their exploitation. There are distinctive geochemical substrates around methane hydrate deposits and cold seeps, which provide a habitat for chemosynthetic bacteria. These bacteria support a distinctive fauna not dissimilar to that found around hydrothermal vents. However, the fauna associated with methane hydrates occurs over larger areas and is quite similar in different localities.

In Norwegian waters, methane hydrate deposits have been reported around the Håkon Mosby

mud volcano, in the Storegga and Nyegga areas (on the edge of the continental shelf in the southern part of the Norwegian Sea) and on the Vestnesa ridge west of Svalbard (see Figure 3.11).

The bacteria and fauna associated with methane hydrate deposits have been best studied around the Håkon Mosby mud volcano. In this area, there are dense stands of beard worms, which are polychaetes that live in long thin tubes. These in turn support a wider faunal community. The geochemical conditions appear to be more important for the fauna than the water depth.

Little is known about the environmental impacts of exploiting methane hydrates.

3.2.6 Fish stocks

The Norwegian Sea fish community is dominated by three pelagic stocks; Norwegian spring-spawning herring, Northeast Atlantic mackerel and blue whiting. Some of the most important changes since the 2009 management plan have been the growth of the mackerel stock and the expansion of its distribution, the decline in the herring stock and the decline in the blue whiting stock, which is now growing again. The pelagic fish stocks are highly mobile and can cover long distances in search of food. None of these three species spends all its life in the Norwegian Sea. Both migration patterns and stock trends of the pelagic fish stocks have always been very dynamic.

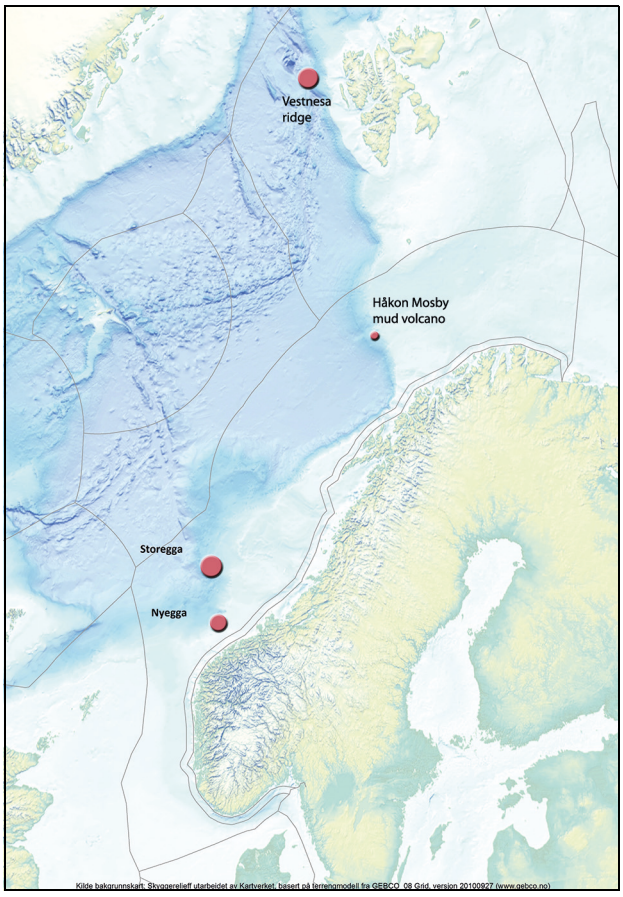

Figure 3.11 Methane hydrate deposits reported in Norwegian waters.

Source: University of Bergen

No agreements involving all the relevant countries have been concluded on the management of the three large pelagic stocks. However, there is an agreement between Norway, the EU and the Faroe Islands on management of the mackerel stock. In addition, these countries have reached agreement on the total allowable catch (TAC) and management plans for blue whiting and Norwegian spring-spawning herring for 2017. Another important stock is saithe, which is at full reproductive capacity and is being harvested sustainably. The beaked redfish stock is considered to have been fairly stable for the past 10 years, and the proportion of mature fish is high. According to the International Council for the Exploration of the Sea (ICES), the beaked redfish stock has recovered to a sustainable level. The Norwegian-Russian Fisheries Commission is preparing a management plan for this stock in consultation with ICES.

Various Atlantic salmon stocks spend considerable periods of time and important life phases in the Norwegian Sea, and a number of them spawn in Norwegian rivers. Changes and natural variability in marine ecosystems have important implications for growth stages of wild salmon and therefore for their survival at sea. Along the coast and in rivers, salmon are affected by fish farming, for example as a result of infection with sea lice at sea, and through genetic pressure and competition with escaped salmon for spawning sites in rivers. Other pressures include the salmon parasite *Gyrodactylus salaris*, acid rain, pollution from agri-

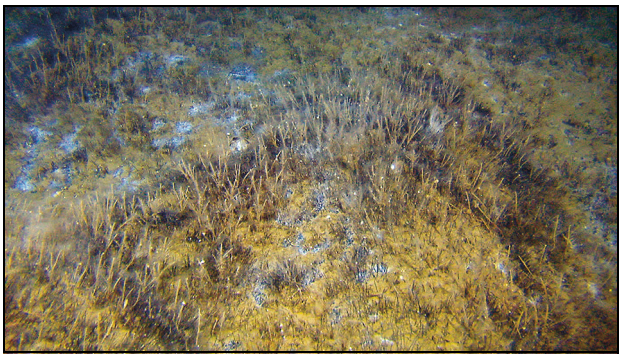

Figure 3.12 An area of cold seeps covered in bacterial mats and beard worms.

Source: MAREANO

culture and other sources, and regulation of rivers for hydropower production. Overfishing of salmon stocks also used to be a considerable problem.

The Greenland halibut stock is now at a relatively high level, but is expected to decline during the next few years as a result of weaker recruitment. The stock is considered to be within safe biological limits. From 2016, ICES has introduced a precautionary level of 500 000 tonnes for the spawning stock of Greenland halibut. The stocks of blue ling and golden redfish have declined since 2009. Both species are classified as endangered in the 2015 Norwegian Red List, and recruitment to the stocks has been weak for the past ten years. ICES has recommended that no catch of these species should be permitted, and that a formal management and rebuilding plan should be established for golden redfish. The fisheries authorities have introduced a prohibition on fishing specifically for these species and have taken further steps to reduce bycatches. A need to further reduce bycatches in trawl fisheries has been identified.

The stocks of herring, mackerel, blue whiting, Northeast Arctic saithe, Northeast Arctic cod and haddock are being managed on the basis of the precautionary approach and in line with management strategies recommended by ICES. Inspection and enforcement to prevent illegal fishing has also been stepped up. The cumulative effects of the fisheries on these stocks for the period 2009–2016 are considered to be minor.

The distribution of the mackerel stock has been expanding as the boundary between Atlantic and Arctic water has been moving northwards and westwards in the Norwegian Sea. The increase in the distribution area of the stock is largely determined by growth in the stock size, whereas the direction of expansion is influenced by water temperature.

Higher temperatures may alter ecosystem structure and function or competition for nutrients.

Ocean acidification has not been shown to have impacts on fish stocks. The early life stages of fish are considered to be more sensitive to ocean acidification than adults.

3.2.7 Marine mammals

The West Ice population of hooded seal is stable, but it is at the lowest level ever recorded. The

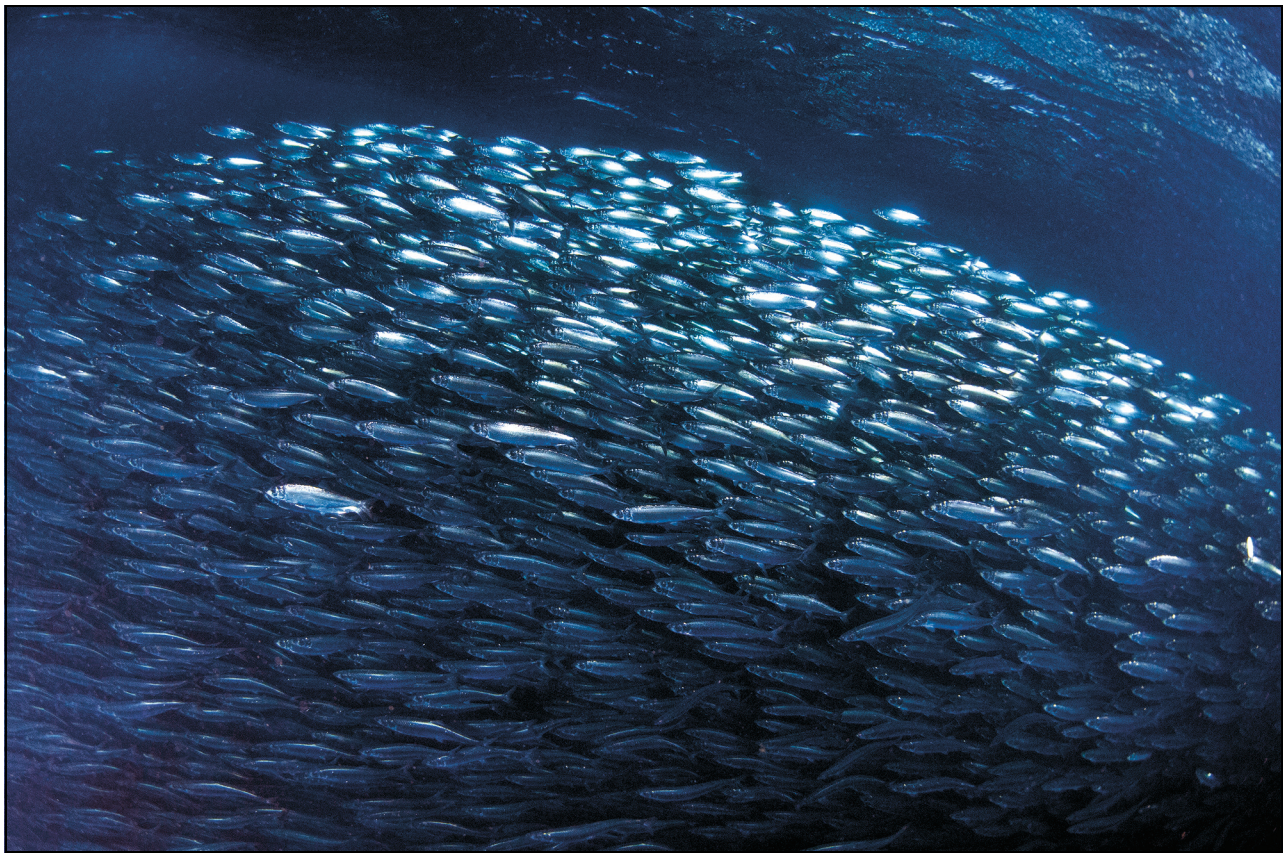

Figure 3.13 Shoal of Norwegian spring-spawning herring.

Photo: Lill Haugen/NTB scanpix

Figure 3.14 Grey seal.

Photo: Per H. Olsen/Norwegian Biodiversity Information Centre

hooded seal is classified as endangered in the 2015 Norwegian Red List. Sealing is probably the most important direct cause of the steep population decline since the 1940s, but food supplies in the Northeast Atlantic have probably also declined in the same period. This explains why the growth of individuals and reproduction have remained low. The harp seal population in the West Ice has been growing steadily since the 1970s, and now numbers about 650 000 animals. Predation by polar bears has increased in recent decades as the extent of the West Ice has declined. An increase in predation by killer whales on harp seals has also been recorded, but not so far on hooded seals.

Data from tagging programmes and collected by a reference fleet for the Institute of Marine Research indicate that bycatches in the angler fishery may be an important reason for the substantial decline in pup production observed in the coastal grey seal population in the Norwegian Sea area from 2010 to 2014–2015. Other possible factors are unreported hunting and predation by killer whales. This decline has resulted in a recommendation that all hunting of grey seal should be stopped in the entire area from Stad in Sogn og Fjordane to the southern tip of the Lofoten Islands. There has also been a substantial local decline in the common seal population in Nord- and Sør-Trøndelag, which may be due to heavy hunting pressure at times. It has been recommended that common seal hunting should be halted in Nord-Trøndelag and that the quota should be greatly reduced in Sør-Trøndelag.

Little is known about the occurrence of bottlenose whales, killer whales, dolphins and porpoises in the Norwegian Sea. This is partly because the behaviour of these species (deep diving, schooling) makes it difficult to obtain good data for them during the sighting surveys for minke whales. Almost all porpoises taken as a bycatch by the coastal reference fleet were caught between 60 and 70 °N, with the largest concentration in the Vestfjorden. The total bycatch in the Norwegian Sea area is estimated at about 2000 animals a year. The minke whale population is stable.

There has been a decrease in the observed levels of some classic persistent organic pollutants in hooded seals in and around the Norwegian Sea. There are generally higher levels of persistent, bioaccumulative and toxic substances in hooded seals from the West Ice than in harp seals from the same area, but so far no signs have been found of any biological effects in hooded seals. Levels of these substances in polar bears and toothed whales are still so high that biological effects at population level are to be expected. Several studies have also shown substantial concentrations of new types of persistent, bioaccumulative and toxic substances in marine mammals.

Several species of marine mammals feed on commercially exploited fish species, and fishing pressure may therefore influence the availability of food for these species. One possible example is the hooded seal, which is believed to feed on species including Greenland halibut, redfish and greater argentine.

It is also considered likely that natural variability and climate change may affect the availability of food for seals and whales. The impacts of such factors will vary from one species to another, and ice-dependent species will probably be most vulnerable.

There are large bycatches of porpoises, but it is difficult to assess what impact, if any, this has on the porpoise population before the survey results for 2016 are available. If there is a population decline, other pressures such as oil spills, hazardous substances and disease may increase their vulnerability.

3.2.8 Seabird populations

Populations of many seabirds in the Norwegian Sea have declined steeply since the early 1980s, when most monitoring programmes began. This is particularly true of the common guillemot population (critically endangered), which has dropped by 99 %, while kittiwake numbers (endangered) have decline by 78 % and puffins (vulnerable) by 75 % during this period.

Figure 3.15 Fulmar

Photo: Tycho Anker-Nilssen, Norwegian Institute for Nature Research

For the common guillemot, the decline has been most severe in the more northerly colonies in the management plan area, particularly on the Røst archipelago (Nordland). Puffin numbers apparently remained stable for a long time at the colony on Runde (Møre og Romsdal), but here too there has been a negative trend in the last 10 years. The breeding population on Sklinna in Nord-Trøndelag has also declined. The breeding population of fulmars is declining throughout the Norwegian Sea area, and many colonies are at risk of being wiped out. Numbers of the lesser black-backed gull (subspecies *Larus fuscus fuscus*) along the southern Nordland coast have declined in recent years. The fulmar population in the Norwegian Sea has been greatly reduced, and there are now hardly any breeding birds left in many colonies, for example on Runde. Numbers of common eider have also declined in recent years, while shag numbers have dropped steeply on Runde but increased on Sklinna. One species that has shown a large population increase since the early 1990s is the gannet; its total breeding population has more than tripled. This is probably related to the large stocks of herring and mackerel. High levels of persistent, bioaccumulative and toxic substances have been measured in seabird eggs, giving cause for concern about the pressures and impacts of such substances on seabirds in the Norwegian Sea.

After a survey of its breeding populations of seabirds in summer 2010, Jan Mayen was included as a key site of the seabird mapping and monitoring programme SEAPOP from 2012. Although the time series for Jan Mayen are still short and the results must be treated with caution, some trends are beginning to become apparent The figures indicate that populations of common and Brünnich's guillemots are declining by 5 and 13 % per year respectively. On the other hand, the Jan Mayen fulmar population seems to be relatively stable.

Breeding success for common guillemots along the coast of mainland Norway has been poor except for the colony at Sklinna in Nord-Trøndelag, where better results may be explained by plentiful supplies of young year-classes of cod. During the breeding season, seabirds are tied to the colonies and need to find food within a limited area. Food availability near the colonies varies a great deal from year to year and is largely determined by recruitment to younger year-classes of fish and by climatic and oceanographic conditions in the sea.

The reason for the poor status of many of the seabird populations in the Norwegian Sea area is not clear-cut, but is related to a number of factors including reduced availability of food, greater competition for nutrition and predation pressure. Changes in the availability of food (zooplankton and small fish of pelagic and demersal species such as herring, gadids and sandeels) are very significant. Some of the changes are probably related to climate change, which can for example influence when important food species are availa-

Box 3.5 Sandeels and seabirds

Sandeels are important prey for seabirds, particularly kittiwakes, common guillemots, razorbills and puffins. Sandeels are a group of strongly schooling species in the sand lance family that are highly dependent on specific sandy substrates. Sandeels occur all along the Norwegian coast, but our knowledge of the populations of different species and where they occur along the coast is limited. Since the different species require specific types of sandy substrate, it is unlikely that it will be possible in practice to map all areas of suitable habitat along the entire Norwegian coast. The known areas of sandy substrate on which sandeels depend are in the coastal zone.

Sandeels, mainly the lesser sandeel, are monitored in central parts of the North Sea where there are large commercially harvestable stocks and where numbers have increased. Sandeels are further discussed in the North Sea–Skagerrak management plan.

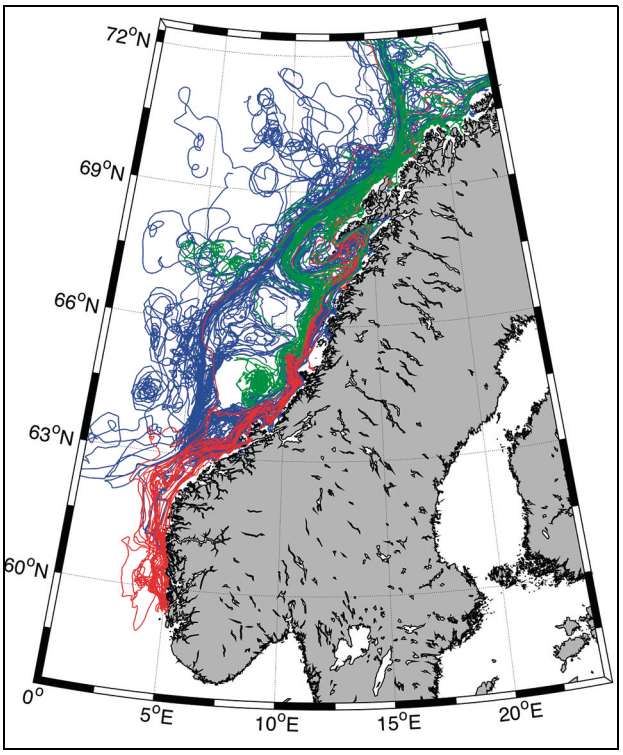

Figure 3.16 Transport of herring larvae with the currents from spawning grounds off Møre og Romsdal (blue) and more southerly (red) and northerly (green) areas in 2006.

Source: Institute of Marine Research

ble for seabirds. Models that show the patterns of drift of fish larvae with ocean currents can be used to build up knowledge about how variable food availability affects seabirds. The timing of larval drift larvae past seabird colonies may be of crucial importance, and there may be a strong negative impact on breeding success if it is too early or too late relative to the seabird breeding season. The availability of herring larvae is vital for good production of puffin chicks on Røst, and for other pelagic seabird species in the management plan area. The Norwegian spring-spawning herring stock has not produced a strong year-class of larvae since 2004, and this has had a serious effect on the breeding success of Norwegian populations of pelagic seabirds. Climate change will have longer-term effects on seabirds, but it is difficult to distinguish between direct and indirect effects. Indirect effects can be related to changes in fish stocks or to changes in oceanographic conditions that in turn influence the climate. One result may be that established colonies are no longer optimally sited in relation to feeding grounds. The mackerel stock in the Norwegian Sea has grown substantially since 2007, and this may have intensified competition between mackerel and seabirds for herring larvae and other prey.

A project has been carried out to find ways of reducing unintentional bycatches of seabirds in Norwegian coastal fisheries. It involved a broad-based group including representatives of the authorities, the fisheries and the research community. The project focused on measures that are relevant in specific areas and that are proportionate to the scale of the bycatch problem. The impacts of unintended bycatches of seabirds in fishing gear in the Norwegian Sea are uncertain, but bycatches have probably been reduced over time through various preventive measures. This work will be continued, and will include assessments of whether further measures are needed to reduce bycatches of seabirds.

Seabirds are particularly at risk from marine litter, especially since they can mistake fragments of plastic for food, see Chapter 4. Exposure to hazardous substances can put additional pressure on seabirds.

As a result of the decline in many seabird populations, additional pressures such as oil spills may have more serious impacts than would previously have been the case. Since the 2009 management plan was published, experience gained in cleaning and rehabilitating oil-contaminated seabirds has been evaluated, and the need for further follow-up as regards the implications for populations and animal welfare has been assessed. The conclusion was that cleaning and rehabilitation should only be carried out if the survival of individual birds is important at population level for the species in question. At present, this only applies to the lesser white-fronted goose and Steller's eider in Finnmark.

Seabirds are further discussed in the white paper on Norway's national biodiversity action plan.

3.2.9 Threatened species and habitat types

There has been some improvement in the conservation status of threatened species in the Norwegian Sea since 2010. In 2015, eight species were assessed as having better conservation status, including the common seal, beaked redfish and four species of molluscs, all of which were transferred to the category Least Concern (LC) and are thus no longer red-listed. On the other hand, there has been a deterioration in the status of the blue whale and four seabird species (razorbill, common tern, fulmar and Brünnich's guillemot).

Table 3.1 Red-listed species in the Norwegian Sea (vertebrates and anthozoans only)

Scientific name	English name	Category 2006	Category 2010	Category 2015	Pressures
Mammals					
Balaenoptera musculus	Blue whale	NT	NT	VU	Historical harvesting
Balaena mysticetus	Bowhead whale	CR	CR	CR	Climate change, habitat degradation (commercial activities)
Cystophora cristata	Hooded seal	VU	EN	EN	Harvesting (very limited, research purposes), climate change
Lutra lutra	Otter	VU	VU	VU	
Monodon monoceros	Narwhal	DD	EN	EN	Climate change
Fish					
Dipturus batis	Blue skate	DD	CR	CR	Bycatches
Anguilla anguilla	Common eel	CR	CR	VU	Pollution, habitat degradation, random mortality
Squalus acanthias	Spiny dogfish	CR	CR	EN	Pollution, climate change, random mortality
Molva dypterygia	Blue ling	VU	EN	EN	Human disturbance, random mortality
Sebastes norvegicus	Golden redfish	VU	EN	EN	Pollution, bycatches, human disturbance, random mortality
Lamna nasus	Porbeagle	VU	VU	VU	Climate change, random mortality
Cetorhinus maximus	Basking shark		EN	EN	Random mortality
Birds					
Uria aalge	Common guillemot	CR	CR	CR	Food supply, other native species
Cepphus grylle	Black guillemot	NT	VU	VU	Alien species, harvesting, human disturbance
Fratercula arctica	Puffin	VU	VU	VU	Food supply, other native species
Alca torda	Razorbill		VU	EN	Food supply, other native species
Rissa tridactyla	Kittiwake	VU	EN	EN	Other native species
Sterna hirundo	Common tern	VU	VU	EN	Other native species
Fulmarus glacialis	Fulmar		NT	EN	Prey and predator species
Uria lomvia	Brünnich's guillemot	NT	VU	EN	Food supply, other native species
Anthozoans					
Lophelia pertusa		NT	NT	NT	Habitat degradation, climate change, ocean acidification
Paragorgia arborea		DD	NT	NT	Habitat degradation, random mortality

CR = critically endangered, EN = endangered, VU = vulnerable, NT = near threatened, DD = data deficient
Source: Norwegian Red List for Species 2006, 2010 and 2015.

Table 3.2 Red-listed habitat types in the Norwegian Sea

Dominant species	Habitat type	Category 2011	Pressures
	Mud volcano	VU	
Lophelia pertusa	Coral reefs	VU	Habitat degradation
	Hydrothermal vents	NT	
Paragorgia arborera	Coral gardens	NT	Habitat degradation

VU = vulnerable, NT = near threatened
Source: Norwegian Red List for Ecosystems and Habitat Types 2011

The remaining species have been retained in the same red-list categories as previously. The hooded seal, bowhead whale, narwhal, spiny dogfish, basking shark, blue skate, golden redfish and blue ling are still either endangered or critically endangered. A substantial proportion of the population of most of these species is found in Norway, and several of them are listed as threatened internationally.

Only a few of the red-listed species are monitored regularly. To obtain a more representative picture of the situation of threatened species in the Norwegian Sea will require a considerable effort both to determine the conservation status of different species and to map their occurrence. The most important source of knowledge about habitat types has been mapping as part of the MAREANO programme. There is no systematic monitoring of threatened habitat types.

A list of threatened and/or declining species and habitats in need of special protection has been drawn up under the OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic.

The status of threatened ecosystems and habitat types in Norway was assessed in 2011. The *mud volcano* Håkon Mosby and surrounding area is the only known occurrence of this habitat type in Norwegian waters. Both this habitat type and *coral reefs* are listed as vulnerable, while *hydrothermal vents* and *coral gardens* are listed as near threatened.

A number of the red-listed species in the Norwegian Sea are threatened by human activity and the resultant habitat degradation, pollution or bycatches. In general, too little is known about the impacts of these pressures. There is a clear relationship between biodiversity conservation and ecosystem functioning and the provision of ecosystem services by an area such as the Norwegian Sea. Biodiversity and ecological interactions between species are directly related to the resilience of ecosystem functions such as biological production, habitat diversity, CO_2 storage and oxygen production. These in turn are the basis for ecosystem services that we take for granted, and that are vital for food security and human welfare (see the discussion of ecosystem services in Chapter 2). The loss of biodiversity and changes to healthy animal and plant communities may have negative impacts on marine goods and services, for example making it difficult to maintain commercially important fish stocks.

3.2.10 Alien species

Alien species are species that have been introduced outside their natural distribution area by human agency. There are currently few alien species in the Norwegian Sea, but climate change and increasing maritime activity, including shipping, are increasing the risk of the spread and establishment of new alien species that may be harmful to the natural ecosystem. The Ballast Water Convention is discussed in Chapter 5.2.3.

Little is known about the occurrence and ecological effects of many alien species. There is no systematic monitoring of the occurrence of alien species in Norwegian coastal and marine waters.

However, in 2010–2015, 14 monitoring stations along the Norwegian coast, including the port of Narvik, were regularly investigated for the presence of alien species as part of the national programme for mapping and monitoring biodiversity. The programme has registered a number of alien species that have become established in coastal waters, including the Pacific oyster (*Crassostrea gigas*) in the northern part of Møre og Romsdal. This shows that alien species could potentially spread to the Norwegian Sea management area as well.

Another alien species, the comb jelly *Mnemiopsis leidyi*, was introduced from waters off the east coast of the US to the Black Sea with bal-

last water, and has since spread to large areas of the northeast Atlantic. There are for example reproducing populations in the Baltic Sea and the North Sea. If the water temperature of the Norwegian Sea rises further, reproducing populations are likely to become established here too. Even now, considerable numbers of these comb jellies are from time to time transported northwards into the Norwegian Sea with the coastal current.

3.3 Pollution

Knowledge about pollutants in the Norwegian Sea is needed to gain an overview of the environmental status of the area, in addition to knowledge about the ocean climate and biodiversity, as discussed above. The information provided below is based on indicators for selected hazardous substances in marine organisms and for inputs of pollutants. Appendix 1 lists all the indicators used in the monitoring programme.

3.3.1 Sources of pollution

The main source of pollution in the Norwegian Sea is long-range transport with air and ocean currents. Since the previous management plan was published, the models for inputs of pollution have been further developed. In 2011, new calculations by the Norwegian Environment Agency using results from the Marine Pollution Monitoring Programme showed that inputs of hazardous substances via ocean currents and atmospheric transport are much higher than estimated in the 2009 management plan. The higher estimates are largely explained by improvements in how the models describe inputs of pollutants. There is little to suggest that there has been a real increase in inputs. Hazardous substances that are still in use or are present in the environment because of earlier use are spread with winds and ocean currents to the Norwegian Sea. Inputs from Norway's land areas and the coastal zone are also included in the calculations as external pressures on the management plan area. The total contribution from long-range transport of pollutants is considerably larger than the contribution from local sources for all the substances that have been investigated. The only exception is oil, since shipping and petroleum activities are sources of oil pollution within the management plan area.

3.3.2 Environmentally hazardous substances and oil

Inputs of selected priority hazardous substances are monitored at Birkenes in Aust-Agder, Ny-Ålesund in Svalbard and since 2010, at Andøya in Nordland. The results from Ny-Ålesund show stable or decreasing and low concentrations of hazardous substances in air, with the exception of rising concentrations of the persistent organic pollutant hexachlorobenzene (HCB). Levels of most substances are rather lower at Andøya than in Ny-Ålesund, but it is too soon to identify trends. There is very little data from western parts of the Norwegian Sea, but measurements from Jan Mayen in 2009–2011 showed generally low concentrations of hazardous substances in air and water.

Levels of hazardous substances in the water column are low, as are levels of most hazardous substances in sediments in open sea areas of the Norwegian Sea. Studies suggest that inputs of mercury, lead and PAHs (polycyclic aromatic hydrocarbons) from combustion have shown a weak rise in the last 100 years. Although levels of hazardous substances measured in sediments and the water column are low, certain substances bioaccumulate and are found at relatively high levels in particularly vulnerable species at the top of food chains. Studies carried out since the 2009 management plan was published show that concentrations of these pollutants in some fish species, edible crab, seabirds and marine mammals are so high that they give cause for concern. In certain species, concentrations of some organic pollutants and mercury are high enough that they could have adverse effects at individual level.

Classification systems are used in assessing whether the measured levels of a particular substance are of concern in the environment, and whether they are so high that it is necessary to take action. People and marine organisms 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 marine organisms against the possible adverse impacts of hazardous substances. The levels specified in environmental quality standards (EQS) are often lower than the maximum permitted concentrations of hazardous substances in seafood.

In fish, concentrations of hazardous substances are generally highest in large, long-lived species at higher trophic levels, such as Greenland halibut and cod. Despite the generally low

pollution levels, the EQS for mercury is exceeded in several indicator species (shrimp, cod, herring, tusk, Greenland halibut and minke whale). In several indicator species of fish, the EQS for liver is exceeded for one or more organic pollutants. Fillet meat of Greenland halibut also contains certain organic pollutants at concentrations exceeding the EQS.

High concentrations of hazardous substances have also been measured in seabird eggs. There has been a decrease in the observed levels of some classic POPs in hooded seals, while levels of these substances in other species, for example toothed whales, are still so high that biological effects are to be expected at population level. Significant levels of new types of hazardous substances have also been found in several studies of seabird eggs and marine mammals.

More knowledge and information is needed about hazardous substances and whether their combined effects can reduce species tolerance to other pressures such as climate change, changes in the availability of prey and disease.

On the whole, concentrations of undesirable substances in seafood are below the maximum permitted levels, and seafood from the Norwegian Sea is generally considered to be safe. However, Greenland halibut has proved to be an exception. Bioaccumulation in this species can result in concentrations of mercury, dioxins and dioxin-like PCBs that are too high. In baseline studies, Greenland halibut caught along the edge of the continental shelf south and west of the Lofoten Islands contained concentrations of certain organic pollutants exceeding the maximum permitted levels. The fisheries authorities therefore decided to close fishing grounds in the area. The source of these pollutants is not clear, but is most likely to be long-range transport. Results from the period 2013–2015 showed an improvement in the situation, and the fishing grounds along the edge of the continental shelf were re-opened in 2016. Mercury concentrations in Greenland halibut have also been found (2011–2012) that are well above the EQS but lower than the maximum permitted level in seafood.

Levels of dioxins and dioxin-like PCBs in the fatty liver of coastal cod are also high, and the average level in 2012–2014 exceeded the maximum permitted level in seafood. A large-scale survey of tusk and ling in 2013–2016 showed that the liver from fish caught in coastal and marine waters of the Norwegian Sea south of the Lofoten Islands contained concentrations of dioxins and dioxin-like PCBs exceeding the maximum permitted level. Fillets of tusk from the Vestfjorden were found to contain mercury at concentrations above or just below the maximum permitted level. Furthermore, high levels of cadmium have been found in edible crab north of Bodø, and restrictions on crab sales have therefore been intro-

Box 3.6 Environmental effects of produced water

A ten-year research programme on long-term effects of discharges to sea from petroleum-related activities (PROOFNY) has been carried out as part of the Oceans and Coastal Areas programme under the Research Council of Norway. Results from the programme were published in 2012 and in the final report from the Oceans and Coastal Areas programme in 2016. The PROOFNY programme focused particularly on certain PAHs and alkyl phenols, but actual samples of produced water were also investigated.

It has been found that components in produced water can have a range of negative impacts on health, biological functions and reproduction in individual fish and invertebrates. The 2012 report concluded 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. The report also concluded that it is still very uncertain whether effects on individuals and communities close to discharges have repercussions on larger areas, populations and communities.

According to the final report from the Oceans and Coastal Areas programme in 2016, research and monitoring results indicate that there is only harmful exposure to discharges of produced water and water-based drilling mud in an area stretching no more than 1–2 km from a discharge point. According to the report, this means that the probability of effects at population level is low. The results of environmental monitoring support this conclusion.

Research now being carried out includes studies of the long-term effects of exposure to low doses of oil on early life stages of haddock. These studies are to be completed in 2017.

duced in certain areas. During the past 10 years, a more integrated monitoring system has been built up for undesirable substances in fish. In addition to providing data relating to food safety, this is helping to build up time series for concentrations of hazardous substances in seafood.

Inputs of oil to the Norwegian Sea may originate from operational discharges or from acute pollution from shipping, petroleum activities and land-based activities. Operational discharges of oil are considered to have little environmental impact.

Produced water is extracted from oil wells together with the oil and contains oil residues, naturally-occurring hazardous substances and residues of substances added during the production process. In the 2009 management plan, operational discharges of produced water were not considered to have measurable impacts at population level on the species that were assessed. However, there was uncertainty about the long-term effects of produced water. The knowledge base has been improved through several studies of the effects of produced water that have been completed since 2009 (see Box 3.6).

3.3.3 Nutrients

Nutrients enter the management plan area mainly in the Gulf Stream (the Atlantic current) and the Norwegian coastal current. The latter carries nutrients from industrial areas in continental Europe, land areas around the Kattegat and Skagerrak, and from rivers, agriculture, waste water and fish farms along the Norwegian coast. Atmospheric inputs of nitrogen also account for a significant proportion of the total.

Since 1990, total inputs for nutrients to coastal areas bordering on the Norwegian Sea have risen. Inputs of phosphorus have tripled in this period and inputs of nitrogen have risen by 50 % (Figure 3.17). This is largely explained by a rise in discharges from agriculture. However, the inputs to coastal waters are not measurable in open sea areas of the Norwegian Sea, where inputs are dominated by nutrients transported by the Atlantic current. Monitoring results show that neither long-distance transport of nutrients nor discharges in coastal areas have had impacts on the management plan area.

3.3.4 Radioactive substances

The main sources of radioactive pollution of the Norwegian Sea are fallout from atmospheric tests of nuclear weapons, fallout from the Chernobyl accident in 1986, and discharges from reprocessing facilities for spent nuclear fuel (Sellafield and Cap de la Hague). Discharges of produced water also contain naturally occurring radioactive substances.

Atmospheric nuclear testing was halted in 1980, and this combined with better control and abatement of emissions from reprocessing plants

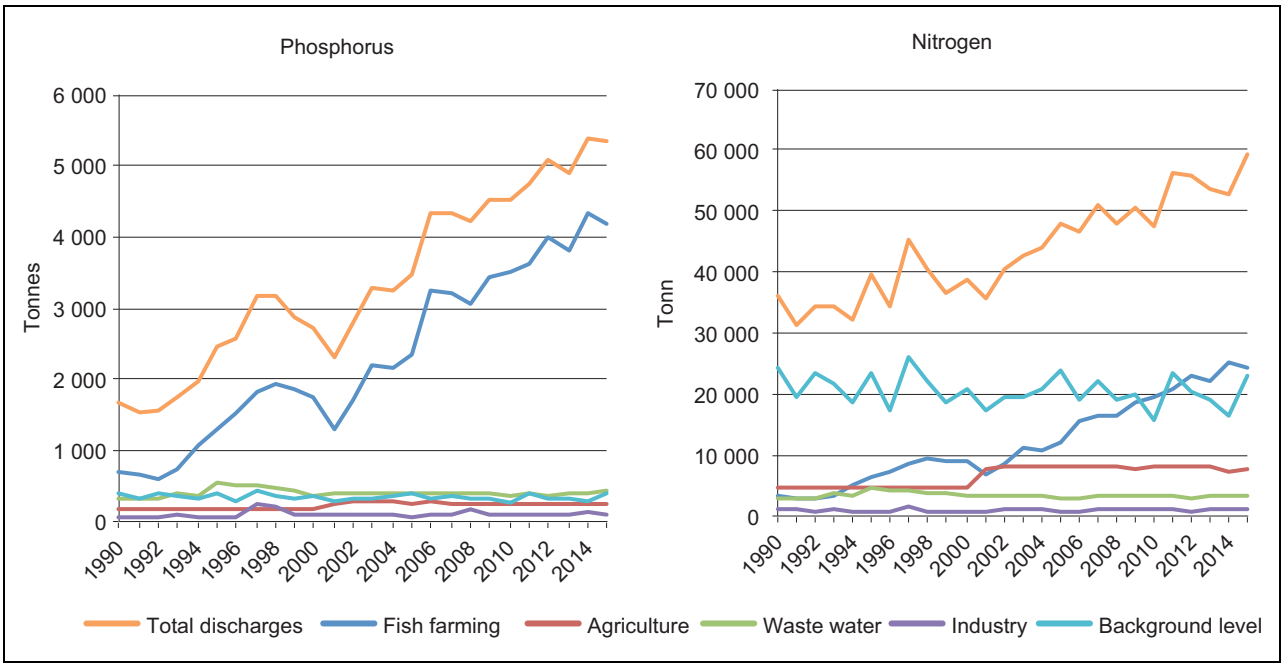

Figure 3.17 Inputs of nutrients to the coastal zone from land.

Source: Norwegian Environment Agency

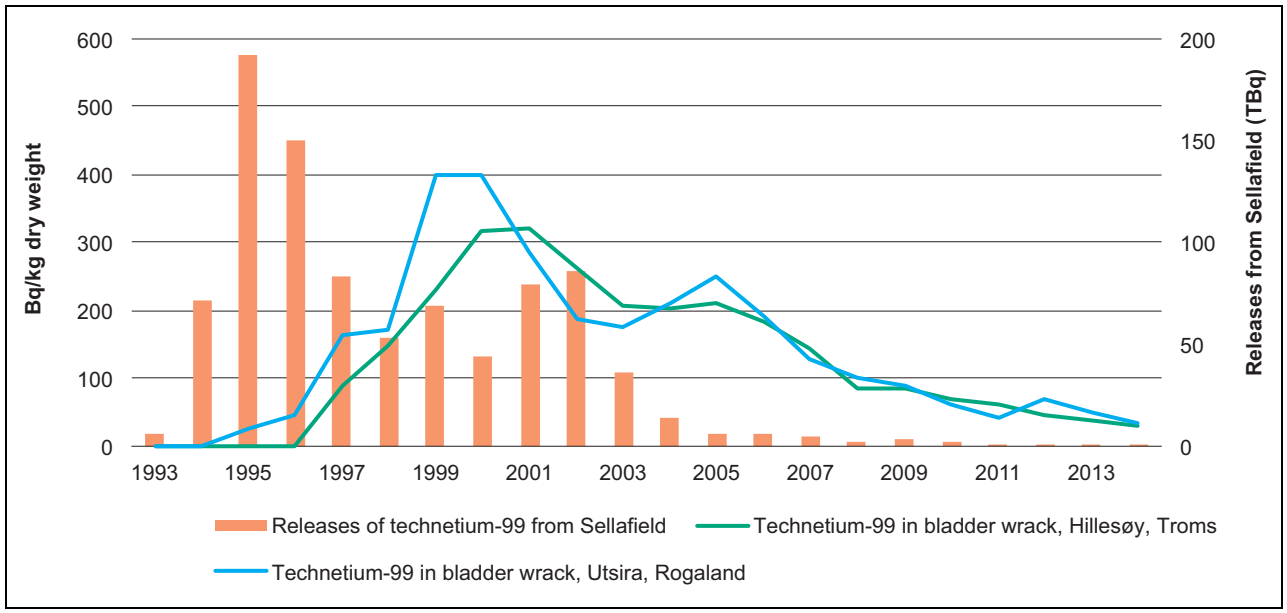

Figure 3.18 Concentrations of technetium-99 measured in bladder wrack along the Norwegian coast.

Source: OSPAR Commission, British Nuclear Group, Institute for Energy Technology, Norwegian Radiation Protection Authority

has eliminated or reduced the most important sources of radioactive pollution of the Norwegian Sea.

Abatement technology at the Sellafield processing plant has reduced emissions and resulted in lower levels of technetium-99 and strontium-90 in Norwegian waters. Releases of technetium-99 from Sellafield have been greatly reduced since new technology to remove technetium from the waste stream was taken into use in 2004 (Figure 3.18).

Radioactive substances from the Chernobyl accident are spread with precipitation and the outflow of water from the Baltic Sea to the Norwegian coastal current and through the Norwegian Sea to the Barents Sea. Radioactive pollution from the Chernobyl accident is still present in the Norwegian Sea.

The risk of damage associated with radioactivity depends on the radiation dose and the type of radiation Levels of radioactive pollution in seawater, sediments and biota are low and generally declining. This trend is explained by radioactive decay, sedimentation and dilution, in addition to the reduction in releases of radioactivity. Levels of radioactivity in seawater are not considered to be harmful for marine life or for humans through consumption of seafood.

3.3.5 Underwater noise

Growing attention is being paid to the possible impacts of underwater noise on marine species. The main sources of underwater noise in the Norwegian Sea are propeller noise from shipping, seismic surveys and the use of military sonar (see Chapter 5.2.3 and 5.3.3). The construction of offshore wind farms could also increase noise levels.

In the 2009 management plan, it was concluded that seismic surveys only have minor impacts on fish and insignificant impacts on marine mammals in the form of behavioural changes. Since then, more knowledge has been acquired on the effects of underwater noise from various sources on fish and marine mammals, but we still know too little to draw clear conclusions on the impacts of underwater noise. For the Norwegian Sea management area, seismic surveys are still considered to have only minor impacts on fish.

New knowledge has altered our understanding of noise and the impacts on whales of noise in the form of sound pulses from seismic surveys and sonar. Several whale species have proved to be very sensitive to military sonar. Research carried out in other countries has given inconsistent results as regards the behaviour of different species of whales. There are few studies of the impacts of seismic sound sources on marine mammals in Norwegian waters.

The scientific basis for this update of the management plan concludes that it is unlikely that noise from shipping has direct negative impacts on fish and marine mammals, but that temporary scare effects are to be expected. Given new knowledge obtained in the last few years, the Interna-

tional Maritime Organization (IMO) now considers underwater noise from shipping to be a greater problem than was previously the case. This applies particularly to marine mammals and to a lesser extent to other marine animals.

The impacts of underwater noise on fish in the management plan area are still considered to be minor, but more knowledge is needed about the impacts of underwater noise.

3.3.6 Environmental impacts of acute pollution

There are acute pollution incidents involving shipping and the petroleum industry every year. Most spills in the Norwegian Sea since 2009 have been small and the total quantity of oil in spills has been small compared with operational discharges

The environmental impacts of oil or chemical spills depend on a variety of factors, including their timing and location, the species and habitats affected and the vulnerability of the area, the type of spill and its volume, weather conditions and the emergency response measures initiated. The effects, especially on seabirds and fish, can be very serious if there is a large spill in unfavourable circumstances. This applies above all to the particularly valuable and vulnerable areas (see 3.4 below). However, the probability of a large spill is low. For a further assessment of the environmental impacts and environmental risk associated with acute pollution, see Chapter 5.2.3 and 5.3.3.

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 biological production in the entire management plan area. They are selected using predefined criteria, the main ones being that the area concerned is important for biodiversity or for biological production. 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.

In 2012–2013, the MAREANO programme mapped the particularly valuable and vulnerable areas in the Norwegian Sea, largely within the areas that were already delimited. This work was not done with the aim of assessing the delimitation of the areas. In the Sula reef area, new coral structures were identified within the established boundaries of the area. Geological mapping suggests that the coral reef extends beyond the area as it is currently delimited, but this has not yet been verified.

In the 2009 management plan, the areas described below were identified as particularly valuable and vulnerable (see Figure 3.19).

The Remman archipelago

The Remman archipelago lies on a shallow plateau projecting out into the Norwegian Sea beyond the island of Smøla in northwestern Møre og Romsdal. This is a characteristic shallow-water area and a core area for kelp forest dominated by *Laminaria hyperborea*. The archipelago is also important for seabirds both during and outside the breeding season. The area has been protected as a nature reserve, and is one of the areas that have been proposed for inclusion in the marine protection plan.

The Froan archipelago and Sula reef

This area covers an important transect from coastal waters to the open sea. Several fish stocks, including Norwegian spring-spawning herring, spawn within the area, thus also providing good food supplies for other species. The Froan archipelago is an important breeding area for grey and common seals and a key feeding area for many species of seabirds both in the breeding season and at other times of year, particularly coastal species such as cormorant, shag, marine diving ducks, lesser black-backed gull and black guillemot.

The Sula reef has been designated as particularly valuable and vulnerable because of the major coral reef complex formed by *Lophelia pertusa*. Biodiversity is generally high on and around coral reefs. Some important species such as golden redfish, ling, tusk and saithe are associated with the reef complex. The use of bottom fishing gear in the area was banned in 2000, and it is now a marine protected area.

The Sula reef complex has been mapped before, but several new finds have nevertheless been made. Two new coral reefs were documented within the marine protected area in autumn 2012, and more than 15 coral reefs have been registered outside the protected area in the northeastern part of the reef complex. Three additional coral reefs were also found in an adjacent

sea area in spring 2012. The Sula reefs are considered to be in very good condition.

The Møre, Halten and Sklinna banks

All three of these bank areas are core areas for spawning and early life stages of herring and saithe. Herring are benthic spawners and require a specific substrate. They use the same spawning grounds year after year, but the proportion of the stock that spawns in different areas may vary over time. The Møre banks are also an important spawning and nursery area for Northeast Arctic cod and haddock. The Halten and Sklinna banks are in addition highly productive retention areas for drifting fish eggs and larvae. The Møre banks are important feeding grounds for many seabird species, including gannets, common guillemot, puffin and razorbill. The Halten and Sklinna banks are important feeding areas for many seabirds outside the breeding season.

There are also marine mammals, particularly common and grey seals, and also porpoises. There are several coral reef complexes, the riches of which, Breisunddjupet in the Møre banks area, is protected against the use of bottom fishing gear. The MAREANO programme registered three new coral reefs in the Møre banks area in 2012–2013, all of them close to previously registered reefs. Soft corals were also observed at four different localities.

The Iverryggen reef

This area is considered to be particularly valuable because it contains the important Iverryggen reef complex. Other important species associated with the reefs include golden redfish, ling, tusk and saithe. The area was protected against the use of bottom fishing gear in 2003.

Since the 2009 management plan was published, the MAREANO project has verified a further four new coral reefs in this area. The coral reefs in this area are considered to be in good condition. Sponge and sea pen communities have also been observed in the shallower parts of the Iverryggen reef complex.

The Vestfjorden

The Vestfjorden is a very important area for Norway's two most important fish stocks, Northeast Arctic cod and Norwegian spring-spawning herring. It is also an important wintering area for the planktonic copepod *Calanus finmarchicus* and is a valuable area for many seabird species throughout the year. Moreover, the Vestfjorden is important for marine mammals such as the grey seal, killer whale, minke whale and porpoise.

The Vestfjorden is part of an area lying above the continental shelf in North Norway that is particularly important for spawning fish, eggs, larvae and juvenile fish. It plays an especially important role for early stages of fish stocks that live in the Norwegian Sea and Barents Sea. The Træna reef at the entrance to the Vestfjorden was protected against the use of bottom fishing gear in 2010.

Jan Mayen and the West Ice

The Jan Mayen area is important for breeding seabirds: there are 15 breeding species and 22 different seabird colonies. In all, 300 000 pairs of seabirds breed in the area. The West Ice, north and west of Jan Mayen, is a core breeding area for hooded and harp seals.

Eggakanten

The edge of the continental shelf is the transitional area between the relatively shallow continental shelf and bank areas along the mainland and the deep-water areas of the Norwegian Sea, and runs all the way from Stad in Sogn og Fjordane to northwestern Svalbard. Biological production and biodiversity are high in the area, there are large concentrations of many fish and seabird species, and there are large coral reef complexes and other coral structures. Early life stages of herring and cod drift northwards along the edge of the continental shelf. There are also important spawning grounds for deep-water species such as golden redfish, beaked redfish, Greenland halibut and greater argentine. Moreover, the area is an important feeding ground for whales, and very important for many seabirds, particularly kittiwakes and auks.

In 2012–2013, ten new *Lophelia pertusa* reefs were registered along the edge of the continental shelf during mapping by the MAREANO programme. Two were in the Storegga area (Møre og Romsdal) where coral reefs had already been registered. In the northern part of the area, up to the southern part of the Skjoldryggen moraine system (southern Nordland), eight new *Lophelia pertusa* reefs were discovered that are not in the proximity of other previously registered reefs. Soft corals, which can form coral gardens, have been registered at 22 localities along the edge of the continental shelf. Seven of these are *Lophelia*

pertusa reef areas where soft corals are also common. In 2015, a new reef complex was discovered further north, off Sandnessjøen. This is a narrow reef complex consisting of 24 reefs and extending for about 1 kilometre along iceberg plough marks.

The Arctic front

The Arctic front is the zone where Atlantic and Arctic water meet. In biological terms, it is a narrow zone stretching all the way through the Norwegian Sea where biological production is high and there is a rich diversity of animal species. The Arctic front is dynamic, and varies in position and geographical extent. The high biological production makes this an important feeding area for several whale species, including blue whale, fin whale, minke whale and northern bottlenose whale.

The coastal zone

The coastal zone is the area stretching outwards from the baseline to 12 nautical miles from the baseline, in other words the part of the management plan area closest to the coast. The section of

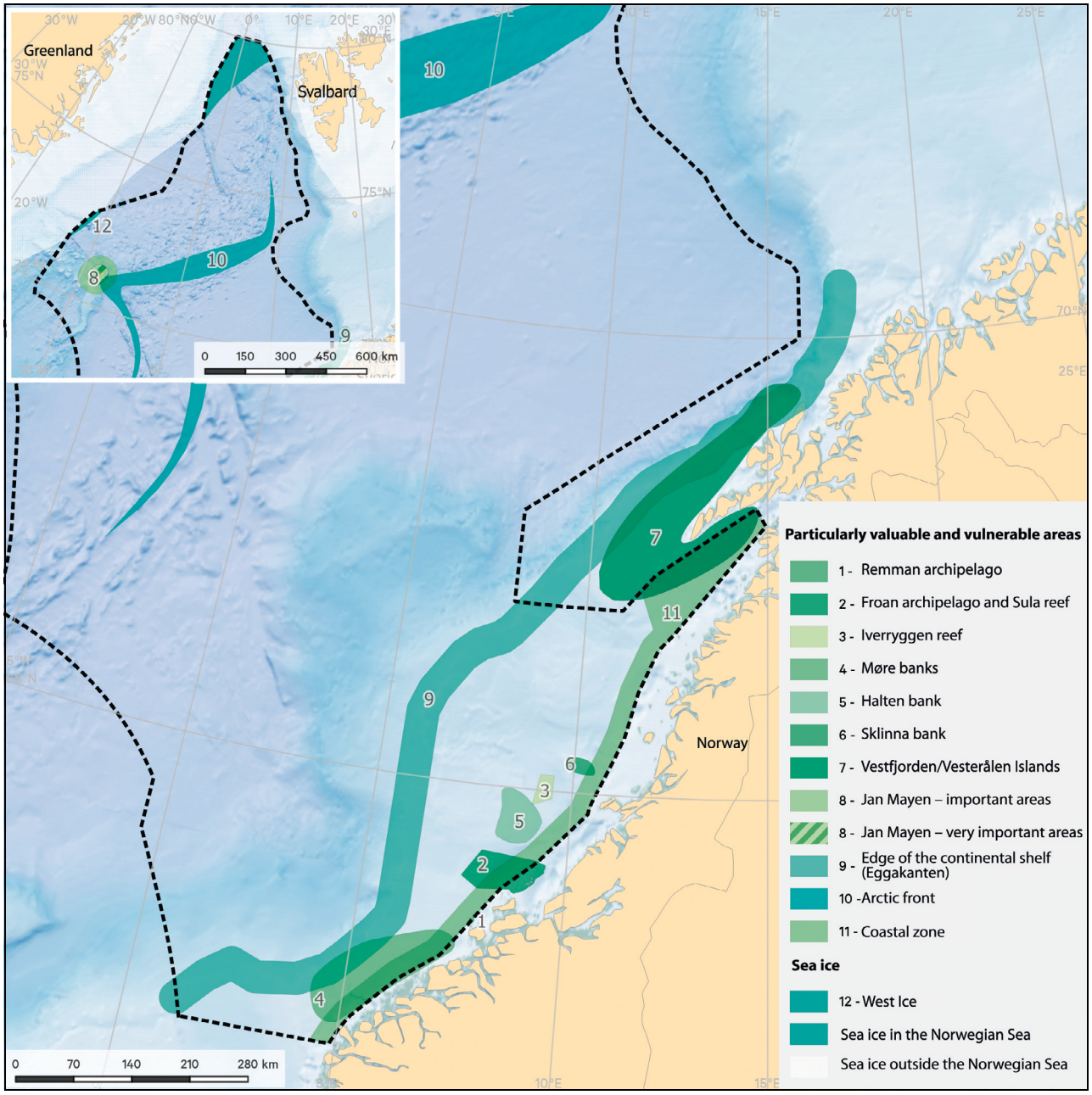

Figure 3.19 Particularly valuable and vulnerable areas in the Norwegian Sea.

Source: Norwegian Environment Agency/Institute of Marine Research

the coastal zone from Stad to Runde, the coast of Sør- and Nord-Trøndelag (including the Froan, Vikna and Sklinna archipelagos) and the southern part of Nordland (including islands and skerries in Sømna and Vega municipalities), the Remman archipelago and the Vestfjorden are considered to be particularly valuable and vulnerable. The area on the landward side of the coastal zone is also very important, and the environmental value of these areas must be considered as a whole. There is a wide variety of biotopes, ecosystems and species in the coastal zone. Many species use the whole area near the coast as a habitat and feeding area, and there are many areas of special importance for local fish stocks and seabirds along the coast of the Norwegian Sea.

3.5 Important knowledge needs

The 2009 management plan identified a number of areas where there were gaps in our knowledge about the Norwegian Sea. These included species, habitats, ecosystem structure and functioning and pressures and impacts on ecosystems from various human activities. A great deal of new knowledge has been acquired since then, for example on ocean acidification, trends in seabird populations and benthic communities in the particularly valuable and vulnerable areas. Nevertheless, there are various areas where further research, mapping and monitoring is needed to improve the knowledge base for integrated, ecosystem-based management. The most important of these are outlined below.

Climate change and ocean acidification

More knowledge is still needed about the impacts of climate change and ocean acidification on the dynamics of ecosystems and their capacity to provide important ecosystem services, and how climate change and ocean acidification interact with other pressures.

Modelling of the impacts of climate change on marine mammals is also needed, particularly as regards the northern Norwegian Sea, to examine how changes in ice cover, temperature, food supplies and pathogenic organisms affect different species.

The seabed

There is a need for mapping of the distribution of habitat types outside the particularly valuable and vulnerable areas to supplement knowledge about habitat types within these areas.

Research cruises in certain areas have documented distinctive species, habitats and ecosystems in deep-water areas, particularly near the Mid-Atlantic Ridge, but so far our knowledge of these areas is incomplete. Habitat types, species diversity and mineral deposits should all be mapped in these areas. Mapping and research in deep-water areas will strengthen the basis for management of the submarine environment and for the possible exploitation of resources for bioprospecting or mineral extraction.

Fish stocks

The major pelagic fish stocks play a dominant role in the Norwegian Sea ecosystem. It is important to learn more about interactions between herring, mackerel and blue whiting and how they are affected by changes in the quantity of zooplankton in the ecosystem.

A better understanding of natural interactions in the ecosystem is also needed. The important issues will vary between fish stocks, but more knowledge is for example needed about the ecosystem effects of the fisheries and the types of effects they have on healthy and weak stocks.

More knowledge is also needed about mesopelagic fish species and their role in the ecosystem. Moreover, we need to know more about how harvesting species at lower trophic levels, for example copepods such as *Calanus finnmarchicus*, may affect the ecosystem.

Seabirds

Major changes are taking place in seabird populations along the coast. Studies are needed to identify the causes and find links between ecosystem processes and population changes. Some studies suggest that there are close links between the ocean climate, larval drift and declining seabird populations. Further studies of such interactions are needed.

In many cases, we know very little about the diet of different seabirds during the year, both along the coast and in the open sea. Since many species are specialists and thus very sensitive to changes in supplies of their prey, knowledge of their diet is of crucial importance for identifying and quantifying both natural and anthropogenic environmental pressures.

Marine mammals

Regular updates of data, for example on changes in sea ice extent and prey species, are needed to understand the responses of marine mammals to environmental change. In addition, better data on migration patterns and habitat use are needed for both seals and whales in the Norwegian Sea to make it possible to assess the effects of human activity in relevant areas. Better data are also needed on population sizes and the geographical distribution of whales other than minke whale, particularly the common porpoise.

Hazardous substances

Knowledge about the sources, inputs and spread of hazardous substances is limited, and in particular we know little about inputs of hazardous substances from different sources to the water column and entering food chains.

More knowledge about inputs, levels and possible effects of hazardous substances at individual, population and community level is needed to make overall assessments of the pollution situation in the Norwegian Sea. In addition, more knowledge is needed about new substances that are not being monitored at present and about the synergistic effects of hazardous substances, especially in seabirds, marine mammals and polar bears.

Underwater noise

Both fish and marine mammals are affected by underwater noise, but our knowledge of the cumulative effects of noise pollution from activities in the Norwegian Sea is limited. Knowledge about the effects of anthropogenic underwater noise, particularly on fish, has been greatly expanded in recent years. However, we still need to know more about how underwater noise from human activity in the management plan area affects marine mammals.

Environmental monitoring

There is a need to further develop several of the indicators used for environmental monitoring or to improve reporting by making the information more accessible or improving the monitoring system. For example there are gaps as regards monitoring of benthic communities, alien species, threatened species and pollution. Monitoring of pressures and impacts associated with human activity needs to be further developed, as does our understanding of which changes are a result of human activity and which are related to natural processes in the oceans. Better and more cost-effective methods also need to be developed for us in mapping and monitoring Norway's sea areas.

4 Marine litter and microplastics

Marine litter is a global problem that transcends national borders and spreads between sea areas. Plastic litter of every size and shape, from large objects to microplastics and nanoplastics, has been carried to every part of the world's marine and coastal waters. Plastics in the sea have negative impacts on marine animals, biodiversity, ecosystems, fisheries, maritime transport, outdoor recreation, tourism and local communities. Plastic pollution is a potential threat to both food security and food safety. A UN report published in 2014 estimated that plastic waste in the oceans causes damage equivalent to more than USD 13 billion a year. A report prepared for the World Economic Forum has estimated that there will be more plastic than fish (by weight) in the oceans by 2050 unless significant action is taken. This estimate is tentative, but there is broad global agreement about the severity of the problem. Under the first target of UN Sustainable Development Goal 14 on the oceans, UN member states have agreed to prevent and significantly reduce marine debris by 2025.

This chapter discusses the distribution, quantities, fate and effects of plastics in the marine environment, and its sources and measures and instruments to deal with the problem at national, regional and global level. Land-based sources and waste management policy in general will be treated more fully in a white paper on waste management policy and the circular economy to be published later in the spring parliamentary session 2017. The measures proposed by the Government as part of international cooperation to combat marine litter are further discussed in the white paper on the place of the oceans in Norway's foreign and development policy.

4.1 Distribution and quantities of marine litter and microplastics in the oceans

Marine litter includes all items of waste that end up on the shoreline or in the sea. Globally, plastics make up about 80 % of all marine litter. In 2010, annual inputs of plastics to the oceans were estimated at between 4.8 and 12.7 million tonnes. Global inputs of plastics to the oceans are rising rapidly.

Estimates of the distribution of plastic waste in the marine environment vary widely. Figures that are often quoted are that 70 % ends up on the seabed, 15 % on the shoreline and 15 % at the surface and in the water column. Other estimates suggest that an even higher proportion ends up on the seabed. Concentrations of plastic litter are often far higher on the shoreline than in the sea. Litter will end up in different areas depending on where it is released, ocean current patterns and whether it floats or sinks. The density and buoyancy of litter may change as it degrades and is colonised by marine organisms, so that litter such as plastic bottles may sink to the bottom.

Plastics are very useful because they are so durable, but this also means that they cause serious and long-lasting environmental problems when they end up in the environment. For example, it takes 450 years for a plastic bottle and 600 years for a fishing line to break down in the sea. During degradation, plastics break down into smaller and smaller fragments and eventually to microplastics (particles 1 mm to 5 mm in diameter) and then nanoplastics (less than 1 mm in diameter). The term microplastics is often used to cover all particles less than 5 mm in diameter, i.e. both microplastics and nanoplastics. No figures are available for the quantities of nanoplastics in the oceans or how much is ultimately completely degraded to inorganic compounds. Degradation proceeds most rapidly in areas such as the shoreline, where plastics are scoured against rocks and sand and are exposed to sunlight and bacteria. On the seabed and in sediments, degradation is extremely slow because temperatures are low and there is a lack of ultraviolet radiation and oxygen. It is uncertain whether plastics in the deepest parts of the oceans break down at all. Extreme weather events, flooding and natural disasters result in an increase in inputs of marine litter.

Plastic litter and microplastics are transported over long distances by ocean currents and can be

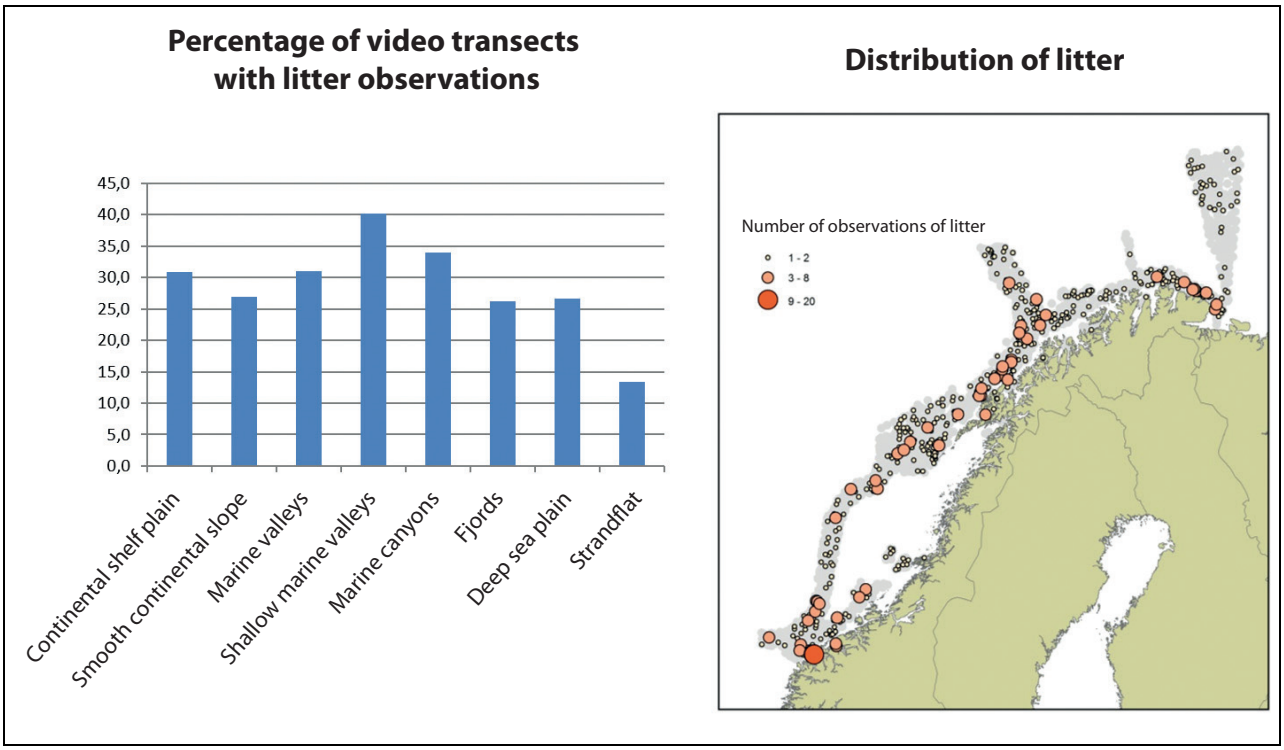

Figure 4.1 Left: Percentage of video transects with litter observations in different marine landscapes. Right: geographical distribution of litter recorded by the MAREANO programme.

Source: Institute of Marine Research

found far from their sources. Marine litter has spread even to the most undisturbed areas where there is very little human activity, for example parts of the Arctic and remote, uninhabited tropical islands. Plastic bags and other waste have been found at a depth of 2500 metres in the Fram Strait in the Arctic, in concentrations similar to those in deep waters off the city of Lisbon. The Earth's rotation, wind patterns and ocean currents result in the formation of ocean gyres, which are large rotating current systems. Plastics, microplastics and other waste accumulate in these areas. The largest gyre is in the Pacific Ocean and covers an area of more than 1.4 million km^2. Relatively dense patches of waste can be found floating on the surface within the gyres, but most of the plastics are in the form of small particles floating on the surface and in the water column. The number of particles is estimated at more than 200 000 per km^2, corresponding to less than one microplastic particle per m^2. Plastics in the surface water are estimated to make up less than 1 % of the total quantity of plastics in the oceans. An investigation of microplastics in the ice in the Arctic showed a higher concentration than in the most polluted gyres, probably because microplastics become more concentrated in the ice when the water freezes.

Norway has been monitoring and reporting beach litter under the OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic since 2011. There are currently five monitoring sites on the coast of mainland Norway and two in Svalbard. Most of the waste that has been registered consists of fishing lines, nets and pieces of net, and rope. Both older records (from before the OSPAR method was developed) from the island of Været west of Trondheim, and records from all the OSPAR beaches since 2011, show that more than 70 % of the objects found are of plastic. There are generally high levels of waste on the beaches, but no indication of any significant change in quantities in the last few years.

Litter has been observed in 25 % of the video transects of the seabed recorded by the MAREANO programme in the Norwegian Sea and the Barents Sea–Lofoten area. These observations indicate that the average quantity of litter is around 200 kg per km^2. However, almost 10 tonnes per km^2 has been found locally near the coast. Particularly large quantities of litter have been observed in coastal waters just west of Ålesund. Most of the litter in this area can be traced back to the fishing industry, and includes heavy objects such as lost fishing gear, wires and

cables, and an 'unspecified' category that probably also includes fisheries-related objects. Litter accumulates in marine valleys and narrow canyons. Most litter is found at depths of 200–300 metres, but increasing quantities are also being recorded at depths of 1100–1400 metres. Figure 4.1 shows the distribution of litter in different marine landscapes.

4.2 Impacts of marine litter and microplastics

In 2001, a UN report estimated that about 1 million seabirds, 100 000 marine mammals and unknown numbers of fish and other animals were being injured or killed by marine debris every year. The figures for 2017 are likely to be much higher. Animals can mistake fragments of plastic for food, or become entangled in fishing nets and rope. As a result, they can suffer external or internal injuries and infections, or be strangled or starve to death. According to a report published by the UN in 2016, more than 800 marine species are known to be negatively affected by marine plastic litter. Seabirds, fish, marine mammals and sea turtles are species groups that are particularly badly affected. Living organisms can be dispersed by rafting from one continent to another on plastic litter, thus resulting in the spread of invasive alien species and pathogenic bacteria and viruses. Marine litter reduces people's enjoyment of the seashore and has a negative impact on outdoor recreation and tourism. In some areas, damage to fishing gear and litter that becomes entangled in fishing nets is also a problem. Collisions with larger items of litter may cause damage to vessels, engine shutdown or a loss of steering. This may also be caused by ropes and fishing gear becoming entangled in propellers, and smaller fragments of plastic entering engine cooling systems.

Every year, large quantities of gill nets and other fishing gear are lost during commercial fishing operations. Lost fishing gear, pots and traps left on the seabed continue to catch fish and other marine animals (this is known as 'ghost fishing'), resulting in unregistered fish mortality and a significant harvest. This is a waste of resources and can be a threat to vulnerable and endangered species. Lost fishing gear and other litter can become entangled in corals or damage seabed habitats in other ways. The loss of fishing gear also represents an economic loss. Where the water depth is less than 50–100 metres, the fishing efficiency of lost gill nets generally declines quite rapidly

Figure 4.2 Lost fishing gear being hauled on board during a retrieval operation.

Photo: Directorate of Fisheries

because of fouling by marine organisms and water movement. In deeper water, gill nets may continue to fish for much longer. Ghost fishing has been shown to continue for seven years off the coast of Senja island in North Norway. Lost fishing gear may also end up as microplastics when it is finally broken down. Parts of fishing gear and other plastic materials that are beached at an early stage of degradation break down into smaller and smaller fragments and eventually into microplastics.

Plastics and microplastics have been found in a wide variety of marine organisms at different trophic levels in marine food chains. Plastic litter has been recorded in the stomachs of marine mammals, seabirds and many species of fish (see Figure 4.3). Researchers have found microplastics

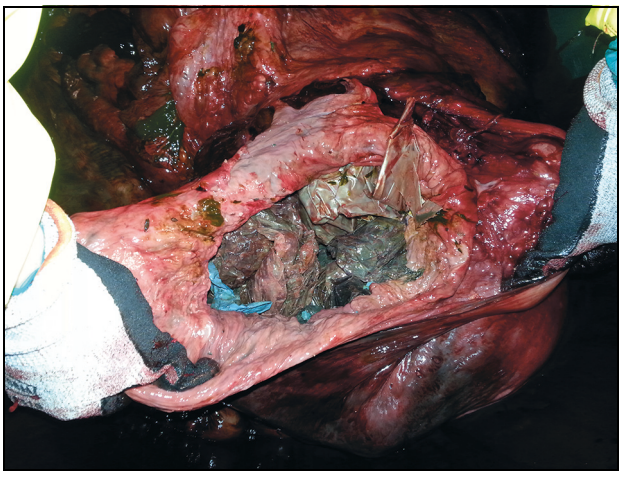

Figure 4.3 In February 2017, a Cuvier's beaked whale that became beached on the island of Sotra in Hordaland was found to have 30 plastic bags in its stomach.

Photo: University of Bergen

in organisms including lobsters, squids and octopuses, crabs and molluscs, and zooplankton, which in turn are food for many other organisms. People may ingest microplastics when they consume seafood species that are eaten whole. Studies have shown that levels of microplastics in cultivated mussels and oysters in the North Sea can be considerably reduced by keeping the animals in clean water for three days.

Microplastics can injure and in the worst case kill marine organisms. In molluscs, it has been shown that nanoplastics can be absorbed into the blood system and tissue/cells, and can cause an inflammatory response. One study has shown that microplastics from mussels fed to crabs were transferred to the crabs, and the microparticles were subsequently found in crab haemolymph (circulatory fluid), gills and ovaries. Some plastics also contain hazardous substances. Because they have a large surface area relative to their volume, microplastic particles can also absorb significant amounts of organic pollutants from seawater. Thus, in addition to being harmful in themselves, microplastics may add to the harm caused by hazardous substances and play a part in bioaccumulation of hazardous substances in food chains.

So far, little is known about the impacts of plastics and microplastics on whole ecosystems and food chains. There is no evidence indicating that plastics and microplastics in seafood constitute a health risk, but the level of uncertainty is high. The European Food Safety Authority (EFSA) considers the smallest plastic particles, nanoplastics, to be of great concern as regards food safety because they can cross cell membranes.

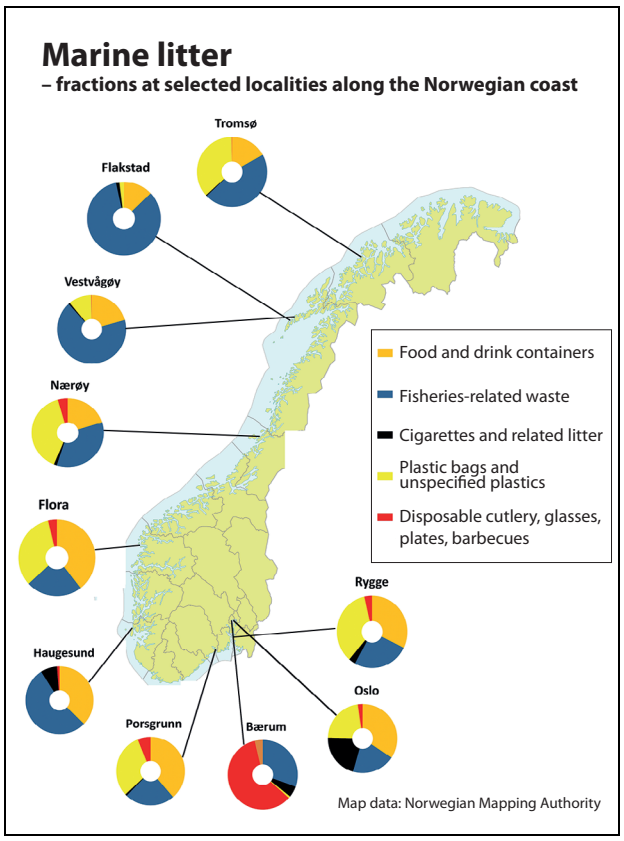

Figure 4.4 Proportions of different fractions of marine litter collected at selected localities in 2011. The very high proportion of disposable cutlery and similar items recorded at the locality in Bærum is explained by an event that had been held there shortly before.

Source: Bo Eide, Tromsø municipality

4.3 Sources of marine litter

It is commonly assumed that 80 % of plastic litter in the world's oceans comes from land-based sources, and 20 % from sea-based sources such as the fisheries and shipping. However, this is a very rough average for the world as a whole and is largely based on registration of plastic litter on beaches. Little data is available for surface water and the seabed. The proportions of litter derived from land-based and sea-based sources also vary widely between sea areas and regions. Further information on sources of microplastics will be presented in the forthcoming white paper on waste management policy and the circular economy.

Data from beach clean-up organised in Norway shows that most litter on beaches in the southern part of the country is from land-based sources such as households, industry, construction and agriculture, while the proportion of litter from the fisheries and other ocean-based sources tends to be higher further north (see Figure 4.4). Discarded leisure craft are also a source of marine litter. Sea-based sources include the fisheries, shipping, petroleum-related activities, ports and aquaculture. Marine litter on beaches in Svalbard consists largely of plastic litter from fishing fleets in various countries.

The organisation *Hold Norge Rent* (Keep Norway Beautiful) organises a national beach clean-up campaign every year. In 2016, 77 % of the items found were made of plastics. Figure 4.5 shows the ten largest fractions of plastic litter by number of items.

The mapping and monitoring programme for the Norwegian seabed, MAREANO, also collects data on marine litter. It has been confirmed that more than half the litter observed on the seabed

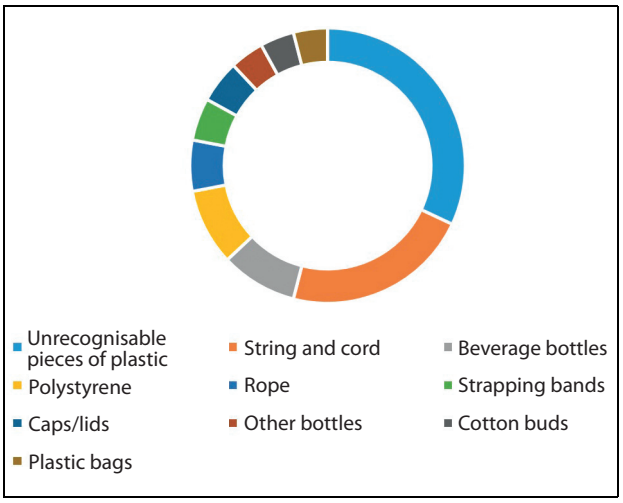

Figure 4.5 The ten largest fractions of plastic litter found during national beach clean-up campaign in Norway in 2016 (shares by number of items).

Source: Hold Norge Rent

during surveys is from fisheries activities (see Figure 4.6).

Modern fishing nets are made of various types of synthetic fibres, which degrade very slowly. It is estimated that in the european fisheries more than 33 000 nets a year are lost because of poor weather conditions, ocean currents and equipment failure. Norway has a good system for reporting of losses of fishing gear by the commercial fisheries, which is combined with a retrieval programme. However, there is some underreporting, and losses of nets, traps and pots and other equipment during recreational fishing have not so far been registered. The fisheries authorities estimate that annual losses of fishing gear are at least equivalent to the amount removed by the retrieval programme.

Abandoned mussel cultivation facilities along the Norwegian coast are another source of marine litter. In particular, they can be a navigation hazard, since rope from the facilities may become entangled in ship propellers. Ropes and other litter from the facilities can be difficult to see or detect on radar.

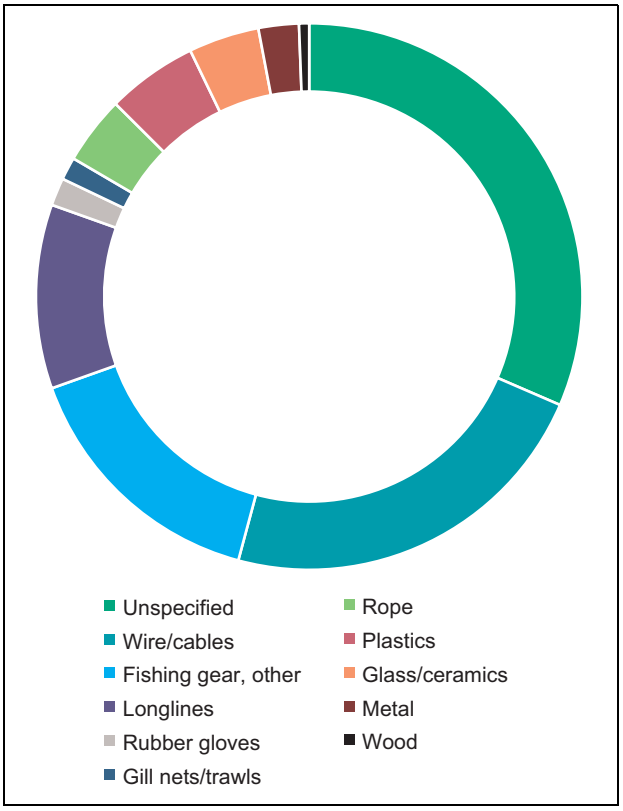

Figure 4.6 Types of litter observed on the seabed during MAREANO surveys in the Norwegian Sea and the Barents Sea–Lofoten area.

Source: Institute of Marine Research

4.4 Mapping and monitoring

To gain an understanding of the scale of the marine litter problem and monitor trends in the quantities and types of marine litter, and thus be able to take appropriate action, it is essential to use a consistent methodology for quantifying the amount of litter and to develop time series of relevant data. Through OSPAR, Norway is taking part in international cooperation to monitor marine litter in accordance with agreed objectives and indicators. Beach litter is monitored in line with the OSPAR indicator at seven selected Norwegian beaches. The monitoring system for the marine management plans includes beach litter as an indicator for the Barents Sea–Lofoten area and plastic litter in fulmar stomachs as an indicator for the North Sea–Skagerrak area.

Since 2010, the annual ecosystem surveys in the Barents Sea carried out by the Institute of Marine Research and the Russian marine research institute PINRO (Knipovich Polar Research Institute of Marine Fisheries and Oceanography) have registered an increase in the amount of plastic litter caught as a bycatch in pelagic and benthic trawls.

In order to establish scientifically sound mapping and monitoring systems for microplastics in the marine environment, internationally agreed definitions, standardised quantitative methods and regionally suitable indicators are needed. Under JPI Oceans, a number of European countries are taking coordinated action to develop a

Box 4.1 Plastic litter in fulmar stomachs

OSPAR's long-term goal is that less than 10 % of fulmars analysed should have more than 0.1 g of plastic in their stomachs, and this was included in the set of indicators for the North Sea–Skagerrak management plan in 2013. Fulmars in the North Sea area were investigated in 2015, and it was found that 95 % of them had plastic litter in their stomachs, and 67 % of beached birds had more than 0.1 g of plastic in their stomachs. Moreover, 34 % of fulmars taken as a bycatch in the fisheries also had more than 0.1 g of plastic in their stomachs. The quantity of plastic litter in fulmar stomachs shows a clearly declining trend northwards in the North-east Atlantic.

common standard for analysing and mapping levels of microplastics and to investigate the impacts of microplastics on the marine environment and seafood. A similar system is needed for nanoplastics, but will be even more challenging to establish.

Indicators also need to be established for mapping and monitoring microplastics, for use both in the monitoring system under Norway's marine management plans and in international cooperation on environmental monitoring, including the OSPAR system.

4.5 Goals and instruments

The first target under Sustainable Development Goal 14 is to prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution, by 2025. Under OSPAR's *Marine Litter Regional Action Plan*, Norway has adopted the goal of reducing inputs of litter that have negative impacts on coastal waters, the sea surface, the water column or the seabed.

Norway's goals for marine litter in the three marine management plans are not identical, but their meaning is essentially the same. For the Barents Sea–Lofoten area, the goal is that 'litter and other environmental damage caused by waste will be avoided'. For the North Sea–Skagerrak area, the goal is that 'inputs of litter that have negative impacts on coastal waters, the sea surface, the water column or the seabed will be reduced.' For the Norwegian Sea, the goal is that 'litter and other environmental damage caused by releases and waste from activities in the Norwegian Sea will be avoided.' These goals are not considered to have been achieved. The goals for marine litter in the different management plans need to be updated and coordinated. Marine litter also needs to be monitored more closely so that it is possible to improve assessments of status, trends and progress towards goals.

Box 4.2 The environmental authorities and marine litter

The Ministry of Climate and Environment has the overall responsibility for the marine environment and for providing the framework to ensure appropriate handling of waste and minimise damage to people and the environment. The Norwegian Environment Agency provides the Ministry with technical advice, conducts analyses and proposes measures for achieving Norway's environmental targets, is responsible for inspection and enforcement, and takes part in Nordic, regional and international cooperation on marine litter. The Norwegian Polar Institute is an advisory body for the Norwegian authorities on polar matters, and is building up knowledge about marine litter and microplastics in the Arctic through mapping, research and monitoring activities and Arctic cooperation, and disseminating this knowledge internationally. The Environment Agency and the Polar Institute also implement measures to deal with marine litter and manage grant schemes.

The Pollution Control Act states that littering is prohibited, and this applies both on land and at sea. Sound waste management is of crucial importance in preventing and reducing marine litter. Under the Pollution Control Act, municipalities are responsible for collecting and treating household waste, while business and industry are responsible for proper handling and treatment of their waste. Most municipalities now organise separate collection of various waste fractions, including plastic packaging. Extended producer responsibility applies to several waste types, including packaging. This approach means that producers are responsible for the products they sell throughout their life cycle, even after they have been discarded as waste. Any waste treat-

ment facility that may cause pollution is required to hold a permit from the environmental authorities. The municipalities are also responsible for waste water treatment and treatment of sewage sludge.

To prevent littering, municipalities are required to provide waste receptacles at excursion spots and other heavily used areas where people are likely to discard waste, and arrange for them to be emptied. The same applies to anyone who runs a sales outlet where waste is likely to be discarded.

Before summer 2017, the Government will publish a white paper on waste policy and the circular economy. This will include a further account of how it intends to follow up the recommendations from the Norwegian Environment Agency for dealing with marine litter and microplastics, which were presented to the Ministry of Climate and Environment in 2016.

The Storting has requested the Government to put forward a proposal with a view to prohibiting the use of microplastics in cosmetic and body care products. The Norwegian Environment Agency has carried out an assessment of possible measures to deal with the most important land-based sources of the spread of microplastics in Norway. These include measures to reduce the spread of microplastics from the following sources: car tyres and road dust, rubber granules from artificial turf, maintenance of boats and ships, textiles and plastic pellets. The Environment Agency has been asked to assess several of these measures further.

Cosmetic and body care products are a relatively minor source of the spread of microplastics, and there are few producers of cosmetics in Norway, with only a small share of the market. The Norwegian Environment Agency therefore recommends that the Norwegian authorities should support international regulation of microplastics in cosmetic and body care products rather than introducing a national prohibition.

At the same time, several countries are now considering national prohibitions on these products. For example, Sweden is considering a national ban on microplastics in 'rinse-off' cosmetics. Cosmetics are not believed to be a major source of microplastics in Sweden either, and the Swedish proposal refers to national and international work that is being done to phase out the use of microplastics in cosmetic products.

The Ministry of Climate and Environment will consider the Swedish proposal for national regulation of microplastics in cosmetic products more closely and will initiate a dialogue with the Swedish authorities to obtain more information about how their national prohibition will be designed. A ban on the use of microplastics in cosmetic and body care products in Norway could be introduced in the form of regulations under existing legislation.

The Ministry will also consider the possibility of cooperation with other Nordic countries to encourage the EU to introduce a prohibition on the use of microplastics in cosmetic and body care products. An EU-wide prohibition would have a much greater effect than a national one, and would also apply in Norway. Marine litter and microplastics have high priority on the agenda during Norway's presidency of the Nordic Council of Ministers in 2017. In this connection, the environmental authorities will maintain contact with the other Nordic countries about work that is in progress and the possibility of further cooperation in this area.

Norway regulates discharges of waste from ships through the Regulations on environmental safety for ships and mobile offshore units under the Ship Safety and Security Act. The Norwegian taxation system also provides economic incentives to deliver waste from ships to an appropriate facility. A waste management fee that covers waste reception and treatment is payable regardless of whether waste is delivered to a reception facility in port. The waste management fee is not levied on leisure craft and fishing vessels that do not pay harbour dues.

Under the Marine Resources Act, fishermen are required to search for lost fishing gear and report losses to the Norwegian Coast Guard if gear is not retrieved. The Directorate of Fisheries organises an annual retrieval programme for lost fishing gear. Retrieval operations take place mainly along the coast between Ålesund and Kirkenes, with the main focus on areas from the Lofoten Islands and northwards. Since this programme started in the early 1980s, about 20 000 gill nets (almost 600 km) and large amounts of other fishing gear have been retrieved. From 2010, the retrieval programme was expanded by 40 %, and the quantities retrieved have increased considerably. From 2010 to 2016, the programme retrieved 6 600 gill nets, 185 000 metres of longlining gear, more than 300 king crab pots, 70 000 metres of rope, 47 000 metres of wire, trawls, purse seines, Danish seines and much more (see Figure 4.7). Most of the retrieved fishing gear is taken ashore to be cleaned, sorted and delivered for recycling.

The retrieval programme has reduced the risk of snagging and more losses of fishing gear, reduced the waste of seafood resources, improved the reliability of data on fish stocks and reduced pressure on biodiversity. The duration of the programme and the length of the time series of data on lost fishing gear is probably unrivalled anywhere in the world.

Through the Fishing for Litter project (see Box 4.3), the environmental authorities are gaining experience and knowledge as a basis for what may become a permanent system for fishing vessels to deliver marine litter they retrieve at sea free of charge in ports. The Norwegian Environment Agency is reviewing the possibility of introducing such a system for fishing vessels and other vessels.

Plastics and other waste from the fisheries, and to some extent the aquaculture industry, are a source of marine litter. The Norwegian Environment Agency is reviewing a proposal for a producer responsibility scheme for the fisheries and aquaculture industry.

In addition to clean-up, work is in progress on various solutions for finding lost gear more quickly and on reducing the effects of ghost fishing by using different materials in gill nets and traps and pots. In 2017, the Directorate of Fisheries is launching a new mobile app for recreational fisheries that will make it possible for people to report lost fishing gear and thus further reduce ghost fishing.

After a succession of bankruptcies in the mussel farming industry, the Directorate of Fisheries and the Norwegian Coastal Administration have been removing a number of mussel cultivation facilities. A deposit system has been established for such facilities established after 2007 to ensure that they are removed/cleaned up in the event of bankruptcy. In 2015, 22 facilities were removed in Nordland county, and in 2016, 26–30 tonnes of waste was removed from five facilities. Removal of abandoned mussel cultivation facilities also improves maritime safety.

At one stage, large quantities of non-rechargeable batteries were used in the Norwegian Coastal Administration's beacons and light buoys. The Coastal Administration has received reports of finds of batteries dumped in the sea near some of these. The fjords of Møre og Romsdal county were surveyed in 2016 to find dumped batteries. Video filming of the seabed at 29 localities showed

Figure 4.7 Coast Guard vessel with a cargo of retrieved marine litter, Hansnes, Troms.

Photo: Bo Eide

Box 4.3 Fishing for Litter

Norway's Fishing for Litter initiative is a two-year trial project (2016–2017) commissioned by the Norwegian Environment Agency, and is being carried out by the consultancy firm SALT Lofoten. Its objective is to gather information on the amounts and types of marine litter that fishing vessels pick up during normal fishing operations, and about the best ways of organising delivery in ports and, where possible, recycling. At the same time, the project contributes to clean-up. The fishing vessels that are taking part are provided with large robust bags for any litter caught in trawls and other fishing gear during fishing operations. They can deliver the bags in port, where the waste is sorted, registered and handled. Any suitable waste is delivered to the company Norsk fiskeriretur for recycling. In 2016, 28 ocean-going vessels and three ports (Tromsø, Ålesund and Egersund) took part in the project on a voluntary basis. A total of 48 tonnes (48 183 kg) of waste was delivered in these three ports in 2016. Of this, 37 tonnes was fisheries-related waste that was suitable for recycling. The rest included all other types of waste, including fisheries-related waste that was not suitable for recycling. The fishing vessels made a total of 44 deliveries of waste.

The project is part of Norway's action to implement OSPAR's Marine Litter Regional Action Plan, and is expanding knowledge about the types of marine litter in the sea and about recycling of litter.

Box 4.4 Keeping Norway clean

Hold Norge Rent (Keep Norway Beautiful) is a non-profit foundation which in 2016 had 34 companies, organisations and public-sector agencies as members. The board includes members of waste management and recovery companies, industry organisations, energy companies and outdoor recreation organisations. The foundation also cooperates with the Norwegian authorities. Its overall objective is to prevent marine and other litter and to involve volunteers in cleaning up litter and hazardous waste in Norway. In 2016, 18 500 volunteers were registered as taking part in the nationwide clean-up effort organised by Hold Norge Rent, and litter was cleared from a total of 869 km of shoreline. Other volunteers also take part in clean-up campaigns without being registered.

batteries or possible batteries at six localities, all in the same area. The Coastal Administration will remove these batteries in 2017, and carry out a survey in other coastal areas.

Large-scale clean-up operations will continue to be needed to deal with marine litter. Normally, beach clean-up operations are the most cost-effective because concentrations of litter are high and beaches are more easily accessible than the open sea. Beach clean-up should be given highest priority in areas where there are vulnerable habitats or other where other assets such as important recreational areas are most seriously damaged by litter. Retrieval of lost fishing gear from areas of the seabed where such litter accumulates has also proved to be effective. Clean-up operations in surface waters may be appropriate in ports and other heavily polluted areas, but it is not realistic to expect clean-up operations in surface waters far out to sea to be cost-effective.

In addition to the clean-up campaigns organised by central and local authorities, voluntary work is of key importance for practical clean-up activities, awareness-raising and communicating knowledge. Through a grant scheme run by the Norwegian Environment Agency, support is provided every year for projects to prevent and clean up marine litter. In 2016, more than 70 applications were received and NOK 15 million was allocated to 22 projects. In 2017, the funding available was increased to NOK 35 million. Some of the funding has gone to Hold Norge Rent (see Box 4.4), which administers a system for refunding expenses incurred by volunteers for transport and delivery of litter collected from beaches. Businesses, private foundations and others also provide substantial grant funding and practical assistance with clean-up operations.

The Government intends to establish an oil spill preparedness and response and environmental centre in the Lofoten/Vesterålen region, which will also be involved in activities to combat marine litter. Ways in which the centre can work towards a cleaner marine environment by promoting knowledge, technology and methods for oil spill response and for dealing with marine litter are under review.

Figure 4.8 Marine litter on the beach at Skulsfjord, Troms.

Photo: Bo Eide

4.6 International cooperation

Marine litter is a global environmental problem that can only be dealt with through effective international cooperation. Ocean currents spread marine litter and microplastics all across the world. The largest inputs globally are from a handful of Asian countries with large populations where waste management systems are inadequate and consumption of plastics is high. Coastal states with large populations and fast-growing economies may also become major sources of marine litter if growth in consumption is not followed up with effective systems for preventing plastic litter. Improving waste management systems in these countries may be prove to be cost-effective. Many countries that are badly affected by marine litter have limited resources and are not major sources of litter. Norway is therefore giving high priority to international cooperation in this field. Further information on Norway's international efforts to combat marine plastic waste is presented in the Government's white paper on the place of the oceans in Norway's foreign and development policy.

Norway has taken the initiative for global cooperation to combat marine litter through the UN system, particular through the UN Environment Assembly (UNEA), which is the UN's highest-level decision-making body on the environment, and the UN Environment Programme (UN Environment). Norway proposed UNEA resolutions on marine litter and microplastics in 2014 and 2016, unified decided by 170 countries. Norway has also provided funding for implementation of the resolutions through UN Environment.

In response to the 2014 resolution (UNEA 1/6), a global peer-reviewed report was produced by a group of experts coordinated by UN Environment. The report gives an account of the best available knowledge on sources, effects and experience of action to deal with the problem. The report was presented in 2016 as a basis for the second resolution (UNEA 2/11), which was adopted in May 2016. The 2016 resolution contains recommendations on action and priorities for authorities, industry, civil society, regional and global commissions and other stakeholders. Among other things, it recommends regional cooperation through action plans for specific sea areas. On the basis of a proposal from Norway, it was decided to make an assessment of the effectiveness of international, regional and sub-regional governance strategies, approaches and regulatory frameworks for combating marine plastic litter and microplastics, and identifying possible gaps and options for addressing them. The assessment will be presented to the third ses-

sion of UNEA in December 2017. One of its purposes is to identify the potential that lies in coordinating international processes more closely and expanding existing agreements, and to evaluate whether a new legally binding agreement should be developed to reduce inputs of plastics to the oceans. Norway will continue to press for progress in this area.

The International Convention for the Prevention of Pollution from Ships (MARPOL) under the International Maritime Organization (IMO) regulates discharges of garbage into the sea. It includes a general ban on discharging waste into the sea from ships. Waste from ships that is not incinerated on board must be delivered in port.

Action on marine litter and microplastics is a high priority in the regional cooperation between the countries around the North-East Atlantic on the marine environment under the OSPAR Convention, in which Norway plays an active part. In June 2014, OSPAR adopted its *Marine Litter Regional Action Plan* (see Box 4.5). Norway will seek to speed up progress in the implementation of the action plan.

The Food and Agriculture Organization of the UN (FAO) has taken several initiatives to reduce losses of fishing gear from fishing vessels. FAO's Committee on Fisheries is working on guidelines for the marking of fishing gear to facilitate retrieval and avoid ghost fishing. Norway has helped to keep this issue on the agenda, and has urged other countries to carry out retrieval campaigns.

In the last few years, Norway has also taken active steps to put marine litter and microplastics on the agenda of the Nordic Council of Ministers. Several cooperation projects have been carried out, and there is general Nordic agreement on the importance of this issue. During its presidency of the Nordic Council of Ministers in 2017, Norway has put lost fishing gear, ghost fishing, marine litter and microplastics even higher on the agenda. Strategic efforts will include closer dialogue at ministerial level in the Nordic region, initiatives for closer cooperation between the Nordic countries in regional and international processes, and specific Nordic projects on topics including microplastics in marine organisms and action against ghost fishing.

Norway will also assume a leading role through the Arctic Council to strengthen the knowledge base on marine litter and microplastics in the Arctic. This will provide an important basis for the next step, which would be to prepare a regional marine litter action plan to be adopted by the Arctic states.

Box 4.5 OSPAR

OSPAR's *Marine Litter Regional Action Plan* includes action against litter from both sea-based and land-based sources, removal of litter, enhancing knowledge and awareness, and education and outreach.

OSPAR has previously established guidelines and systems for:
- monitoring beach litter;
- monitoring plastic particles in fulmar stomachs;
- monitoring seabed litter;
- fishing for litter initiatives (see Box 4.3).

The Norwegian authorities have so far started monitoring of beach litter, monitoring of plastic particles in fulmar stomachs and a fishing for litter project. In addition, Norway will make a special contribution to the following activities under OSPAR:
- developing guidelines for best practices in waste management in the fisheries;
- identifying areas where fishing gear that has been abandoned, lost or otherwise discarded tends to accumulate as a result of fishing activities, the underwater topography or patterns of ocean currents;
- developing solutions for reducing inputs of litter, especially microplastics, to the oceans via waste water from land.

On 2 December 2015, the European Commission presented its Circular Economy Package. This included proposals for a number of measures dealing with plastics and marine litter, which were also intended to address the target of reducing marine litter under Sustainable Development Goal 14.

4.7 Knowledge needs – marine litter and microplastics

Broad-based international cooperation is particularly important for developing scientific definitions of microplastics and standardised sampling and measurement techniques and indicators. These are needed for satisfactory monitoring of marine litter and microplastics in the Norwegian

Sea. Monitoring should be initiated based on the OSPAR indicators that are already available.

There is also an urgent need for research on plastics in the oceans, including the distribution and quantities of plastics in the marine environment and living organisms, the spread and sources of plastics, and degradation under various kinds of realistic conditions in the shore zone and at sea. More knowledge is also needed on the impacts on marine organisms, biological production, biodiversity and ecosystems, food safety and human health.

In addition, more research and development is needed on effective, environmentally friendly ways of preventing marine litter and inputs of microplastics to the oceans, and of cleaning-up marine litter.

5 Ocean-based industries and value creation in the Norwegian Sea

The Government presented its Ocean Strategy, *New Growth, Proud History, on* 21 February 2017. The main objective of the strategy is to maximise sustainable value creation and employment in the ocean-based industries. Norwegian ocean-based industries are to be further developed on the basis of already existing industries and in the interactions and interfaces between these industries. The Government will continue to give priority to industries where Norway has competitive advantages, and will stimulate research, innovation and technology development to promote emerging industries. We will seek to provide good framework conditions by continuing and further developing effective, predictable and knowledge-based regulation of these industries. We will also strengthen the international competitiveness of Norwegian ocean-based industries by providing assistance in the fields of market access, internationalisation and image-building.

To clarify the overall framework and encourage closer coordination and clear priorities for management of the Norwegian Sea, it will be necessary to carry out an integrated, updated assessment of the ocean-based industries and value creation associated with the area. This chapter discusses established, emerging and future industries in the area and their contribution to value added, and provides an overview of the management and framework conditions by sector. Together with Chapter 3, it forms a basis for facilitating further value creation and food security, and for maintaining the high environmental value of the Norwegian Sea in line with the purpose of the management plan.

As part of the work on the scientific basis for the management plan, the Forum for Integrated Marine Management obtained figures for value creation in 2014 by county from Statistics Norway, which are presented in Table 5.1. The figures indicate value added and employment in core activities and for the largest companies in the direct supplier industry for each sector, but do not include wider spin-off effects. The sections on individual ocean-based industries also quote some national figures for value added and employment from 2016 that do include spin-off effects.

In terms of both value added and employment, the petroleum industry is by far the largest industry in the Norwegian Sea. The next largest is the seafood industry, which is responsible for almost half the total national value added generated by activities in and along the coast of the Norwegian Sea. Other important activities in the region are shipping and tourism.

Since 2014, value added in the petroleum and maritime industries has declined due to the drop in oil prices, whereas value added in the seafood industry has grown, due among other things to a weaker krone and higher demand. Employment is more stable, but this too changes from year to year. The number of people employed in the

Table 5.1 Value added and employment in ocean-based industries associated with the Norwegian Sea in 2014 (core activities and largest companies in the direct supplier industry for each of them), not including wider spin-off effects

	Value added 2014		Employment 2014	
Industry	NOK billion	% of total in Norway	1000 persons	% of total in Norway
Seafood	19.9	49 %	14.8	46 %
Petroleum industry	219.6	30 %	42.2	30 %
Shipping	4.4	11 %	5.0	11 %

Source: Statistics Norway

petroleum and maritime industries has declined since 2014, but has risen somewhat in the seafood industry.

Work on the figures for value added in the scientific basis for the management plan is ongoing.

5.1 Fisheries and aquaculture

For hundreds of years the fisheries have been a major source of income and played a vital part in the culture of Norway's coastal communities. Today Norway is one of the world's largest exporters of seafood from fisheries and aquaculture.

5.1.1 Activity in the Norwegian Sea

The four counties bordering on the Norwegian Sea account for a major share of Norway's total activities in the fisheries sector. In 2015, 44 % of all Norwegian fishing vessels were registered in one of these four counties, and in several of the smaller towns and built-up areas along the coast fisheries and aquaculture are the most important industries in terms of settlement and employment. In its broadest sense, the sector includes all areas of the fisheries and aquaculture industries, including everything from fishing operations and fish farming to processing and exports, and also service and supply industries. The number of fishing vessels has declined over the last few decades, but their average size has grown (Figure 5.1). There is still a potential for further restructuring and rationalisation of the industry, but the reduction in the number of vessels has slowed in recent years.

The largest fishery in the management plan area is the herring fishery, which starts in the first three months of the year off the Møre coast and moves northwards and eastwards to the Barents Sea in the course of the year. There is a good deal of bottom trawling on the Halten and Sklinna banks and along the edge of the continental shelf. In the latter area there is also a considerable amount of fishing with gill nets and longlines. Greater argentine is harvested at the Sklinnadjupet trough. The main fishery around Jan Mayen is for shrimps, but there is also some pelagic fishing.

Under the Aquaculture Act a licence is required to operate a fish farm, and only limited numbers of licences are issued for the commercial production of salmon, trout and rainbow trout in seawater. Since the 2009 round of awards, increasing attention is being paid to environmental considerations, and there is political agreement that further growth in the aquaculture industry must be environmentally sustainable. Awards in the 2013 round ('green licences') were granted to the companies with the best plans for dealing with the problems of infection with sea lice and escapes of farmed fish. In 2015 the Government introduced a system of development licences intended to promote the commercialisation of innovative concepts for solving environmental problems and issues relating to spatial management in the aquaculture industry.

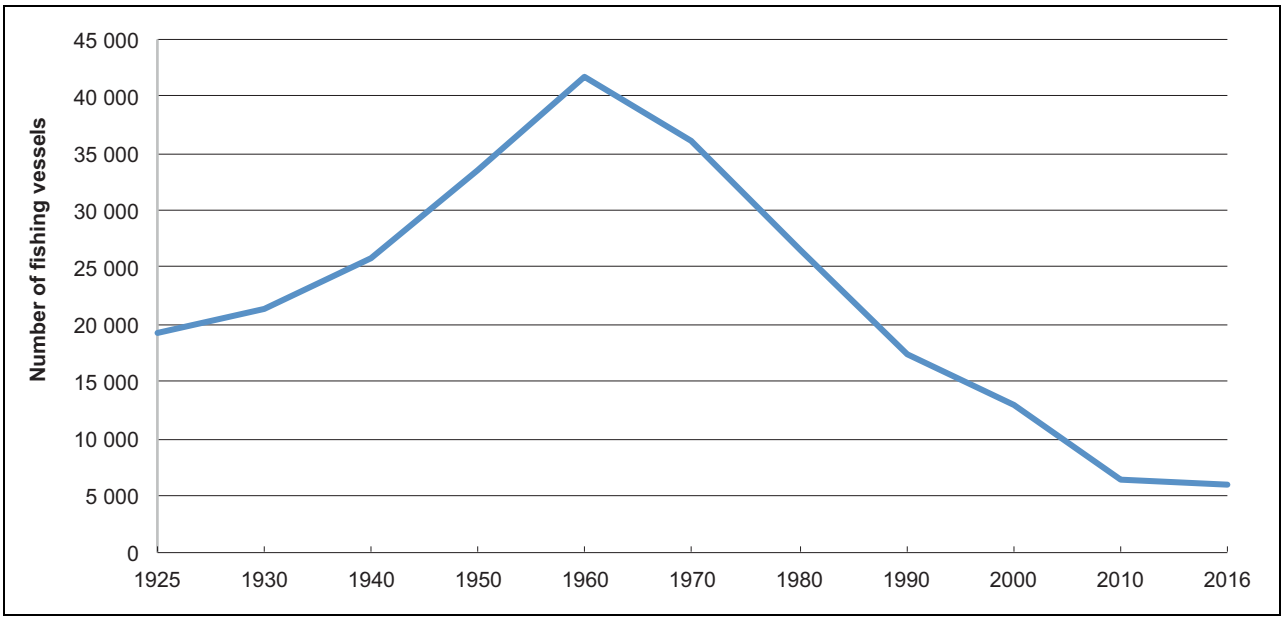

Figure 5.1 Number of Norwegian-registered fishing vessels.

Source: Directorate of Fisheries

Table 5.2 Value added and employment in the seafood sector in the counties bordering on the Norwegian Sea in 2014

Industry	Value added 2014		Employment 2014	
	NOK billion	% of total in Norway	1000 persons	% of total in Norway
Fisheries	3.8	39 %	4.0	39 %
Aquaculture	8.1	48 %	3.2	47 %
Fish processing	5.9	60 %	5.7	53 %
Production of crude fish oils and fats	0.0	39 %	0.1	39 %
Wholesale of fish, crustaceans and molluscs	0.8	44 %	0.7	43 %
Supply industries	1.2	49 %	1.2	46 %
Total	19.9	49 %	14.8	46 %

On 26 January 2017, there were in all 978 approved locations for seawater salmon farming in the country as a whole. Just under half of them (457) were located along the coastline of Møre og Romsdal, Sør-Trøndelag, Nord-Trøndelag and Nordland counties.

In 2015, the Government published a white paper on predictable and environmentally sustainable growth in Norwegian salmon and trout farming (Meld. St. 16 (2014–2015)) describing how it intends to facilitate predictable growth in the fish farming industry. Growth in salmon farming will in future be regulated by means of a new system for adjusting capacity based on defined production areas and environmental indicators. The new system is intended to ensure that growth will only take place where the environmental impact is acceptable.

Considerable advances have been made in aquaculture technology, both in the further development of equipment and in devising innovative concepts. Open net pens in coastal waters have been the main form of production until now, but semi-enclosed systems and offshore systems are being developed (see section 5.5.3).

5.1.2 Value added

The statistics for 2015 show that the landed value of fish and shellfish delivered by Norwegian vessels was NOK 16.9 billion (2.3 million tonnes). The landed value for aquaculture was NOK 46.7 billion (1.4 million tonnes).

The value added generated by the Norwegian seafood industry is assessed regularly. The industry is defined as the sum of the aquaculture- and fisheries-based value chains and all direct and indirect suppliers of goods and services to the various links in the chain. The value chains are made up of four industries: fisheries, aquaculture, fish processing, and export and trade in seafood. An analysis by SINTEF of value added based on 2014 figures showed that the Norwegian seafood industry as a whole, including spin-off effects, generated NOK 65.7 billion in value added, and provided 51 800 person-years of employment, 26 200 of which were directly linked to the industry and 25 600 to associated activities.

In 2014, fisheries and aquaculture along the Norwegian Sea generated NOK 19.9 billion in value added and employed 14 800 people, not including wider spin-off effects (see Table 5.2).

5.1.3 Pressures and impacts of fisheries and aquaculture on the environment

Fisheries affect both the fish stocks that are harvested and the ecosystem as a whole. The aim of fisheries management is to minimise the negative impacts of harvesting through long-term, sustainable management strategies. Although unintentional bycatches are an unavoidable consequence of fisheries activities, new methods of minimising the impacts are constantly being developed.

Fisheries can also have unintentional impacts on benthic communities, especially in connection with bottom trawling in areas with coral reefs or other valuable benthic fauna. However, the reduction in the number of bottom trawlers and trawling hours in the Norwegian Sea since 2009 (see

Table 5.3 Number of bottom trawlers and trawling hours in the Norwegian Sea

Norwegian vessels (over 24 m)	2009	2012	2015
Number of bottom trawlers	60	57	44
Number of trawling hours	42 720	24 914	13 469

Source: Directorate of Fisheries

Table 5.3) indicates that the impact on benthic communities has been lessened.

In 2011, regulations on bottom fishing were introduced for areas under Norwegian jurisdiction. They prohibit bottom fishing in areas over 1000 metres in depth unless the vessel has a special permit for experimental fisheries from the Directorate of Fisheries. Such permits are only issued if the vessel has submitted detailed plans for collecting data on vulnerable benthic habitats and harvesting, including plans for avoiding damage to vulnerable marine ecosystems. The regulations also require all fishing vessels to keep detailed records of any contact with vulnerable habitats regardless of water depth, report such contact to the Directorate of Fisheries and move at least 2 nautical miles away from the area concerned before resuming fishing. Up to 2016, vessels were required to report any catches containing more than 60 kg live coral and 800 kg live sponge. In 2016 these limits were further reduced, and are now 30 kg live coral or 400 kg live sponge per haul or catch.

The regulations relating to sea-water fisheries contain a general requirement to show special care during fishing operations near known coral reefs. Four coral habitats in the Norwegian Sea are closed to bottom trawling: the Iverryggen and Sula reefs, the Træna reef and the Breisunddjupet area. The Iverryggen and Sula reefs have been designated as particularly valuable and vulnerable areas, and Breisunddjupet is situated in the Møre banks area. The Træna reef and Breisunddjupet have been closed to bottom trawling since 2010.

In 2016, all areas that were already closed to bottom trawling were designated as marine protected areas, and a further nine were established in Norway's exclusive economic zone under the Marine Resources Act. There are now a total of 18 marine protected areas for corals in Norway's exclusive economic zone.

5.1.4 Management and 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
- The 1995 United Nations Fish Stocks Agreement
- The 1992 UN Convention on Biological Diversity
- The 1995 Code of Conduct for Responsible Fisheries drawn up by the Food and Agriculture Organization (FAO).

Box 5.1 National regulation of fisheries

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 where 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 Trade, Industry and Fisheries, 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, and so on. In addition to the annual quota regulations, Norway has a number of permanent national and local regulations. For example, there are regulations on position reporting and electronic transmission of reports for Norwegian fishing vessels, which lay down provisions on tracking and reporting. The regulations relating to sea-water fisheries include provisions on the use of gear, types of gear, mesh sizes, minimum sizes, the ban on discards and requirements to use sorting grids, and the regulations relating to bottom fisheries include provisions on the protection of vulnerable benthic habitats.

Box 5.2 Management cooperation under the North East Atlantic Fisheries Commission (NEAFC)

The NEAFC promotes long-term conservation and optimum utilisation of the fishery resources of the Convention Area. Its most important function today is to promote the development of good regional control and enforcement schemes and a more ecosystem-based approach to management of the relevant sea areas. The Commission's primary function with regard to stocks that migrate between different countries' exclusive economic zones and international waters is to coordinate the regulation of fisheries. These are mackerel, blue whiting, Norwegian spring-spawning herring and beaked redfish.

The parties to the NEAFC are Denmark, representing the Faroe Islands and Greenland, the EU, Iceland, Norway and Russia. The NEAFC Convention applies to all fishery resources in the Convention Area apart from marine mammals and, insofar as they are dealt with by other international agreements, highly migratory species (such as tuna).

The NEAFC has taken active steps to adapt to developments in the Law of the Sea, in accordance with the precautionary principle and the ecosystem approach. The organisation has implemented a comprehensive system for satellite tracking of fishing vessels in the North-East Atlantic and operational rules on the protection of sensitive marine ecosystems.

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

The Marine Resources Act regulates all harvesting and other utilisation of wild living marine resources and the genetic material derived from them. Under the Act, the authorities must evaluate which management measures are necessary to ensure sustainable management of these resources.

In the years to come, we expect that measures to reduce unregistered mortality in fisheries and at the same time their impacts on ecosystems will be further developed. Knowledge about fish stocks is likely to increase, and scientific advice will be based on more complex ecosystem considerations.

The International Council for the Exploration of the Sea (ICES) promotes and coordinates marine research in the North Atlantic area and disseminates the results. ICES 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. It provides mapping data and data from scientific cruises, and performs a significant amount of the research on which ICES advice is based.

Almost all the fish stocks harvested in Norway are also found in other countries' zones, which makes international cooperation on their management essential. There are a number of forums for international cooperation on the Norwegian Sea, the most important of which is the North East Atlantic Fisheries Commission (NEAFC) (see Box 5.2). In addition, Norway has a number of agreements with other coastal states on the distribution and management of stocks of Norwegian spring-spawning herring, mackerel, blue whiting, beaked redfish and capelin off Iceland, Greenland and Jan Mayen.

5.2 Shipping

The Norwegian Sea is an important area for freight traffic in Norway, and several of the country's largest ports lie along the Norwegian Sea coastline.

5.2.1 Maritime transport in the Norwegian Sea

Six of Norway's 10 largest dry bulk ports border on the Norwegian Sea. Narvik is Norway's next largest port and by far the largest dry bulk port, and handles 17.5 million tonnes gross weight of goods every year. Substantial volumes of dry bulk are also shipped from the ports of Rana, Kristiansund, Trondheim, Molde and Brønnøysund (Table 5.4).

Kristiansund, Molde and Bremanger are also major wet bulk (petroleum) ports, and substantial volumes of general cargo are shipped through the ports of Kristiansund, Rana, Trondheim and Ålesund. Ålesund is a particularly important port for the fisheries industry and Bodø and Trond-

Table 5.4 Annual gross weight of goods handled in the largest ports bordering on the Norwegian Sea in 2015, in tonnes

Narvik	17 558 820
Kristiansund	7 072 499
Rana	4 839 872
Molde	4 735 284
Trondheim	4 128 372
Brønnøy	1 888 653
Ålesund	1 529 325
Mosjøen	1 286 522

Source: Statistics Norway

heim are important hubs for goods transport in their regions.

In 2015 the volume of shipping in the Norwegian Sea was just over 13 million nautical miles measured as total distance sailed, which is 31 % of the total volume of shipping in Norwegian sea areas. The volume of shipping is larger than that in the Barents Sea–Lofoten area but smaller than that in the North Sea–Skagerrak area. General cargo ships and passenger ships account for the greatest distance sailed in the Norwegian Sea, and make up 23 % and 32 % of the total respectively. There is also a considerably higher proportion of small vessels in the Norwegian Sea in terms of distance sailed than in other Norwegian sea areas. There has been a considerable improvement in the underlying shipping data since 2009, partly due to the further development of AIS base stations along the coast and the launching of AIS satellites, a factor that makes it difficult to assess the trend in shipping volumes since 2009.

Shipping density is highest in the fairways along the coast and in the southern Norwegian Sea. A relatively large proportion of shipping in the Norwegian Sea is in transit, in other words passing through without calling at any ports.

The volume of shipping in the Northeast Passage may influence shipping density and traffic patterns in the Norwegian Sea. Even though the ice is melting faster than previously expected, and ships can sail north of both Russia (through the Northeast Passage) and Canada/the US in summer, the volume of traffic is so far moderate. In 2013, 71 ships passed through the Northeast Passage, but in 2014 and 2015 the numbers dropped to 31 and 18 ships respectively. It is difficult to predict future traffic volumes through the Northeast Passage, but the recent decline may be a sign that previous predictions about the profitability of using this route were too optimistic.

According to forecasts in a marine safety analysis (2015) by the Norwegian Coastal Administration, distance sailed in the management plan area is expected to increase by 40–45 % by 2040.

An increase in activity is expected for most types of vessels apart from offshore and fishing vessels, where a reduction is expected. Gas carriers and container ships are expected to show the strongest percentage growth, and strong growth is also expected for cruise ships.

The expected strong growth in container shipping is based on the assumption that ice melt in the Arctic will continue, and that over the long-term Arctic sea routes will become more commercially viable. The increase in the number of tankers can be largely attributed to petroleum exports from northwestern Russia and the expectation that there will be a general increase in oil and gas activities in the Barents Sea.

It is expected that the increase in activity will be largely along the routes currently used by transit traffic and coastal shipping. The future volume of transpolar traffic and how it will influence the traffic picture are somewhat uncertain.

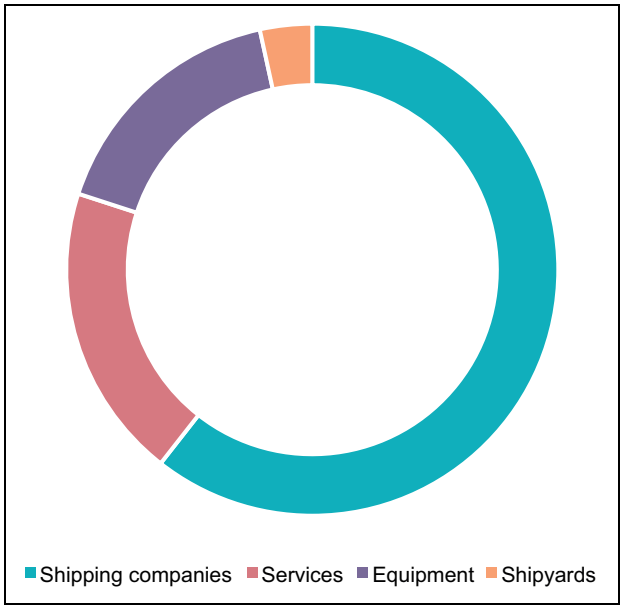

Figure 5.2 Value added in the maritime sector for 2015, divided into four segments. Total value added amounted to NOK 175 billion.

Source: Maritime Forum Maritim verdiskaping 2017

5.2.2 Commercial activities and value added

The Norwegian maritime industry is global and knowledge-driven, and occupies a strong position in world markets. It is responsible for almost NOK 175 billion in total value added and employs over 110 000 people in Norway. The term 'maritime industry' refers to all enterprises that own, operate, design, build and supply equipment or specialised services to all types of ships and other floating structures. Today Norway is the world's 11th largest shipping nation in terms of gross registered tonnage, and the sixth largest shipowning nation in terms of fleet value.

The publication *Maritim verdiskaping* 2017 provides an overview of value added in the maritime industry. It includes all enterprises that supply and develop equipment and services to the industry, and is mainly based on the various companies' accounts for 2015.

Norway is one of the few high-cost countries that still has a shipbuilding industry. Ships built in Norway are equipped with advanced marine technology, which gives shipyards a major competitive advantage. Although the shipbuilding sector is the smallest segment in the shipping industry in terms of both value added and employment, the value added generated by shipyards has tripled over the last decade.

There are also world-leading Norwegian companies in the maritime supply sector. Suppliers of services occupy a leading place worldwide in the fields of design, insurance, brokerage, classification and finance. This segment has experienced strong growth in the last 10 years and accounts for one-fifth of total value added in the maritime sector. Equipment suppliers deliver three main groups of products: mechanical equipment, electrical and electronic equipment, and other operating equipment. For these companies the Norwegian part of the continental shelf is an important source of clients, and the Federation of Norwegian Industries estimates that around 60 % of

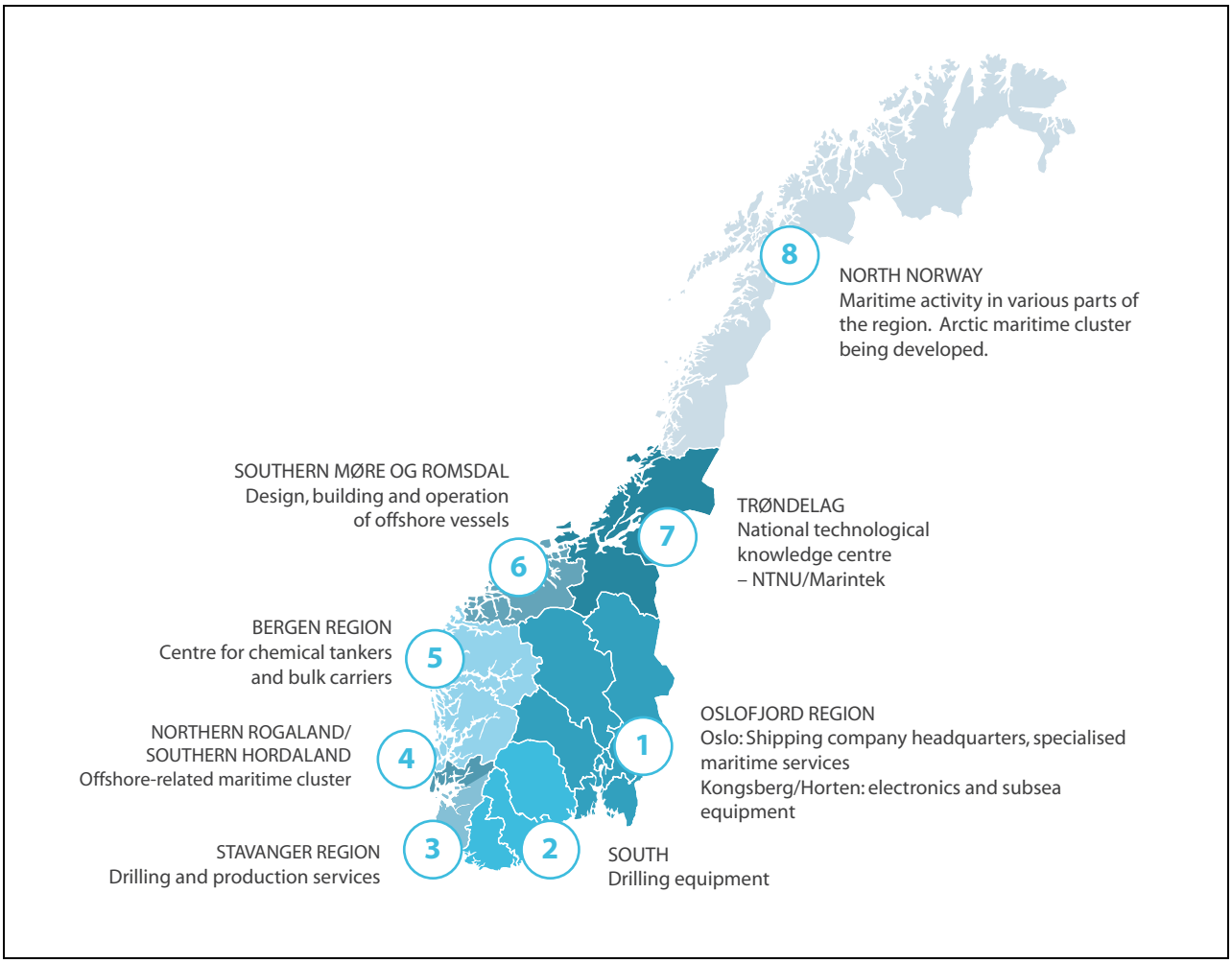

Figure 5.3 Maritime regions and maritime clusters in Norway.

Source: Maritime Forum Maritim verdiskaping 2017

Table 5.5 Value added and employment in shipping companies in the four counties bordering on the Norwegian Sea (excluding fisheries, petroleum and tourism) in 2014

	Value added 2014		Employment 2014	
Branch of industry	NOK billion	% of total in Norway	1000 persons	% of total in Norway
Foreign shipping, freight	2.0	7 %	2.3	7 %
Domestic shipping, freight (incl. tugboats)	0.8	34 %	0.4	21 %
Domestic coastal routes	0.2	34 %	1.2	21 %
Supply industries	1.4	15 %	1.1	20 %
Total	4.4	11 %	5.0	11 %

Source: Statistics Norway

equipment deliveries are made to the offshore market.

The maritime industry has been tailored to petroleum activities for many years, and the drop in oil prices and decline in the activity level on the Norwegian shelf have seriously affected the industry. The current situation and the turbulence in the global economy in the last few years are still affecting shipping. A decline in the level of investment in the Norwegian shelf has resulted in many offshore vessels being laid up and employees being laid off, and a reduction in the number of orders to Norwegian shipyards.

Maritime enterprises are situated all along the Norwegian coast. In the last 10–20 years companies have tended to form local specialised clusters (see Figure 5.3). The cluster in Møre og Romsdal county consists of a complete value chain of companies that specialise in maritime equipment and the design and construction of offshore vessels, as well as a large number of offshore shipping companies.

In 2014, shipping companies (excluding those in the fisheries, petroleum and tourism sectors) located in the four counties bordering on the Norwegian Sea generated a total of NOK 4.4 billion in value added, and provided employment for 5 000 people, not including wider spin-off effects (see Table 5.5).

5.2.3 Pressures and impacts on the environment

Shipping can put pressure on the marine environment through operational discharges to air and water, illegal releases of pollutants and acute pollution, the spread of alien species and subsea noise.

Releases to air and water

Operational discharges to the sea from shipping consist mainly of oily bilge water, cargo residues, tank washings, ballast water, sewage and food waste. Discharges are regulated internationally by Annexes I, IV and V of MARPOL 73/78 (International Convention for the Prevention of Pollution from Ships), and are considered to have little impact on the Norwegian Sea environment. There is no overview of actual operational discharges to water in either the Norwegian Sea or other sea areas. A study made in 2012 showed that the oil separation systems in use generally comply with the requirement in Annex I of MARPOL that vessels must not discharge water if the oil content exceeds 15 parts per million (ppm), and the majority of the systems examined were able to reduce the oil content to 5 ppm or less.

The provisions of Annex V of MARPOL, on the prevention of pollution by garbage from ships, are being tightened, and this is expected to result in a reduction in operational discharges from ships.

Figures for acute pollution from shipping have been available since 2013 and show that most spills are small. In 2015, 10 spills of various types of oil and oil-based drilling mud from shipping in the Norwegian Sea were registered, with a total volume of around 17 000 litres.

Emissions to air from shipping include greenhouse gases, acidifying substances and nutrients from engines, and fugitive emissions of volatile substances from cargoes (petroleum and petroleum products). As shown in Table 5.6, carbon dioxide emissions are highest. Since the previous management plan was published, further international regulatory measures to reduce emissions to air from ships have been introduced by various

Table 5.6 Calculated emissions to air from shipping in the Norwegian Sea in 2016

Vessel categories	CO_2 (tonnes)	CO (tonnes)	NO_X (tonnes)	SO_2 (tonnes)	PM (tonnes)
Tankers	279 884	633	5 603	1 005	421
Dry cargo vessels	584 642	1 341	10 485	1 373	592
Passenger ships	531 413	1 187	8 994	1 076	543
Fishing vessels	237 523	549	3 295	135	90
Offshore vessels	315 639	640	4 103	302	135
Other	187 310	397	2 419	147	75
Total	1 367 47 5	3 560	22 610	2 963	1 856

Source: havbase.no

organisations, including the International Maritime Organization (IMO). The development and introduction of new technology will also reduce emissions. The external costs of maritime transport are on average lower than those of road transport.

Introduction of alien species

The introduction of alien species is a threat to biodiversity because they can displace native species and disrupt ecosystems. The main causes of the spread of alien species are discharges of ballast water and hull fouling.

There is no systematic monitoring of alien species in Norwegian coastal and marine waters, but a number of ports along the coast of the Norwegian Sea where large volumes of ballast water are discharged are monitored for the presence of alien species.

The discharge, intake and treatment of ballast water are regulated by IMO and the International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Management Convention), which was adopted in 2004. When the convention enters into force on 8 September 2017, all ships will be required to have the necessary treatment technology on board. Norway adopted its own ballast water regulations in 2010, which will be revised to ensure that the whole convention is incorporated into Norwegian law. The introduction of alien species through hull fouling is not regulated internationally, but IMO has issued voluntary guidelines on the management of hull fouling.

Underwater noise

Propeller noise from ships lies within the range of frequencies that can be heard by fish and marine mammals. In 2014 IMO issued guidelines for the reduction of underwater noise. Naval frigates use sonar equipment to detect submarines at great distances, which emit intense sound pulses that are well within the hearing range of marine mammals but less audible to fish. The navy has introduced guidelines for the use of sonar in Norwegian waters. The environmental impacts of underwater noise are described in Chapter 3.3.5.

Risk of acute pollution

A white paper on *maritime safety and the preparedness and response system for acute pollution* (Meld. St. 35 (2015–2016)) was published in 2016 and contains an analysis of maritime accidents, the probability of accidents, and the environmental risks associated with shipping in Norwegian sea areas.

Maritime accidents such as groundings, collisions, structural failure and fire or explosion occur at irregular intervals, but only a small proportion of them result in acute pollution.

The accident statistics show a decline in the number of maritime accidents involving serious damage to vessels. There also seems to be a slight decline in the annual number of maritime accidents leading to acute pollution, and in the total volume of spills. This is partly due to the introduction of a number of preventive measures to improve maritime safety (see below for more details). Thus there are strong indications that the probability of maritime accidents in the Norwegian Sea management plan area has been reduced since 2009.

The probability of maritime accidents is influenced by a number of factors, including the volume of transport, the traffic situation, the technical standard and equipment of vessels, crew qualifications and the preventive measures that have been introduced. The forecast frequency of accidents in the Norwegian Sea is higher than that in the Barents Sea–Lofoten area and lower than that in the North Sea–Skagerrak area. This corresponds to the share of total distance sailed in each of the management plan areas and also the shares of total distance sailed that are close to the coast. Most accidents are expected to be groundings on the landward side of the baseline. Passenger ships, fishing vessels and general cargo vessels account for the longest distances sailed and the highest forecast accident frequency.

The expected frequency of accidents is strongly influenced by the forecast trends in traffic. The Norwegian Coastal Administration has estimated that the number of accidents in the management plan area will rise by around 35 %, to 70 accidents a year by 2040 unless new preventive measures are introduced. The number of accidents involving acute pollution is also expected to rise by around 35 % by 2040.

A risk analysis commissioned by the Norwegian Coastal Administration and carried out by DNV GL identified a number of areas along the Norwegian coast where there is an elevated environmental risk. The analysis also showed that the environmental risk level is generally higher in the North Sea–Skagerrak than in the other management plan areas. This is mainly because the larger volume of shipping along the coast of Southern Norway means that there is a higher probability of spills.

Any environmental consequences of accidents are likely to be greatest in North Norway. However, the relatively low probability of spills means that the overall level of environmental risk is lower in the north than in the south.

An environmental risk and preparedness and response analysis for Svalbard and Jan Mayen made by the Norwegian Coastal Administration (2014) showed that there was a low level of environmental risk in the waters around Jan Mayen, due to the small volume of shipping and low expected frequency of accidents. Furthermore, the preponderance of smaller types of vessels in these waters means that any spills are likely to be small.

Maritime safety measures

Maritime safety measures are intended to reduce the probability of accidents at sea and protect society from incidents that can result in loss of life, personal injury, environmental damage and adverse financial consequences. To prevent accidents, it is important that vessels meet high technical and operational safety standards and that crew members have adequate qualifications. The Norwegian Maritime Authority is the administrative and supervisory authority in matters that include maritime safety for Norwegian vessels and their crews and control of foreign ships in Norwegian waters. Ensuring a high standard of maritime safety is one of its priorities. A number of measures to improve maritime safety have been implemented under the 2007 Maritime Safety Act. Since the adoption of the 2009 management plan for the Norwegian Sea, further measures have been introduced to improve maritime safety and reduce the environmental risk associated with shipping in these waters.

Traffic separation schemes and recommended routes outside territorial waters were established in 2011 between Runde and Utsira and between Egersund and Risør. These and corresponding measures for the Vardø–Røst route, which were adopted in 2007, have moved maritime traffic away from the coast, separated opposing traffic streams and established regular sailing patterns. Although the traffic separation schemes do not formally apply to the whole of the management plan area, the density plot for maritime traffic shows that they have a clear influence on traffic streams in the Norwegian Sea as well. The schemes reduce the probability of collisions, simplify traffic surveillance and give the maritime traffic control centres more time to come to the assistance of vessels when necessary.

Systems for monitoring shipping in Norwegian waters have been strengthened since 2009, particularly through further development of the infrastructure of AIS base stations along the coast, which are operated by the Coastal Administration in cooperation with the Defence Forces. Since 2010 Norway has also operated a satellite-based AIS system. Thus we now have a far more detailed picture of the maritime traffic situation than before.

The mandatory ship reporting system Barents SRS has provided a better overview of shipping and the kinds of cargo that vessels are transporting in the management plan area. The system is operated in cooperation with Russia, and has been

Box 5.3 Measures set out in the white paper on maritime safety and the preparedness and response system for acute pollution

In June 2016 the Government presented a white paper on *maritime safety and the preparedness and response system for acute pollution* (Meld. St. No. 35 (2015–2016)).

Maritime safety measures:

- The Government will consider extending the catchment areas of the vessel traffic service centres (VTS centres). The first step would be to include the waters between Fedje and Kristiansund in the area covered by the VTS centres in Western Norway.
- The Government will build land-based AIS base stations in Svalbard to improve maritime traffic surveillance and provide the Vardø VTS and other agencies with up-to-date information on the maritime traffic situation.
- The Government will further develop and modernise the existing infrastructure to optimise risk reduction and reduce operational and maintenance costs.
- The Government will take steps to facilitate the development and implementation of intelligent transport systems (ITS) for shipping.

Preparedness and response system for acute pollution

- The Government will consider measures to improve the preparedness and response system for acute pollution in Svalbard and Jan Mayen.
- The introduction of basic training in dealing with acute pollution will be evaluated in connection with the development of a new model for the training of fire and rescue personnel.
- The Government will consider establishing governmental chemical dispersion capacity for spills of bunker fuel in coastal waters.
- The Government will commission the Coastal Administration to invite tenders for the storage, operation and transport of governmental emergency response equipment.

R&D

- The Government will facilitate research and development on maritime safety measures and the preparedness and response system for acute pollution, and will examine the organisation of existing research programmes in consultation with the Research Council of Norway.

approved by IMO. Larger vessels and vessels carrying dangerous or polluting cargo are obliged to report through this system before entering the area between the Lofoten Islands and the Norwegian–Russian border. Although the geographical area where the system applies is largely outside the management plan area, the system has also resulted in better information on high-risk traffic in the Norwegian Sea.

The navigational warning service (NAVCO) operated by the Norwegian Coastal Administration has been strengthened in the management plan area. Navigational warnings inform ships of hazards they are likely to encounter, such as drifting objects or lighthouse lights that are unlit. Since 2010 Norway has been transmitting weather reports and navigational warnings for the waters of the Norwegian Sea, the Barents Sea and as far as the North Pole (NAVAREA XIX).

The Norwegian Coastal Administration has made improvements in several fairways in the management plan area since 2009. These include Måløysundet in Sogn og Fjordane, Lepsøyrevet, Djupflua, Åramsund, the approach to Ålesund in Møre og Romsdal, Torgværleden and the approach to Bodø in Nordland. These measures have improved safety and navigation in narrow channels and hazardous waters. Navigation marks in these waters have also been reviewed and updated.

The governmental preparedness and response system for acute pollution

The Pollution Control Act distinguishes between private, municipal and governmental levels of the preparedness and response system for acute pollution. At operational level, the overall preparedness and response system involves cooperation

between these three levels. No major changes in areas of responsibility or the framework for Norway's preparedness and response system have been made since the adoption of the first management plan for the Norwegian Sea. The white paper on maritime safety and the preparedness and response system provides a broad overview of the system at government level and sets out priorities for the years ahead. The primary objective of the governmental system is to prevent or limit environmental damage and lower the risk of acute pollution.

The governmental preparedness and response system is intended to deal with major incidents of acute pollution that are not covered by municipal or private systems, and the risk of such spills. The private-sector preparedness and response system in the petroleum sector is described in section 5.3. Vessels sailing in Norwegian waters are not required to have their own preparedness and response system to deal with acute pollution. The risk of acute pollution from shipping is primarily related to spills of fuel and petroleum products (cargo). The governmental preparedness and response system is mainly intended to deal with oil spills from ships.

Since the adoption of the 2009 Norwegian Sea management plan, the emergency response equipment in government depots and on Coast Guard vessels has been renewed and replenished.

Three new Coast Guard vessels for areas outside territorial waters (KV *Barentshavet*, KV *Bergen* and KV *Sortland)* are now operating in the management plan area, and are equipped with oil spill response equipment and oil spill detection radar. Since 2012, the Coast Guard's multi-purpose offshore vessel OV *Utvær* has been operating in the southernmost part of the management plan area. A similar vessel for the coast of Nordland, OV *Skomvær*, became operational in 2013. The vessels are normally used for maintenance of navigation infrastructure, but can also be used in oil spill response. The capacity to detect acute pollution in these sea areas has been strengthened by the renewal and upgrading of the Coastal Administration's surveillance aircraft.

Measures have been introduced to ensure a rapid response in order to isolate any spills from disabled vessels and improve the availability of suitable vessels during governmental response operations in the Norwegian Sea. Equipment has been deployed to the pilot stations in Sandnessjøen and Lødingen and the SAR (search and rescue) stations in Rørvik and Bodø. Contracts have been signed with owners to make three vessels available for response operations at each of the depots in Ålesund, Ørland, Sandnessjøen, Bodø and Lødingen. In order to be prepared for situations where a vessel needs to be brought to a port of refuge, the Norwegian Coastal Administration has evaluated possible sites along the coast in a dialogue with central, regional and local authorities.

The capacity of the intermunicipal acute pollution control committees to provide assistance during governmental oil spill response operations has been increased. The committees have been provided with governmental emergency response equipment and given training in the use of the equipment.

A national preparedness and response system has been developed to deal with chemical spills from ships. Operational preparedness is maintained through agreements between the Norwegian Coastal Administration and the RITS teams (maritime incident response groups) provided by the fire brigades in Oslo and Bergen, who have dedicated equipment and training in combating accidents involving hazardous substances.

The Coastal Administration's emergency response organisation has been strengthened, among other things by taking on response personnel at the regional offices in Central Norway and Nordland. The number of training courses and exercises has been substantially increased and a national curriculum has been developed for training in dealing with acute pollution.

Preparedness and response plans and the organisation of operations have been reviewed and updated, and a more unified command and organisation of response operations has been developed. The Norwegian Coastal Administration has conducted emergency preparedness analyses of worst-case scenarios, and developed a national plan for an emergency response system for acute pollution. In cooperation with the Norwegian Oil and Gas association and operating companies, plans have been developed for coordinated command in the event of major pollution incidents associated with petroleum activities (see section 5.3).

Thus the emergency preparedness and response system for acute pollution in the Norwegian Sea management plan area has been substantially strengthened since 2009, which has helped to reduce the level of environmental risk in the area.

5.2.4 Framework and management

Shipping is a global industry, and the conditions under which it operates are mainly established at the international level. Through international cooperation at the global, regional and bilateral levels, Norway seeks to achieve global requirements for the industry that are as uniform as possible, together with open markets, free trade and strict requirements for maritime safety, environmental protection and social standards. The United Nations Convention on the Law of the Sea provides the most important international legal framework for the regulation of maritime transport and marine waters. The regulations applicable to shipping are mainly established through international cooperation in IMO, the EU, ILO and the Paris Memorandum of Understanding on Port State Control.

Safety in Norwegian waters depends on binding international cooperation and an international system of rules.

In recent years, shipping has become subject to a stricter international regime, with rules limiting emissions to air and water. The stringent requirements governing discharges, together with a desire to reduce fuel consumption costs, are causing the industry to seek ways of making its operations more energy-efficient. International environmental standards adopted in IMO and the creation of a market for good environmental solutions are the most effective measures for ensuring environmental protection. Norway is a driving force in the development of a sound international framework for a climate-friendly and environmentally sound shipping industry.

Maritime transport is in general an energy-efficient alternative for freight transport. The Government has ambitious environmental objectives for the maritime industry. In its white paper *New emission commitment for Norway for 2030 – towards joint fulfilment with the EU* (Meld. St. 13 (2014–2015)), it identified environmentally sound shipping as a priority area of Norwegian climate policy.

New technology and new solutions for vessel operations, such as the use of greener fuels and energy-efficient vessels, are key factors in the reduction of emissions from shipping.

Maritim21 is an integrated maritime strategy for research, development and innovation, which was submitted to the Government in November 2016. It provides a set of recommendations on how to promote sustainable growth and value creation, improve the competitiveness of the maritime industry and realise the potential for synergy between ocean-based industries. The strategy has identified enabling technologies, smart solutions, digital transformation, promoting greener maritime activities and safety and security at sea as priority areas for the maritime industry.

In its National Transport Plan (2018–2029) the Government has set out its goals in this sector: reducing the costs of freight transport, exploiting the advantages of the different means of transport and transferring more freight from road to sea and rail.

5.3 The petroleum industry

Petroleum activity in the Norwegian Sea started in 1980. The first field to start producing in this area was Draugen, in 1993. A total of 2.0 billion standard cubic metres of oil equivalents (Sm^3 o.e.) has been proven in the Norwegian Sea, of which 1.1 billion Sm^3 o.e. has been sold and delivered. The remaining 0.9 billion Sm^3 o.e. consists of reserves and contingent resources in fields and discoveries. There has been some decline in total production from the Norwegian Sea in recent years, but the level is expected to remain relatively stable in the years ahead.

5.3.1 Petroleum activities and resources in the Norwegian Sea

At present the areas on the Halten bank and near the Ormen Lange field are considered mature, with large-scale oil and gas production and well-developed infrastructure. In 2015, total petroleum production in the Norwegian Sea amounted to 66 million Sm^3 o.e.

There are currently 16 oil and gas fields in production in the Norwegian Sea. The development concept for Draugen, Heidrun, Åsgard, Skarv and Norne uses platforms and FPSOs (floating production storage and offloading vessels). The remaining fields have subsea installations tied back to Åsgard (Morvin) and Norne (Alve, Marulk and Skuld) installations. The Njord and Hyme fields are currently not producing because the Njord A platform has been shut down for upgrading. The Aasta Hansteen, Maria, Dvalin and Trestakk fields are under development. An investment decision has been made with respect to the Bauge field, and there are plans for investment decisions concerning the Pil&Bue and Snadd discoveries in the course of 2017.

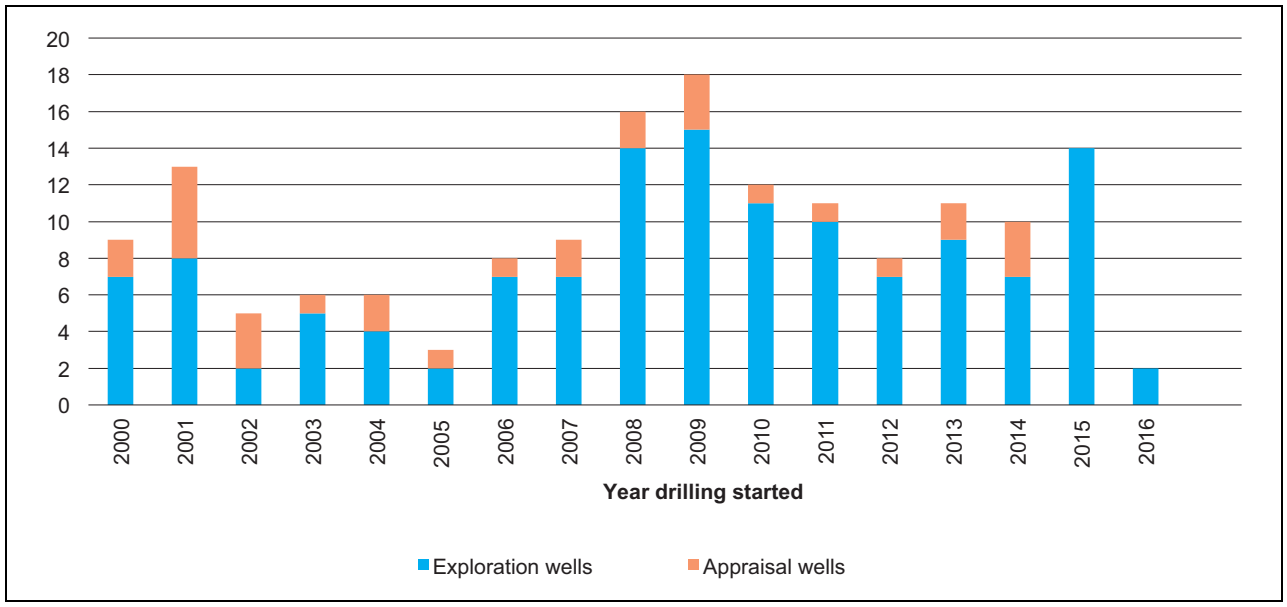

Figure 5.4 Number of exploration wells in the Norwegian Sea.

Source: Norwegian Petroleum Directorate

The gas pipeline Polarled was completed in 2015 and will link the Aasta Hansteen field to the Norwegian gas pipeline network. Gas from the Norwegian Sea is largely transported by pipeline to various onshore facilities in Norway and onwards to the UK and continental Europe. The oil is loaded directly onto tankers (buoy-loading) and transported to the markets.

From 2008 to 2016, 106 seismic surveys were conducted in the Norwegian Sea, 75 of which were 3D seismic surveys, together with a further 55 electromagnetic surveys. Few surveys were conducted in 2015 and 2016.

Since 2008, 89 completed exploration wells have been drilled, resulting in 51 discoveries.

The greatest activity in the Norwegian Sea has been on the Halten and Dønn Terraces off Sør-Trøndelag, Nord-Trøndelag and Nordland, and most of the discoveries and almost all the developed fields are to be found in this area. This is the most mature area, but is nevertheless the area where a large proportion of the remaining undiscovered resources in the Norwegian Sea are expected to lie.

Parts of the deep-water areas in the western Norwegian Sea are still considered to be frontier areas, where large finds could still be made. Exploration drilling has resulted in a number of finds, but the volumes are smaller than expected and consist mostly of gas resources. In the west, near the Atlantic Margin, obtaining good seismic data from below the basalt layers poses special problems. There has been little exploration in these areas, and resource estimates are therefore very uncertain.

So far, the only developed deep-water field is Ormen Lange. The Aasta Hansteen field in the north of the Norwegian Sea is under development and is expected to come on stream in 2018. A number of smaller gas discoveries have been made in the Vøring Basin in the last few years, which are important additional resources for the Aasta Hansteen field.

Small to medium-sized oil or gas discoveries can be expected on the Halten and Dønn Terraces, and isolated large finds are also possible. Large gas discoveries may still be made in the Møre and Vøring Basins.

Undiscovered resources in the Norwegian Sea are estimated at almost 0.8 billion Sm^3 o.e. (expected value).

The Norwegian Petroleum Directorate estimated total discovered and undiscovered resources on the Norwegian continental shelf at approximately 14.3 billion Sm^3 o.e. on 31 December 2016. 'Resources' is a collective term for all technically recoverable quantities of petroleum. The resource accounts include all resources on the Norwegian continental shelf, including those in areas that are not currently open for petroleum activities.

Data from seismic surveys and other geological data collected under the auspices of the Norwegian Petroleum Directorate have increased our knowledge of potential petroleum resources in the unopened parts of Nordland IV and V. In summer

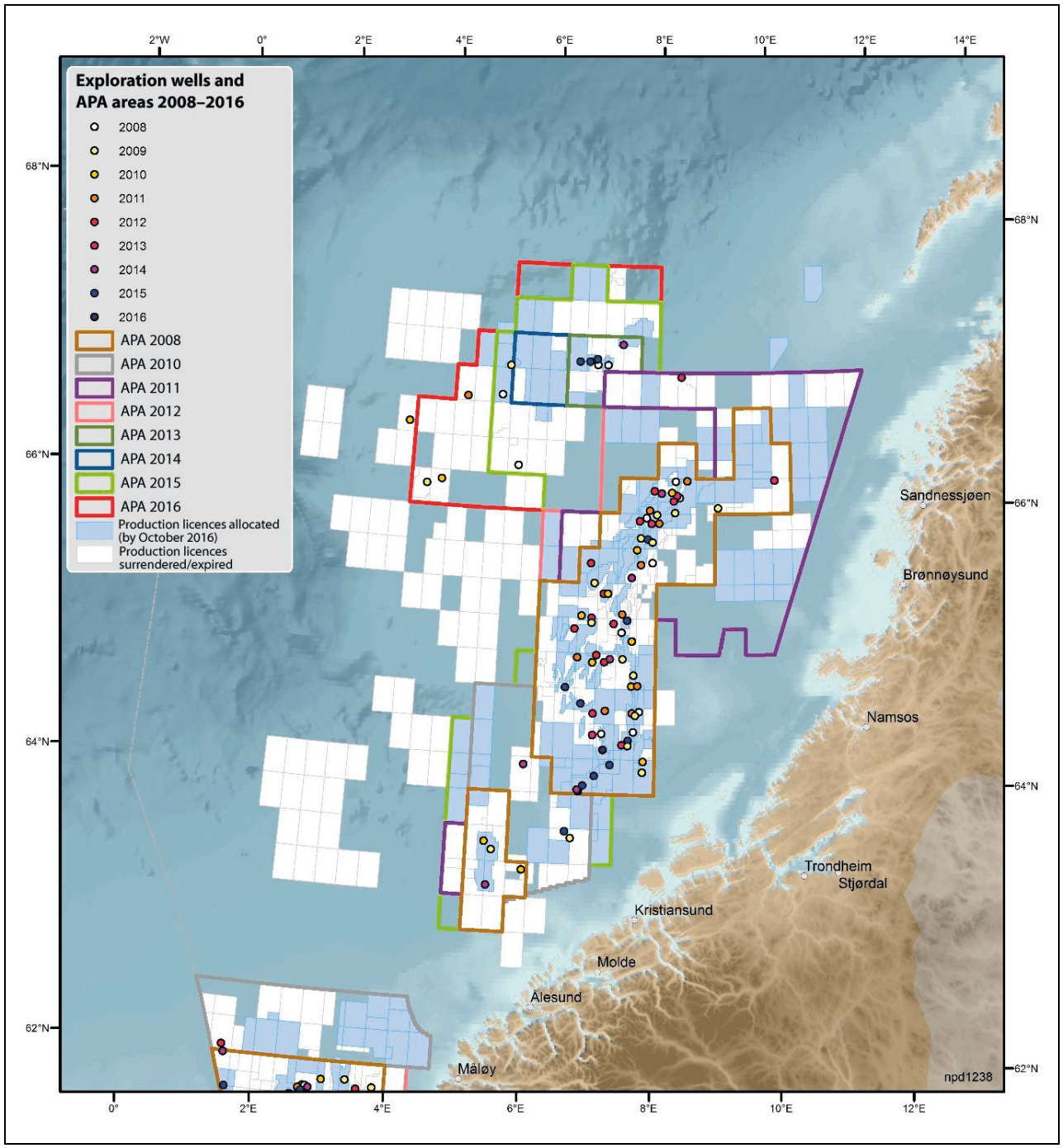

Figure 5.5 Exploration wells and awards in predefined areas (APA) in the Norwegian Sea.

Source: Norwegian Petroleum Directorate

2012, 2D seismic data were collected in the area through collaboration with the fishing industry and the fisheries authorities, and some older collections of data were reprocessed.

In the 2009 management plan, the Government then in power announced that it intended to initiate an opening process for the areas around Jan Mayen with a view to granting production licences. This was repeated in the white paper *An industry for the future – Norway's petroleum activities* (Meld. St. 38 (2010–2011)), together with more details on the opening process. As part of the process, the Petroleum Directorate conducted seismic surveys in the areas around Jan Mayen in 2011 and 2012. In 2013, the directorate published a resource evaluation based on the collected data, and so far there is no reason to revise this. Expected recoverable resources in this area are estimated at 90 million Sm^3 o.e., but the figure is

very uncertain. An impact assessment has been made for Jan Mayen under the Petroleum Act.

5.3.2 Commercial activity and value added

It is more than 50 years since petroleum activities were first started in Norway, and this is now the country's largest industry measured in terms of value added, state revenues, export value and investments. The petroleum sector includes oil companies, supply industries and petroleum-related research groups. In 2016 value added from the industry accounted for 12 % of GNP, and it generated over NOK 125 billion in net cash flow to the state. Petroleum activities also create a demand in associated and supporting industries, which often has positive regional spin-off effects. Most of the oil and gas produced on the Norwegian shelf is sold abroad and provides substantial export revenues. Oil and gas accounted for approximately 35 % of total exports in 2016.

The petroleum sector employs around 185 000 people in all parts of the country. In 2016, this accounted for about 7 % of total employment.

Petroleum activities involve major current and future investments that will provide substantial value added and high employment for many decades to come. In 2014, petroleum activities in the Norwegian Sea generated a total of NOK 219.6 billion in value added and direct employment for 42 200 people (see Table 5.7). When people who are indirectly involved in supplying goods and services to the oil and gas industry are included, the figure rises to about 67 500 people.

Established petroleum activities in the Norwegian Sea account for about one-third of all direct employment in the industry in Norway. A large proportion of these people work offshore, but the onshore facilities at Tjeldbergodden and Nyhamna, the main supply bases in Kristiansund and Sandnessjøen, and Statoil's bases in Stjørdal and Harstad provide a significant proportion of employment and spin-off activities on land as well. The supply industries deliver goods and services to the fields throughout their lifetimes. The largest proportion is supplied during the production stage, followed by the development phase, but the exploration phase also accounts for a significant proportion of deliveries, about 20 %. The large and stable domestic Norwegian market plays an important role in the further development of the world-class supply industries that have grown up in Norway.

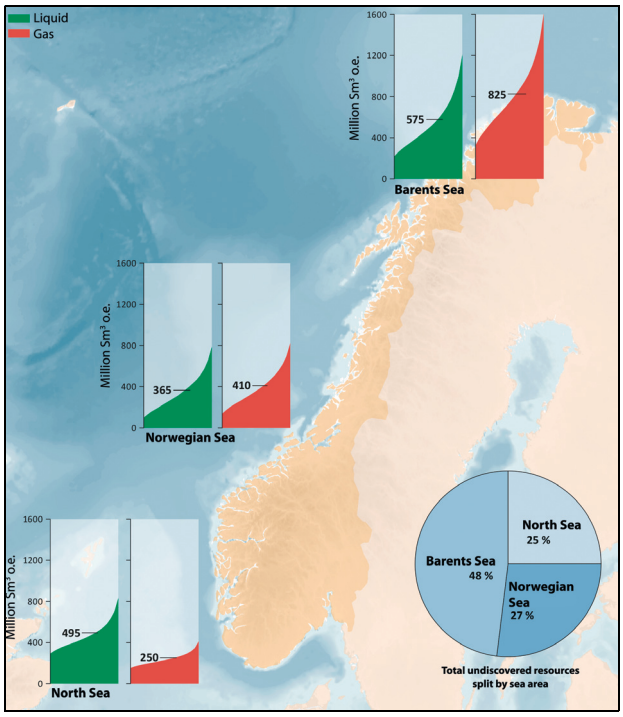

Figure 5.6 Resource estimates for the Norwegian part of the continental shelf.

Source: Norwegian Petroleum Directorate

Table 5.7 Direct value added and employment in petroleum activities in the Norwegian Sea in 2014

Industry	Value added 2014		Employment 2014	
	NOK billion	% of total in Norway	1000 persons	% of total in Norway
Production	174.6	31 %	9.5	30 %
Pipeline transport	1.2	7 %	< 0.04	-
Services	15.1	30 %	9.9	30 %
Supply industries	28.6	30 %	22.7	30 %
Total	219.6	30 %	42.2	30 %

Source: Statistics Norway

5.3.3 Pressures and impacts on the environment

Generally speaking, the petroleum industry can have negative impacts on the environment through operational discharges to the sea and air, acute releases of pollutants, underwater noise from seismic surveys and other pressures such as physical disturbance of the seabed.

Emissions to air

In 2007, projections suggested that emissions to air from petroleum activities would decline up to

Box 5.4 Regional spin-off effects of petroleum activities in Nordland

As licences are granted for blocks further and further north on the Norwegian continental shelf, the local and regional spin-off effects are becoming increasingly marked in North Norway. The white paper *An industry for the future – Norway's petroleum activities* (Meld. St. 28 (2010–2011)) set out the objective of promoting profitable production from new discoveries while at the same time ensuring opportunities for business and industry in North Norway to take part as competitive suppliers to the petroleum industry. BP Norge (now Aker BP) and Statoil have initiated and implemented a number of measures to promote regional ripple effects: large contracts have been split up so that small and medium-sized enterprises are able to compete.

The Skarv field, which is located 210 km west of Sandnessjøen and came on stream in 2012, has had significant spin-off effects in the Helgeland district of Nordland. The operator Aker BP has entered into contracts and options worth NOK 1 billion with local enterprises in the region. Businesses in Mo i Rana, Sandnessjøen and Bodø have supplied equipment to the fields that are on stream and to the Aasta Hansteen field, which is under development, and the gas pipeline Polarled, which will transport gas from Aasta Hansteen to Nyhamna in Møre og Romsdal. By the end of 2014 deliveries to Polarled from companies in North Norway were worth NOK 409 million, 95 % of which came from Helgeland.

The petroleum industry in the north is part of an international market. Low oil prices and the industry's focus on costs have meant that oil companies have delayed or cancelled a number of projects in recent years, and this strongly affects the supply industries in North Norway. As a result, key supply industries have had to lay off employees or downsize.

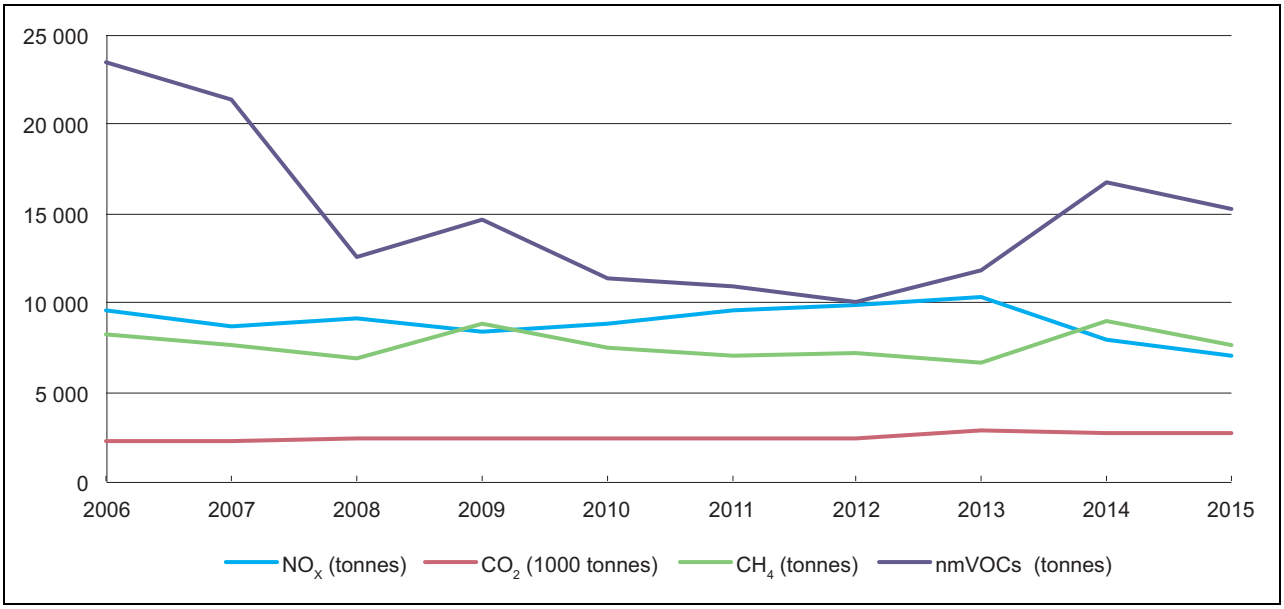

Figure 5.7 Trends in emissions to air from petroleum activities in the Norwegian Sea 2006–2015.

Source: Norwegian Environment Agency

Box 5.5 The zero-discharge targets

The zero-discharge targets for discharges of oil and environmentally hazardous substances to the sea were adopted in a *white paper on an environmental policy for sustainable development (Report No. 58 (1996–1997) to the Storting*). The targets and measures for achieving them were further specified in a number of later white papers and set out in full in the white paper *Management plan for the North Sea and Skagerrak* (Meld. St. 37 (2012–2013)).

Environmentally 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 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 chemicals (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 chemicals 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 for example that 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.

2025. However, the emission projections have since been adjusted, and up to 2025 emissions of both carbon dioxide (CO_2) and nitrogen oxides (NO_X) are expected to remain at about the same level as in 2011. This is because the producing lifetime of installations has been extended as fields continue to produce for longer than was estimated in 2007 and new resources are tied back to new and existing installations. Emissions of volatile organic compounds (methane and NMVOCs) are not very different from the 2007 projections. Figure 5.7 shows the trends in emissions.

The choice of energy supply is an important part of field development, and is evaluated by the authorities during the process of impact assessment and the subsequent review of the plan for development and operation. Whenever proposals are made for new field developments on the Norwegian shelf, the operator must submit an overview of energy needs and an assessment of the costs of using power from shore rather than gas turbines to supply electricity. This ensures that the option of using power from shore is chosen where appropriate.

The largest proportion of applies to most greenhouse gas emissions from petroleum activities are covered by the emissions trading system. Oil and gas companies operating on the Norwegian shelf are subject to other climate-related policy instruments in addition to emissions trading. During the last 25 years a high carbon tax has been levied on a large proportion of emissions. The tax rate is about NOK 500 per tonne CO_2, which gives companies a strong incentive to limit their emissions. Flaring (burning of gas) on the Norwegian shelf is only permitted for safety reasons.

Operational discharges of oil and chemicals to the sea

Norway's goal is for discharges of the most hazardous added chemicals to be eliminated and that discharges of naturally occurring environmentally hazardous substances that are also priority substances should be eliminated or minimised. For oil and other substances, the target is zero discharges or minimal discharges of substances that may cause environmental damage (see Box 5.5 on the zero-discharge targets).

Releases of oil with produced water have increased since 2006, because water production from fields rises as they age and because there has been a small increase in oil concentrations in produced water (see Figure 5.8). The oil content in produced water must be kept as low as possible and may not exceed the OSPAR performance standard of 30 mg/l. In 2015 the average oil content of produced water from the fields in the Norwegian Sea was 13.6 mg/l, but some installations have not managed to keep within the performance standard. The volume of produced water reinjected has also been larger than projected in 2008. The Skarv field came on stream later than expected, which meant that it began discharging produced water at a later date. These factors mean that discharges of produced water have not increased as much as was projected in 2008. Fresh projections indicate that discharges of produced water will drop to about two-thirds of the 2011 level by 2025.

The total quantities of the most hazardous added chemicals (black- and red-category) discharged on the Norwegian continental shelf declined steeply up to 2007 and have remained low. The conclusion in the scientific basis for this management plan is that the target for the quantities of the most hazardous added chemicals discharged in connection with petroleum activities has been achieved for the entire Norwegian shelf, including the Norwegian Sea. However, in the last couple of years an increase in discharges of substances in the most hazardous added chemicals has been reported. The apparent increase in black-category substances is mainly because firefighting foam containing perfluorinated substances has been included in the reporting system since 2012. Operators are in the process of changing to foam that contains less hazardous chemicals. The increase in red-category substances is mainly due to changes in classification (from yellow- to red-category), and does not reflect a real increase in discharges. Trends in discharges of the different categories of hazardous added chemicals are shown in Figure 5.9.

For safety and technical reasons it will still be necessary to use a certain quantity of these substances, and there will continue to be some discharges to the sea in the years ahead. However, the latest figures show that efforts to reach the zero-discharge targets are still important.

Discharges of produced water also contain naturally occurring radioactive substances. At present the only way to reduce the discharges is to reinject produced water.

Physical impacts

Petroleum activity can put pressure on vulnerable benthic fauna such as corals and sponges, for example through deposition of drill cuttings. Cor-

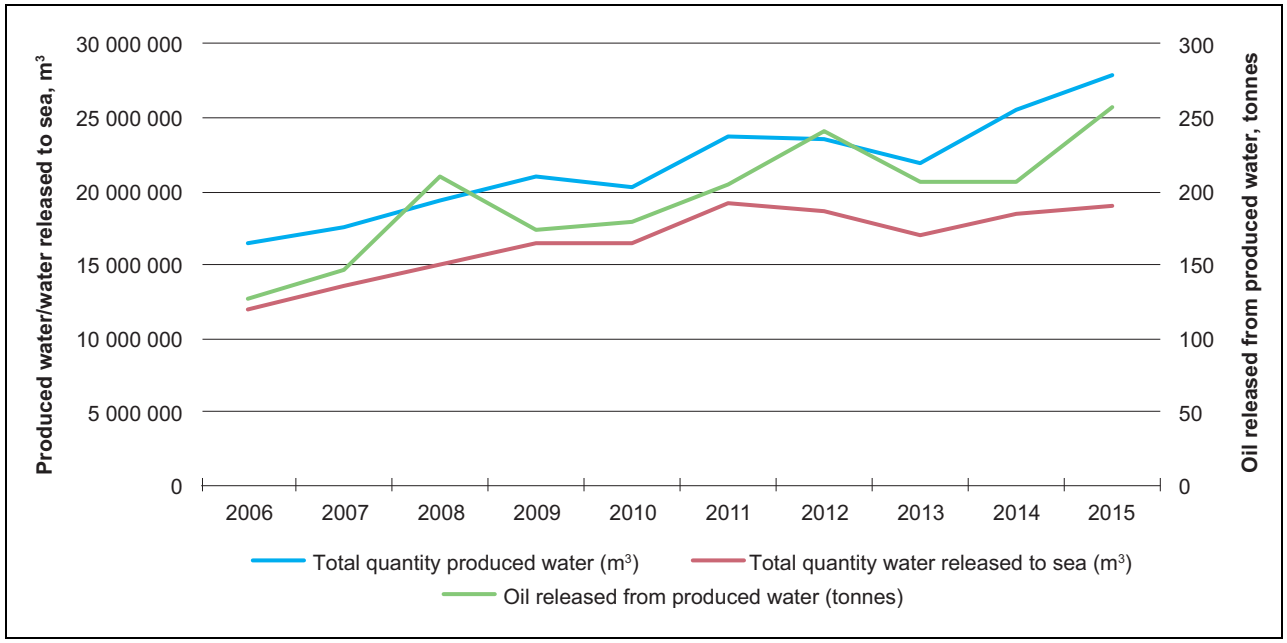

Figure 5.8 Releases of oil with produced water from fields in the Norwegian Sea, 2006–2015.

Source: Norwegian Environment Agency

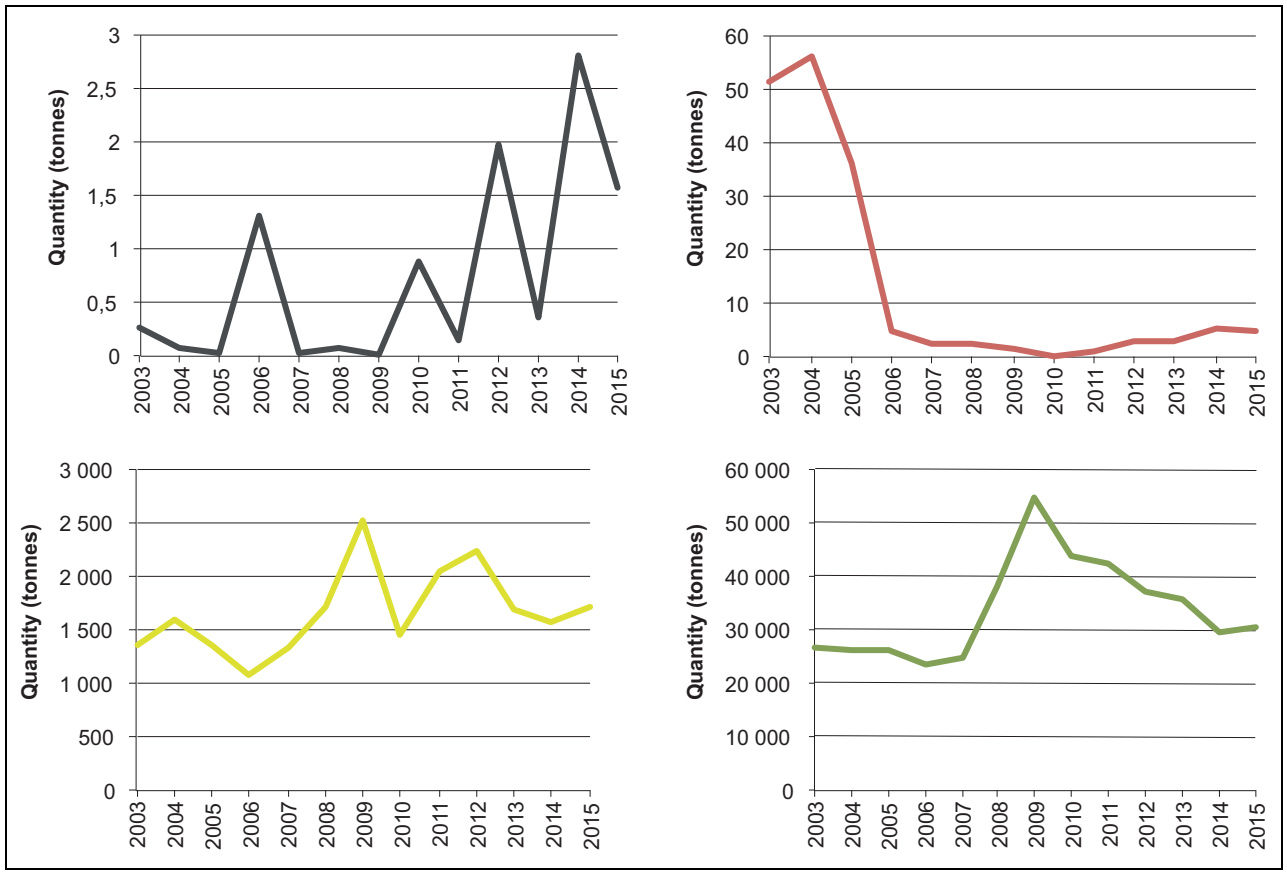

Figure 5.9 Trends in discharges of added chemicals in the Norwegian Sea (black, red, yellow and green categories).

Source: Norwegian Environment Agency

Table 5.8 Historical discharges of drill cuttings containing water-based mud from fields in the Norwegian Sea

Year	2008	2009	2010	2011	2012	2013	2014	2015
Total (tonnes)	10 719	16 910	60 885	49 852	15 980	17 796	11 146	25 100

Source: Norwegian Environment Agency

als and other benthic fauna can also be damaged when pipes and cables are laid and anchor chains and other installations are placed on the seabed.

Total discharges of drill cuttings containing water-based mud in the Norwegian Sea have increased since the previous management plan was published, and reached a peak in 2010–2011 during drilling in the Ormen Lange and Skarv fields.

Environmental monitoring shows that the total contaminated area around petroleum installations in the Norwegian Sea has decreased from 80 km^2 in 2006 to around 44 km^2 in 2015, and that in recent years the average area where there are impacts on benthic fauna around each installation has decreased from 0.7 km^2 to around 0.4 km^2 in 2015.

Operators are required to survey any coral reefs and other valuable benthic communities that may be affected by petroleum activities and ensure that they are not damaged. In areas with important coral reefs, special conditions apply that reduce or eliminate discharges that could damage the reefs. In 2015 coral reef surveys were included in the environmental monitoring programme around relevant installations in the Norwegian Sea.

Since the previous management plan was presented, environmental monitoring by operators has increased our knowledge about coral reefs in the Norwegian Sea, including their vulnerability and current status and the impact of petroleum activities. There are a large number of coral reefs and habitats on the continental shelf in the Norwegian Sea, and corals have been recorded in the Eggakanten area. There has been some exploration drilling in coral reef areas where fishing with bottom gear is prohibited, and in these cases special conditions have been imposed to avoid damage.

Reports from the operators' monitoring programmes after drilling conclude that there has been only limited sediment deposition on corals and no visible damage to corals or other vulnerable benthic animals.

Some damage to corals by anchor chains during the towing of rigs has been reported.

No damage to corals and sponges from discharges of drill cuttings has so far been documented. Since the 2009 management plan was published, a number of research projects have been started to investigate the effects of such discharges on coral reefs and sponge communities. One project has shown indications that the coral *Lophelia pertusa* has limited capacity to sediment as a result of discharges of drill cuttings, but other studies show that *L. pertusa* is rather tolerant of deposition of drill cuttings and that it is only killed by large quantities of drilling waste.

To make it possible to draw clearer conclusions about the impacts of petroleum activities on corals and sponge communities, assessments of long-term effects on these species are needed.

Seismic surveys

Seismic surveys are conducted to assess the potential for petroleum deposits, and are an important aid to good decision-making in the exploration and the production phases. Geological surveys of the seabed involve the use of sound pulses generated by airgun arrays. It is these noise pulses in the form of sound waves or oscillations of particles in the water that can have negative impacts on the marine environment. The sound is within the range of frequencies that are audible to fish and marine mammals.

Since 2008, 106 seismic surveys have been conducted in the Norwegian Sea, which is about the same level of activity as that prior to 2008, but the surveyed areas are not always the same. Few surveys have been made in recent years, apart from a more comprehensive survey of nearcoast areas along the southern part of Nordland. The environmental impacts of underwater noise are discussed in Chapter 3.3.5.

Risk of oil spills in connection with petroleum activities

Since the 2009 management plan was presented, the Petroleum Safety Authority Norway has included risk data concerning acute pollution in its annual reports on trends in risk level (also known as RNNP reports). Some key findings from the 2001–2015 reports are described below.

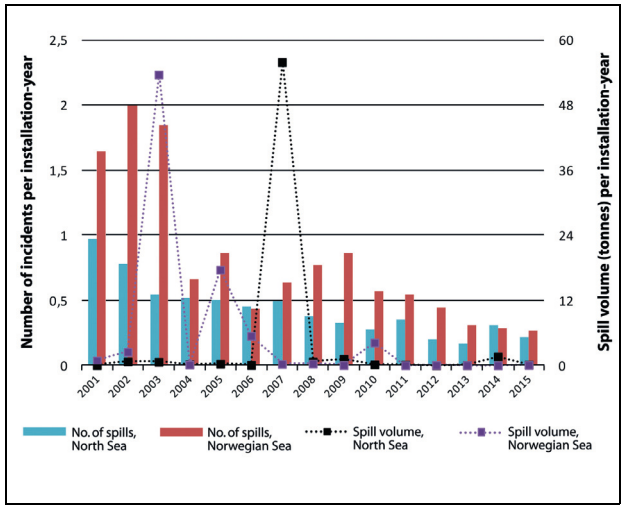

Figure 5.10 Annual numbers of crude oil spills and total spill volumes from petroleum activities in the Norwegian Sea and the North Sea in the period 2001–2015.

Source: Petroleum Safety Authority Norway (RNNP-AU)

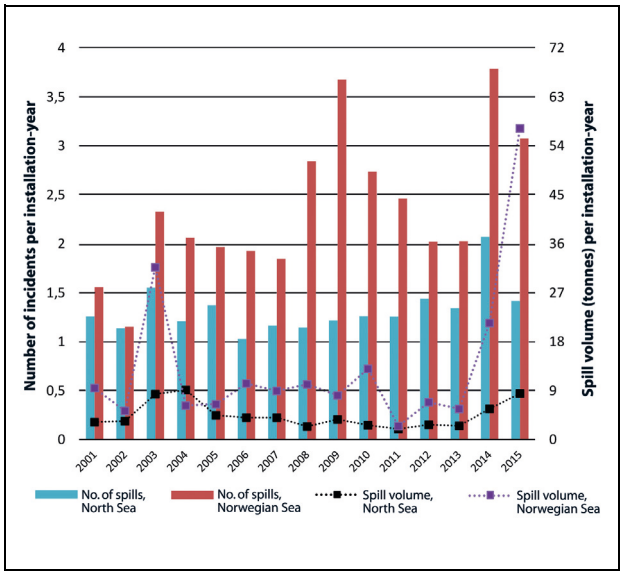

Figure 5.11 Annual numbers of chemical spills and total spill volumes from petroleum activities in the Norwegian Sea in the period 2001–2015.

Source: Petroleum Safety Authority Norway (RNNP-AU)

There has been a decline in the number of *crude oil* spills and near misses that could have resulted in acute pollution if more barriers had failed. None of the spills have been larger than 4 400 m^3. Figure 5.10 shows the number of crude oil spills and total spill volumes in the Norwegian Sea for the period 2001–2015.

Although the number of crude oil spills has dropped, there has been no similar trend in the annual spill volume. Well control incidents and damage to risers, pipelines and subsea production facilities are considered to pose the greatest risk of a crude oil spill. However, the number of such incidents has remained relatively stable during the period for both the Norwegian continental shelf as a whole and the Norwegian Sea in particular.

Chemical spills are undoubtedly the dominant type of spill on the Norwegian shelf, and account for 80 % of all spills with a volume of more than 1 m^3. The number of incidents and the total volume involved have remained relatively stable over time (see Figure 5.11). There have also been several leaks from injection wells. The increase in the *number* of chemical incidents in 2014 and 2015 can be explained by the clarification of the reporting rules and subsequent changes in procedures. The increase in annual *volume* is due to a number of large chemical spills, and not to the changes in reporting.

Petroleum activities in the Norwegian Sea involve the extensive use of subsea technology and a large number of subsea installations. The figures for the years 2006–2015 show that the number of releases from subsea installations on the Norwegian shelf has been relatively stable.

The results reported in RNNP-AU do not show any improvement in the barriers against acute pollution. More attention needs to be paid to barriers that prevent, signal and contain or stop acute pollution. Priority should be given to technology for the detection of leaks at source and barriers that prevent minor leaks from continuing and resulting in large releases over time.

Accidents have taught us that historical accident trends do not provide enough information to assess the risk of an accident occurring in the future. Assessments of the risk of acute pollution in the Norwegian Sea up to 2025 must also take into consideration other information on petroleum activities on the Norwegian shelf in general and in the Norwegian Sea in particular.

One factor that is likely to influence risk level is that existing surface and subsea installations and infrastructure are ageing, which may affect technical and operational integrity. By systematically collecting data on historical risk trends and factors influencing risk level, it is possible to identify signs of change and take steps to reduce the risk of incidents and accidents.

New analyses of environmental risks and consequences

Since the 2009 management plan was published, new analyses have been made of the environmental risks and consequences of petroleum activities in the Norwegian Sea. These include analyses of the extent and significance of losses of eggs and larvae in a particular year class of fish for future recruitment to the stock. The analyses provide more information on the possible spread of oil and which areas, species and habitats would be affected or damaged by spills in the Norwegian Sea, including areas that have not previously been studied.

The analyses are based on the most recent data and updated models and methods for assessing the environmental consequences of a spill for fish and seabirds. They also give a better picture of current patterns in the Norwegian Sea, particularly in the coastal zone. Current, higher quality data indicate that the Norwegian coastal current has a greater effect than previously believed, and simulations indicate greater spread of oil spills (larger impact areas on the surface), especially in a northerly direction, than has been found in earlier studies.

The analyses show that the probability of a large spill from petroleum activities is generally low, but there is a considerable increase in the potential for serious environmental consequences, especially for coastal seabirds during spring and summer and for seabirds in the open sea. Modelling indicates that the level of risk for fish is generally lower than that for seabirds. For fish, only the largest modelled spills, at certain times of year, are associated with a risk of serious consequences.

Restrictions on when drilling is permitted can considerably reduce the environmental risk associated with exploration drilling. By the time production drilling starts, there is much more information about reservoir conditions and types of oil, and the probability of a blowout is lower than during exploration drilling. A gas blowout is primarily associated with a risk of fire or explosion. Oil spill response measures can reduce the consequences of a spill. There is always a possibility of oil spills and discharges of chemicals during oil production or drilling in oil-bearing formations. It is therefore vital that the industry maintains high safety standards and continues its efforts to reduce the risk of spills.

Preventive safety measures

The best way of preventing incidents that may result in acute pollution is to ensure that all actors in the petroleum industry have the necessary expertise and are accountable for the risks their activities involve.

Since the 2009 management plan was presented, work has continued on maintaining a low level of risk of damage to the environment and living marine resources in the Norwegian Sea resulting from acute pollution. Continual efforts are being made to reduce the risk level even further.

During the same period a number of major accidents have occurred abroad, and serious incidents have taken place in Norway. Reducing the risk of major accidents in the Norwegian petroleum industry has been a high priority for the government, the oil companies and research groups. A series of projects have been initiated to gain more knowledge and understanding and develop effective ways to lower the risk level.

The major accident involving Deepwater Horizon in the Gulf of Mexico in 2010 underlined the need for further developments in critical areas like risk management, barrier management, safety culture, organisation and leadership, as well as blowout preventers and capping and containment.

Well safety is critical to the prevention of acute pollution, and the legislation has been made stricter and more specific in several areas. These include requirements for drilling relief wells, capping equipment for subsea wells, and more rapid plugging and permanent abandonment of temporarily abandoned wells.

The Petroleum Safety Authority's system for monitoring trends in risk level has been further developed, and since 2010 the authority has published annual reports specifically dealing with the risk of acute pollution from petroleum activities. This provides a good basis for a more integrated assessment of the risk of accidents and for developing more effective preventive measures against acute pollution.

Since the 2009 management plan was published, the Petroleum Safety Authority has worked continuously on the further development of methods for assessing the risk of accidents and the risk of oil and chemical spills to the sea for specific areas. The Deepwater Horizon accident has provided valuable lessons in this field as well. During this work, attention has been focused on the authorities' need to understand how factors related to specific areas and activities can affect

the risk of accidents and which information is relevant to risk management.

Oil companies' emergency preparedness and response for acute pollution

Private companies are responsible for emergency planning and for taking action if hazardous situations or incidents occur in connection with their own activities. The Norwegian Coastal Administration is the government's supervisory body responsible for overseeing the adequacy of the operators' systems, and can also provide assistance. If necessary the authorities can require a polluter to take action against pollution, and under certain circumstances may even assume, partly or wholly, on-scene command. The governmental preparedness and response system is described earlier in this chapter. The Government and the petroleum industry have concluded an agreement on the use of governmental emergency response resources during a response operation for which an operating company is responsible. Together with the Norwegian Oil and Gas Association and the operating companies, the Norwegian Coastal Administration has drawn up principles for cooperation in situations when the government assumes on-scene command of an operation. The petroleum industry has also taken steps to make more qualified personnel available to participate in operations to deal with acute pollution in coastal waters and along the shoreline.

There have been further developments in response technology since the 2009 management plan was presented. An example of this is the technology development programme Oil Spill Response 2015, initiated by the Norwegian Clean Seas Association for Operating Companies (NOFO) and the Coastal Administration. The programme is intended to encourage the industry in Norway and internationally to present new ideas and proposals for developing commercially available products that will enhance the effectiveness of oil spill response operations in Norwegian waters along the coast and in beach areas.

Since the Deepwater Horizon accident in the Gulf of Mexico, more advanced equipment for well capping and subsea oil dispersion has been developed through a cooperation project involving operating companies in Norway and abroad. One such system has been deployed in Norway and is available to Norwegian operators by agreement.

The petroleum industry has strengthened its preparedness and response for acute pollution in the Norwegian Sea, and has for example concluded agreements on the use of 30 vessels in coastal oil spill response operations from Nordland to Rogaland. New equipment for detecting and mapping acute pollution has been introduced, including new radar systems.

The rapid response vessel *Stril Poseidon* on the Halten bank serves as the first-line response for all producing fields in the Norwegian Sea apart from the Norne field. The vessel is robust, has a high standard of performance and can be rapidly deployed. A new vessel-based dispersant application system has been developed.

5.3.4 Framework and management

Petroleum activities may take place in areas opened by the Storting (Norwegian parliament) under the conditions set out in the marine management plans, and are subject to strict requirements as regards health, safety and the working environment and as regards safeguarding the natural environment. It is also considered important to facilitate coexistence with other industries.

Acreage for petroleum activities is allocated through two equally important types of licensing rounds. New acreage in frontier areas is allocated in numbered licensing rounds, which are normally held every other year. In more mature areas, where more is known about the geology and that are closer to planned or existing production and transport infrastructure, licences are issued every year through the system of awards in predefined areas (APA). The licensing process involves a number of steps. Numbered licensing rounds are opened by inviting companies to nominate blocks. The authorities assess the nominations, and a proposed announcement is submitted for public consultation. After this, the Ministry of Petroleum and Energy announces the round. After the applications have been processed and after negotiations with the companies on licensing conditions, the government makes the final decision on which areas are to be covered by production licences and the mandatory work programme for each licence.

If necessary, the authorities may lay down conditions for or restrictions on activities in a specific geographical area. These are indicated when a licensing round is announced and are specified in the production licences. Restrictions on the times of year when seismic surveys or drilling in oil-bearing formations are permitted are spatial management tools that are used to regulate the petroleum industry. The purpose of such restrictions is to avoid the risk of environmental damage at

times when natural resources are particularly vulnerable, for example during spawning or spawning migration and during the breeding season for seabirds.

Production licences also include general requirements for licensees to carry out necessary survey of any coral reefs or other valuable benthic communities, including sandeel habitats, that may be affected by petroleum activities in the blocks concerned, in order to prevent sediment deposition and physical damage. Requirements concerning surveys of benthic communities are also included in the health, safety and working environment legislation.

Approval from the authorities is required for all phases of activity, including exploration, development, operations and decommissioning. This also includes licences under the Pollution Control Act and consent under the health, safety and working environment legislation. The legislation is designed in such a way that the requirements are stricter when activities are taking place in areas with particularly serious safety and environmental challenges.

The Government's ambition is for the Norwegian petroleum industry to be world-leading in the area of health, safety and working environment. A white paper that will include a broad review of status in this area in the petroleum industry and an assessment of supervisory activity, together with the necessary legislation, is under way and is to be presented to the Storting in winter 2018.

5.4 Tourism

The tourism industry makes an important contribution to the Norwegian economy. Tourism in Norway has considerable potential for growth, due among other things to new trends in international tourism. The industry is classified according to activity, but this applies to the customers' activities, not those of the enterprise. Many customers are demanding packaged products that offer accommodation, transport and food and beverage services as well as recreational activities.

In 2014, tourism in the municipalities along the Norwegian Sea coast generated NOK 2.98 billion in value added and employment for 7230 people, not including wider spin-off effects.

Foreign tourists are still drawn to Norway primarily by the scenery and natural surroundings. The country's long coastline offers a large variety of landscapes and activities, and viable coastal communities and the spectacular scenery provide a basis for value creation in the industry and associated activities. Tourists are attracted to these areas by the opportunities they offer for enjoying the outdoors, fishing, eating fresh seafood and observing marine mammals and seabirds. The development of attractive tourism products creates interesting jobs and strengthens coastal communities.

Fishing tourism

Fishing tourism in Norway has increased over the last few years. In 2007 Innovation Norway launched a campaign promoting coastal and deep-sea fishing that targeted specific markets. Recreational fishing results in a substantial harvest of coastal species.

Sea fishing is popular among tourists, and over the last 20 years a large number of tourist enterprises have grown up along the coast that cater to recreational fishermen. They range from larger companies that provide services, including traditional accommodation, well-equipped fishing boats and guiding and training in gutting and cleaning fish, to individuals who rent out their own boats and houses or cabins to tourists. These enterprises raise the level of activity and employment in many local communities.

There is little regulation of recreational marine fishing and fishing tourism in Norway. Norway's policy is liberal compared with that of other countries, since there are no quotas or fees. However, foreign tourists are only permitted to fish using a rod and handline.

Everyone who harvests Norway's common resources shares the responsibility for ensuring that the harvest is sustainable. Sound management of fisheries resources benefits the tourism industry, since healthy fish stocks are essential for all value creation based on these resources. The scale of recreational fishing organised by tourism companies is not known, but this is a rapidly expanding activity. In addition there are a considerable number of individual tourists who have no contact with commercial companies, such as people who travel in campervans and stop to fish.

The Government is therefore introducing new arrangements for fishing tourism that are intended to maintain value creation in the tourist industry and keep sea fisheries resources at sustainable levels. Legislative amendments and new regulations relating to fishing tourism companies have been drafted and were submitted to public consultation in autumn 2016. The proposals include an increase in the quantities of fish and

fish products that may be taken out of the country by tourists who have been fishing through registered fishing tourism operators. This increase is intended to encourage as many commercial operators as possible to register as fishing tourism enterprises and as many tourists as possible to fish through a registered enterprise. Registration will also provide more information on operators in this sector and make it easier to spread information that can improve safety at sea.

All in all, the tourism fishing industry is expected to become more professional and have greater legitimacy, since it will have a clearer responsibility to promote sustainable resource management.

Cruise traffic

The global cruise industry has increased significantly in volume since the turn of the century, from around 7 million passengers in 2000 to over 22 million in 2015. Norway's share of the global market in 2015 was 2.2 %, or 511 000 passengers, which was 29 % higher than in 2009. In 2016 a total of 1809 calls were made at Norwegian ports.

In addition to being an important sector in itself, the cruise industry makes other substantial contributions to tourism. For many tourists it serves as a gateway to Norway. According to Innovation Norway, almost 2.7 million day-trippers from cruise ships landed at Norwegian ports in 2016, and the prognosis for 2017 puts the figure at around 3 million. Statistics Norway's investigation Cruise 2014 showed that total consumption by cruise tourists in Norway was NOK 12 billion, around 2.3 billion of which was estimated to accrue to Norwegian businesses.

Section 5.2.3 describes the pressures and impacts associated with maritime transport. Discharges to fjords from cruise traffic are outside the scope of Norway's marine management plans.

5.5 Emerging industries in the Norwegian Sea

5.5.1 Fishing for new species

There is a growing interest in commercial harvesting of mesopelagic fish species, which are organisms that live in the water column at depths of about 200 to 1000 metres. A number of these species have a potential as feed for farmed fish or ingredients in food and other substances. Much more knowledge is needed about these species and their commercial potential.

5.5.2 Harvesting at low trophic levels: the copepod *Calanus finmarchicus*

The copepod *C. finmarchicus* is a zooplankton species at a low trophic level. It is the most important prey species for Norway's large pelagic fish stocks (herring and mackerel), and a key species in the Norwegian Sea ecosystem. It is a relatively large marine resource in Norwegian waters, with an estimated biomass of 33 million tonnes. Each year since 2003 the species has been harvested under an experimental licence, which restricts the catch quantity, duration of the open season and number of actors involved.

A great deal of experience has been gained from the harvesting and use of *C. finmarchicus* since 2003. The stock in Norwegian waters is considered to be viable and biologically in good or average condition. After the long period of experimental harvesting it is now considered necessary to determine a framework for commercial catches of the species in Norwegian sea areas, and the authorities are developing a management plan for the stock. It will be based on long-term ecosystem-based management in line with the precautionary principle and other obligations under the Marine Resources Act.

The Directorate of Fisheries recommends that limited catches of *C. finmarchicus* should be permitted in Norway's exclusive economic zone north of 62 °N and west of 24 °E, and in the fisheries zone around Jan Mayen outside 12 nautical miles. The directorate proposes a total catch of 165 000 tonnes using a similar model to that used for quota recommendations for krill in the area of the Antarctic managed by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). The authorities have also based their recommendations on the status of *C. finmarchicus* as a key species in the ecosystem.

5.5.3 New forms of aquaculture and kelp cultivation

The predominant species in Norwegian aquaculture are salmon and rainbow trout, which make up 99.7 % of all aquaculture production. The remainder consists mainly of shellfish, halibut and Arctic char. However, aquaculture trials of other species are being conducted. Cod farming increased during the 2000s, but after a while significant problems arose in connection with production and markets.

New aquaculture concepts are being developed that could lead to new areas becoming avail-

able for fish farming. They include offshore installations, semi-contained systems in sheltered areas in fjords, and land-based systems. Although there are no offshore salmon farms at present, several actors are in the process of developing concepts for offshore farming. If they are successful, offshore aquaculture has a large potential.

There is also a growing interest in the farming of macroalgae (seaweed and kelp), which can be used in the production of food, feed and energy. The growing exploitation of these species has resulted in a need for more knowledge, for example relating to food safety. By 1 October 2016 the Ministry of Trade, Industry and Fisheries had awarded 35 licences to 20 different companies for the farming of macroalgae.

5.5.4 Utilisation of residual raw materials

According to a 2014 SINTEF study, the fisheries and aquaculture industry utilises 76 % of the approximately 890 000 tonnes of residual raw materials it produces. However, while much of the residual raw material from aquaculture and the pelagic sector is utilised, there are large untapped resources in the whitefish sector and to some extent in the shellfish sector. The pelagic sector could supply even greater quantities of residual raw materials if the fish are sold filleted and not whole, which they often are at present.

Residual raw materials from fisheries and aquaculture are utilised mainly for feed (around 78 %), human consumption (around 13 %) and bioenergy (around 8 %). The Ministry of Trade, Industry and Fisheries is drafting a strategy to promote the profitable use of residual raw materials.

5.5.5 Wind power and other offshore renewable energy production

Offshore wind power production shows strong growth internationally, especially in Norway's neighbouring sea areas. According to the association WindEurope, over 3000 MW in new offshore wind capacity came online in European waters in 2015, bringing total capacity in Europe up to 11 000 MW by the end of that year. The only country outside Europe with any significant wind power capacity (around 1000 MW) is China. Most of this has been developed over the last 10 years and the pace of new development is increasing.

It is unrealistic to expect major developments in offshore wind power in Norway in the near future, but Norwegian companies are actively involved in wind power projects in other countries.

The development of offshore wind farms is considerably more costly and technically more complex than onshore development, although the limited availability of suitable onshore sites is expected to result in increasing offshore development. The technical and cost-related problems can to some extent be compensated for by better wind conditions offshore, and the fact that larger wind turbines can be built than is possible onshore.

At present existing and planned offshore wind farms are mainly based on fixed installations in shallow water, i.e. with a typical depth of up to 40 metres. Wind power can be exploited to a much greater extent if turbines are built in deeper water, for example using floating technology. Floating wind power is still under development, and Statoil's offshore floating wind farm Hywind Scotland will be the first of its kind in the world.

In 2010 a working group led by the Norwegian Water Resources and Energy Directorate identified 15 areas it considers suitable for offshore wind power, which have a potential annual energy production of 18–44 TWh. The areas Oldervеggen, Stadthavet, Frøyabanken, Nordøyan–Ytre Vikna, Træna West and Trænafjorden–Selvær lie within or just outside the management plan area (see Chapter 6.1.6, Figure 6.4).

Under the 2010 Offshore Energy Act, offshore renewable energy production outside the baselines may as a general rule only be established after the public authorities have opened specific geographical areas for licence applications.

In 2012 the Water Resources and Energy Directorate conducted a strategic impact assessment of the 15 areas identified by the working group. This ranked the areas according to suitability, and recommended giving priority to five of them. The Government intends to clarify which areas should be opened for licence applications.

Demonstration projects in Norwegian sea areas would enable Norwegian companies to gain experience and contribute to innovation and development in the offshore wind power sector.

The Offshore Energy Act provides for the award of licences for smaller demonstration projects for offshore wind power or wind power integrated with offshore petroleum installations without the area having been opened beforehand. Technology development projects for wind power integrated with petroleum developments may have considerable potential in the future.

Norway has little practical experience of offshore wind power, but neighbouring countries around the North Sea have an extensive portfolio of ongoing projects. If Norway decides to develop offshore wind power it will be necessary to learn from other countries' experience, including information on the environmental impacts, and the Norwegian authorities are in contact with relevant countries on offshore wind power development.

Wind turbines do not themselves produce emissions to air, and it is considered unlikely that there will be any operational discharges to the sea. Thus any releases of pollutants to air or the sea will occur during construction work and maintenance operations. In its strategic impact assessment, the Water Resources and Energy Directorate considered the possible effects of offshore wind power on seabirds, marine mammals and benthic communities. Offshore wind farms will inevitably have some local effects.

5.5.6 Seabed mining

At present there is no mineral extraction from the seabed in the Norwegian Sea or any other Norwegian sea areas. There may be mineral deposits in the Norwegian Sea, for example around Jan Mayen and northwards along the Mid-Atlantic Ridge (see Chapter 3.2). No deposits have been documented as yet.

There is expected to be growing interest in the commercial extraction of new types of minerals from the seabed in deeper-water areas. This means that legislation will be needed to provide a framework for sound resource management and safe and environmentally sound operations, and to facilitate coexistence with other activities. More knowledge is needed on the biology and geology of the areas and the impacts of mineral extraction on the environment before any mining can start. The Ministry of Petroleum and Energy will hold a public consultation on a new act in the near future.

5.5.7 Marine bioprospecting

Marine bioprospecting is a subspeciality of marine biotechnology that involves acquiring knowledge about the properties of marine organisms that can be used for commercial purposes. The Nature Diversity Act and the Marine Resources Act can both be used to regulate bioprospecting. It is important to provide a framework that allows research groups and the private sector to collect biological material from Norwegian environments and at the same time ensure that this is done within an environmentally sustainable framework.

In a commercial context, the purpose of marine bioprospecting is to find substances or genes that can be used as components of products or processes. Its many areas of application include medicine, the process industries, food, feed and biofuels.

Norway is responsible for managing large sea areas with high species biodiversity that have been little studied. Some species live in Arctic waters, where temperatures are low and salinity, light conditions and nutrient availability vary. Others live in oil reservoirs, under high pressure and at high temperatures. Some species in coastal waters and fjords are specially adapted to survive in areas that are species-rich and where pollution levels are high. This wide variety of species indicates that there are prospects of finding marine organisms with unique biochemical traits and containing substances that can be used for a wide range of different purposes.

6 Use of the Norwegian Sea and spatial management

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, making spatial planning in marine areas an important tool. A sound and sustainable spatial management regime must be based on knowledge of ecosystems and the impacts of different forms of use. In future, Norway's sea areas are expected to be more heavily used for value creation such as the production of seafood, offshore energy and mineral extraction, and fisheries, maritime traffic and petroleum activities will continue to be major ocean use sectors.

A comprehensive scientific basis has been compiled for each of the management plans for Norway's sea areas, and the management plans include a number of general decisions about spatial management. Digital mapping tools are extensively used in the plans to illustrate different types of use and protection of marine areas. A consolidated digital mapping tool is being developed that will simplify further work on the marine management plans and make it more effective, and be an asset in developing an integrated and well-coordinated marine management regime.

The North Sea–Skagerrak management plan (Meld. St. 37 (2012–2013)) identified the need for an integrated and easily accessible mapping tool for marine management, and served to initiate the development of such a tool.

Growing awareness of the vital role the oceans will play in food production and other forms of value creation in the future has highlighted the need for integrated, coordinated planning of spatial management and marine protection measures.

The main purpose of marine spatial planning is to ensure sound management of activities in sea areas under national jurisdiction while at the same time protecting marine ecosystems.

The Government's expert committee on green competitiveness has pointed out that growth in marine industries depends on finding solutions to any conflicts that may arise between different interests. The committee has emphasised that it will be necessary to build further on the marine management plans and the processes for developing them in cooperation between the public administration, the research sector and the business sector.

6.1 Spatial use of the Norwegian Sea

The 2009 management plan described the use of the Norwegian Sea by various sectors, especially petroleum activities, fisheries and maritime transport. The plan also discussed the potential use of areas for the development of renewable energy production, particularly offshore wind power, and pointed to the need to protect the particularly valuable and vulnerable areas.

Expansion of oil and gas activities, a high level of fishing activity and a certain increase in the volume of shipping are the main trends in ocean-based industries in the Norwegian Sea since 2009.

6.1.1 Particularly valuable and vulnerable areas in the Norwegian Sea

One important feature of Norway's marine management plans is the selection of particularly valuable and vulnerable areas. These are areas that on the basis of scientific assessments have been identified as being of great importance for biodiversity and biological production in the entire management plan area. The areas identified in the Norwegian Sea management plan area are as follows: the Remman archipelago, the Froan archipelago and Sula reef, the Møre, Halten and Sklinna banks, the Iverryggen reef, the Vestfjorden, Jan Mayen and the West Ice, the edge of the continental shelf, the Arctic front and the coastal zone. Knowledge about the seabed in the particularly valuable and vulnerable areas of the Norwegian Sea has been improved, and the value of these areas has been confirmed through the MAREANO programme. The goal of the management plan is to ensure that activities in the particularly valuable and vulnerable areas are conducted in such a way that their

ecological functioning and biodiversity are not threatened. The areas are described in more detail in Chapter 3.4. An integrated management regime includes both sustainable use of marine areas and protection of areas of high conservation value.

6.1.2 Spatial overlap between ocean-based industries

The further development of existing industries and the potential for the establishment of new ocean-based industries in the management plan area will increase the need for coordinated spatial management.

6.1.3 Fisheries

Overall, there has been little change in fisheries activity in the Norwegian Sea since the 2009 management plan was adopted. The greatest change has been in the mackerel fishery. As a result of a healthy mackerel stock and altered migration patterns and distribution, the Norwegian Sea mackerel fishery has expanded and there have been changes in the areas used by the fisheries. This

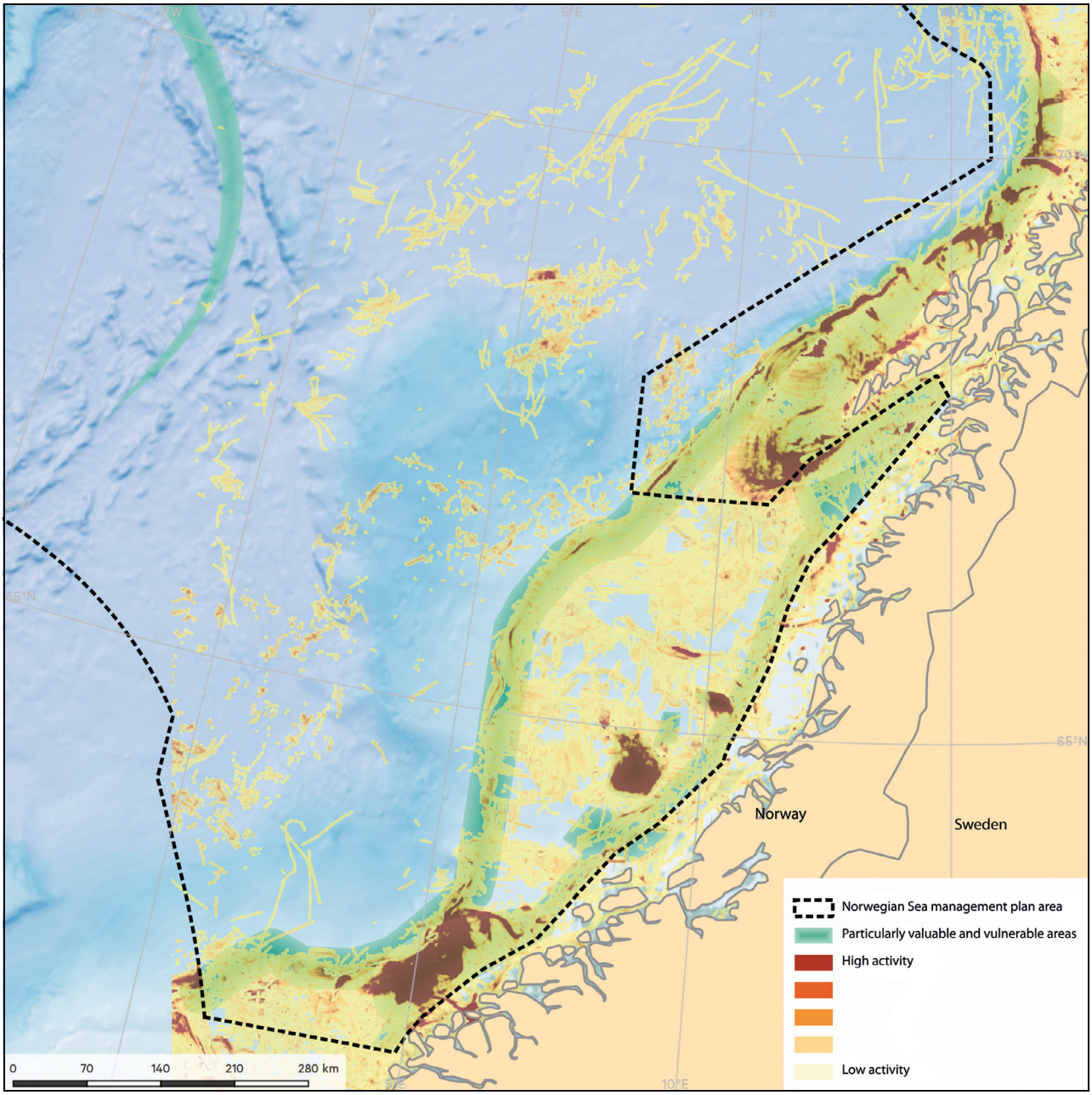

Figure 6.1 Fisheries activity in the Norwegian Sea.

Source: Norwegian Environment Agency/BarentsWatch

applies particularly to nearcoast areas northwards to the Vestfjorden and the Lofoten Islands. The fisheries in these areas take place mainly during the summer months. The herring stock has declined, resulting in lower quotas and a declining herring fishery.

Fisheries activity is expected to increase in summer along much of the coast and on the Møre banks. The Møre banks include some of the most important fishing grounds in the Norwegian Sea. The continental shelf is relatively narrow here, and the principal fishing grounds are relatively accessible for the coastal fishing fleet. There is thus some level of activity throughout the year. The main fish stocks harvested in this area are saithe, herring, angler and mackerel. Any changes in mackerel migration patterns will also result in changed patterns of fisheries activity. Some vessels that previously fished for their allocated quotas in the North Sea will spend more and more time fishing in areas north of 62 ^{0}N.

Spatial overlap between the fisheries and the petroleum industry is discussed below in the section on oil and gas activities.

No major changes in the level of conflict between the fisheries and maritime traffic are expected, except that there will be larger concentrations of fishing vessels in coastal areas in summer than when the 2009 management plan was published. Under normal circumstances the main conflict of interest between maritime traffic and fisheries is caused by the regular passage of cargo vessels through or very close to fishing grounds where there are concentrations of fishing vessels or fixed fishing gear.

The development of offshore energy or offshore aquaculture could result in spatial overlap with the fishing industry in certain areas that would have implications for the fisheries, especially the coastal fishing fleet.

6.1.4 Maritime traffic

The density of maritime traffic in the Norwegian Sea is generally low. The volume of traffic does not seem to have changed significantly, but total distance sailed rose by 10 % from 2012 to 2015. The introduction of traffic separation schemes and recommended routes between Runde and Utsira, combined with similar schemes for the Vardø–Røst route, has helped to move shipping further out from the coast, separate traffic streams in opposite directions and establish a fixed sailing pattern. Although the traffic separation schemes do not formally apply to the whole of the management plan area, the density plot for maritime traffic shows that they have a clear influence on traffic streams in the Norwegian Sea as well.

In 2011, new traffic separation schemes approved by IMO were introduced for maritime traffic along the coast of Southern and Western Norway. These and the recommended routes lie largely outside territorial waters, which means that some maritime traffic has been rerouted further away from the coast. A traffic separation scheme has also been introduced with a minimum separation zone of two nautical miles between opposite lanes. This reduces the risk of accidents and allows more time to come to the assistance of vessels in difficulties. The schemes apply to all vessels of gross tonnage 5 000 and over and those carrying dangerous or polluting cargo, irrespective of size, in transit along the Norwegian coast or in international traffic to or from a Norwegian port.

International processes are required to establish or alter internationally approved traffic separation schemes outside territorial waters. The system of traffic separation schemes has rerouted some shipping further away from the coast and away from areas with a high level of fishing activity or existing petroleum installations. The new routeing system along the coast has also made traffic patterns more predictable and made it easier to monitor maritime traffic.

Coastal shipping can damage passive fishing gear or cause it to be lost. However, experience has shown that the problem can be reduced if the gear is clearly marked. The aquaculture industry is growing, and occupying more and larger areas along the coast. If nearcoast areas are occupied by for example offshore energy or aquaculture installations, areas may be closed to shipping or traffic may have to be rerouted, which can have negative effects on maritime safety and cause delays. Better coordination and improvements in spatial planning in coastal areas will be required in future.

6.1.5 Oil and gas activities

Within the framework established in the 2009 management plan, production licences for oil and gas may be issued through licensing rounds in areas that have been opened for petroleum activities. Licensing rounds are held every year for mature exploration areas, which are included in the system of awards in predefined areas (APA). For other areas, allocation of licences takes place through numbered licensing rounds that are nor-

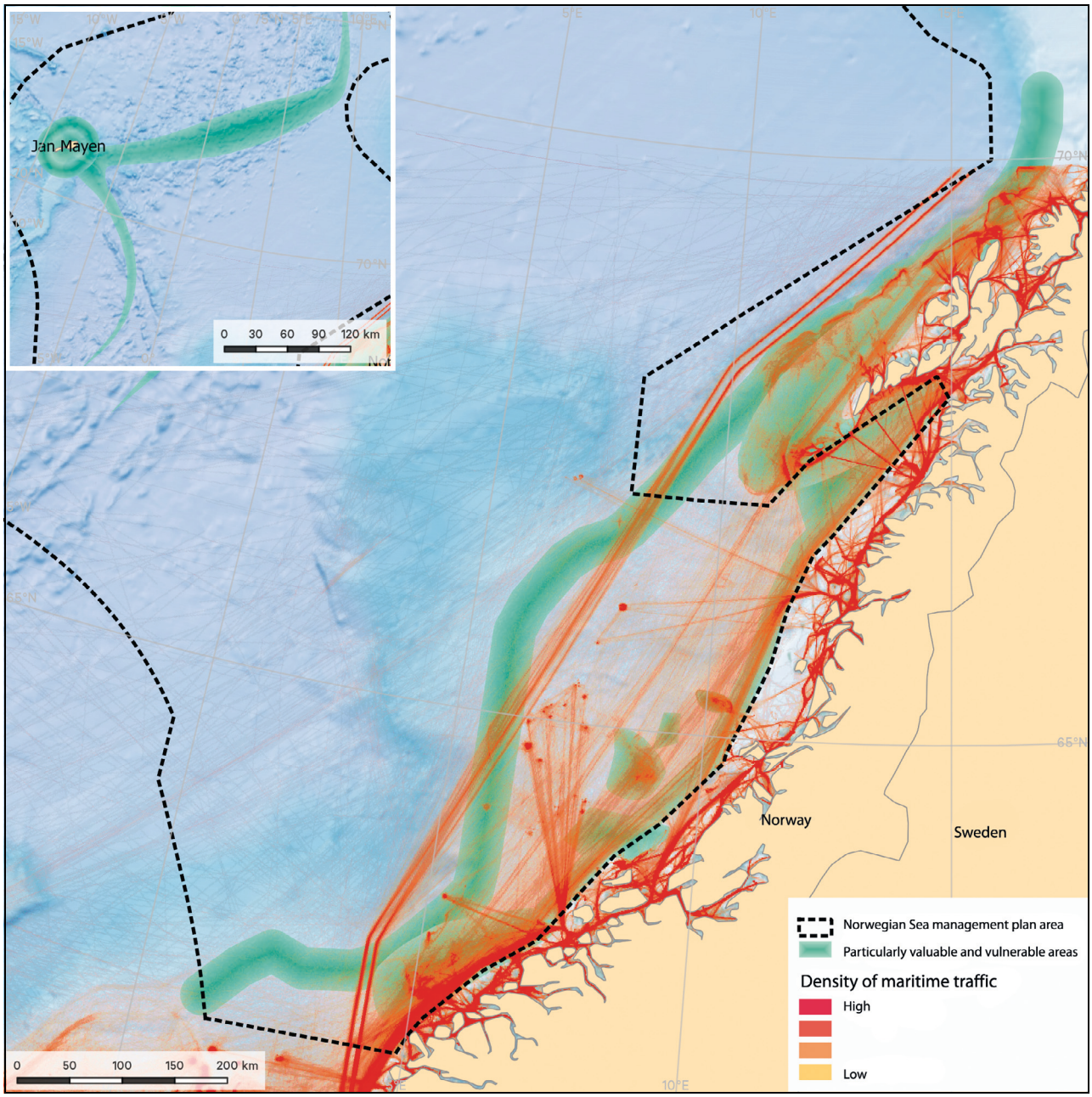

Figure 6.2 Maritime traffic in the Norwegian Sea.

Source: Norwegian Environment Agency/BarentsWatch

mally held every second year. The area included in the APA system is being extended in the Norwegian Sea as more of the shelf matures. The level of activity under each production licence depends on the requirements of its work programme and the results of exploration activity.

Conflicts of interest between the petroleum industry and other industries are mainly caused by spatial overlap between industries, especially certain fisheries. Much of the maritime traffic in the management plan area is related to oil and gas activities.

No significant changes are expected to occur in petroleum activity in the Norwegian Sea up to 2025. The areas used are those covered by exploration or production licences, including oil and gas fields, pipelines, surface installations and areas required for time-limited activities such as exploration drilling and seismic surveying.

Seismic surveys are an essential basis for oil and gas activities. However, seismic activity may have negative consequences for the fisheries if there is competition for the same area and because seismic activity can frighten away fish. Conflicts of interest related to the occupation of

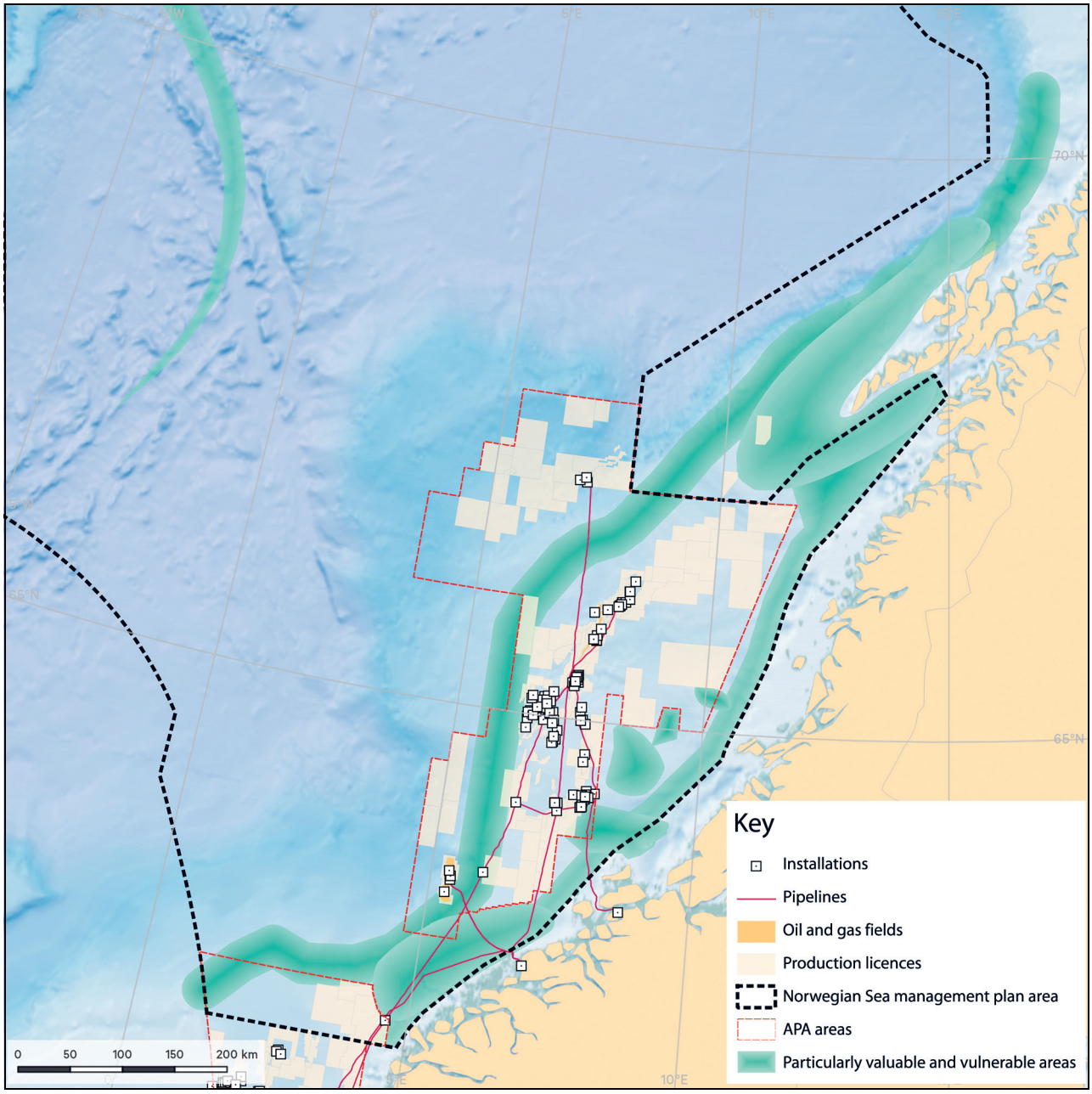

Figure 6.3 Oil and gas activities in the Norwegian Sea.

Source: Norwegian Environment Agency/BarentsWatch

areas during seismic surveys are most likely to arise with fishing vessels that have a limited range and during seasonal fisheries with short fishing seasons. Thus, in some circumstances seismic surveys can affect the size of harvests and the income from fisheries.

Delaying seismic surveys can be extremely costly for the petroleum industry. The fisheries also derive benefits from the oil and gas industry, for example through the emergency preparedness and response system.

A number of steps have been taken in recent years to reduce the potential for conflict between seismic surveying and fisheries. In 2013 the then Ministry of Fisheries and Coastal Affairs and the Ministry of Petroleum and Energy published guidelines to promote greater understanding between the parties and clarify which rules and procedures are applicable. Other measures such as improving the training of fisheries experts on board seismic vessels have resulted in a better dialogue between the parties and a reduction in the level of conflict. The extent of seismic surveys has been considerably reduced over the last two years, but some conflicts have still occurred.

6.1.6 Offshore renewable energy production

There are no offshore energy installations in the Norwegian Sea. The Norwegian Water Resources and Energy Directorate has coordinated assessments to identify options for and the likely impacts of opening certain sea areas for offshore renewable energy production. In the strategic environmental assessment that was carried out, areas that had been identified as suitable for offshore wind power were classified into three groups according to their technical and economic feasibility and the impacts of their development on other user interests in the same area. The areas identified in the Norwegian Sea are not included in the group that the Directorate recommends should be given priority. The Government intends to clarify which areas should be opened for licence applications.

The areas in the Norwegian Sea that are considered suitable for offshore wind power are Stadhavet, Frøyabanken, Nordøyan–Ytre Vikna, Træna West and Trænafjorden–Selvær. Potential conflicts of interest are described in the strategic environmental assessment.

Offshore wind farms cover substantial areas, and there may be conflicts of interest with fisheries and maritime traffic. According to the strategic environmental assessment, there is a possibility of conflicts of interest with other users in all the assessed areas, and opening these areas for wind power would affect environmental, commercial and other public interests.

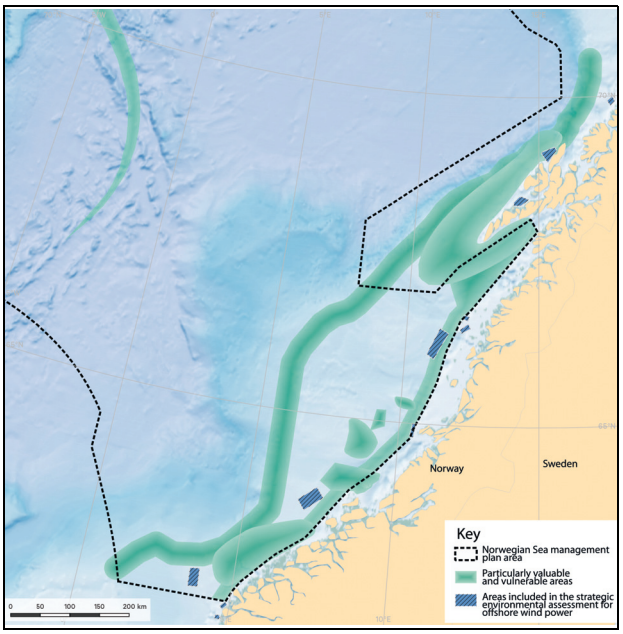

Figure 6.4 Areas included in the strategic environmental assessment for offshore wind power in the Norwegian Sea.

Source: Norwegian Environment Agency

6.2 Marine protected areas

Marine protected areas under the Nature Diversity Act may be established in Norway's territorial waters, which extend up to 12 nautical miles beyond the baseline. The Government's policy is that cross-sectoral marine protection efforts under section 39 of the Act will be continued in order to ensure that a selection of representative, distinctive or threatened underwater habitats along the coast and in territorial waters is safeguarded for future generations. The objective is for these areas, together with areas safeguarded under other legislation, to form a network of protected areas that will safeguard ecosystems, habitats and species.

In addition to the areas that are protected under the Nature Diversity Act, there are many areas that are protected against various types of fishing activities under fisheries legislation. For example, a number of areas are protected against the use of fishing gear and techniques that can damage coral reefs. Marine protected areas under the Marine Resources Act may be established in all Norwegian sea areas and the Norwegian continental shelf.

Under the Convention on Biological Diversity there is a target 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. Norwegian implementation of the international target for conservation of coastal and marine areas was discussed in the white paper on Norway's national biodiversity action plan and the subsequent debate in the Storting.

Efforts to safeguard marine areas and their species and habitat diversity for the future have been in progress for a long time. In 2004 a broad-based advisory committee identified 36 marine areas along the coast that are being evaluated as part of these efforts (see Table 6.1). The marine protected areas that have so far been established in the coastal waters and fjords of the Norwegian Sea are Saltstraumen, Tauterryggen, Rødberget and Gaulosen. Six marine protected areas within the management plan area have been established to protect cold-water coral reefs from being dam-

Table 6.1 Areas proposed for inclusion in Norway's marine protected plan by the advisory committee and their current status

County	Area	Status
	North Sea – Skagerrak	
Østfold	Østfold (Rauøyfjorden)	Ongoing protection process
Aust-Agder	Skagerrak transect	Protected in 2016 as part of Raet National Park
Vest-Agder	Framvaren	Protected in 2013
Rogaland	Jærkysten	Protected in 2016
Hordaland	Ytre Hardangerfjord	Ongoing protection process
	Lurefjorden with Lindåspollene	Ongoing protection process
	Korsfjorden	Ongoing protection process
Sogn og Fjordane	Sognefjorden	Process not yet started
	Dalsfjorden	Process not yet started
	Norwegian Sea	
	Stad	Process not yet started
Møre og Romsdal	Giske	Process not yet started
	Griphølen	Process not yet started
	Remman archipelago	Process not yet started, but some parts are already a nature reserve
Sør-Trøndelag	Gaulosen	Protected in 2016
	Rødberg	Protected in 2016
	Froan archipelago and Sula reef	Process not yet started
	Grandefjæra etc.	Process not yet started
Nord-Trøndelag	Tauterryggen	Protected in 2013
	Børgin	Ongoing protection process
	Skarnsundet	Ongoing protection process
	Borgan-Frelsøy	Process not yet started
Nordland	Saltstraumen	Protected in 2013
	Vistenfjorden	Ongoing protection process
	Nordfjorden (Rødøy municipality)	Ongoing protection process
	Karlsøyvær	Ongoing protection process
	Kaldvågfjorden and Innhavet	Ongoing protection process
	Tysfjorden	Process not yet started
	Barents Sea – Lofoten	
Nordland/ Troms	Andfjorden transect	Process not yet started
Troms	Rossfjordstraumen	Ongoing protection process
	Rystraumen	Ongoing protection process
	Ytre Karlsøy	Ongoing protection process
Finnmark	Lopphavet	Ongoing protection process
	Indre Porsangerfjord	Process not yet started
	Tanafjorden transect	Process not yet started
Marine areas outside territorial waters	Iverryggen reef	Protected under the Marine Resources Act
	Røstrevet reef	Protected under the Marine Resources Act

Source: Norwegian Environment Agency/Ministry of Climate and Environment

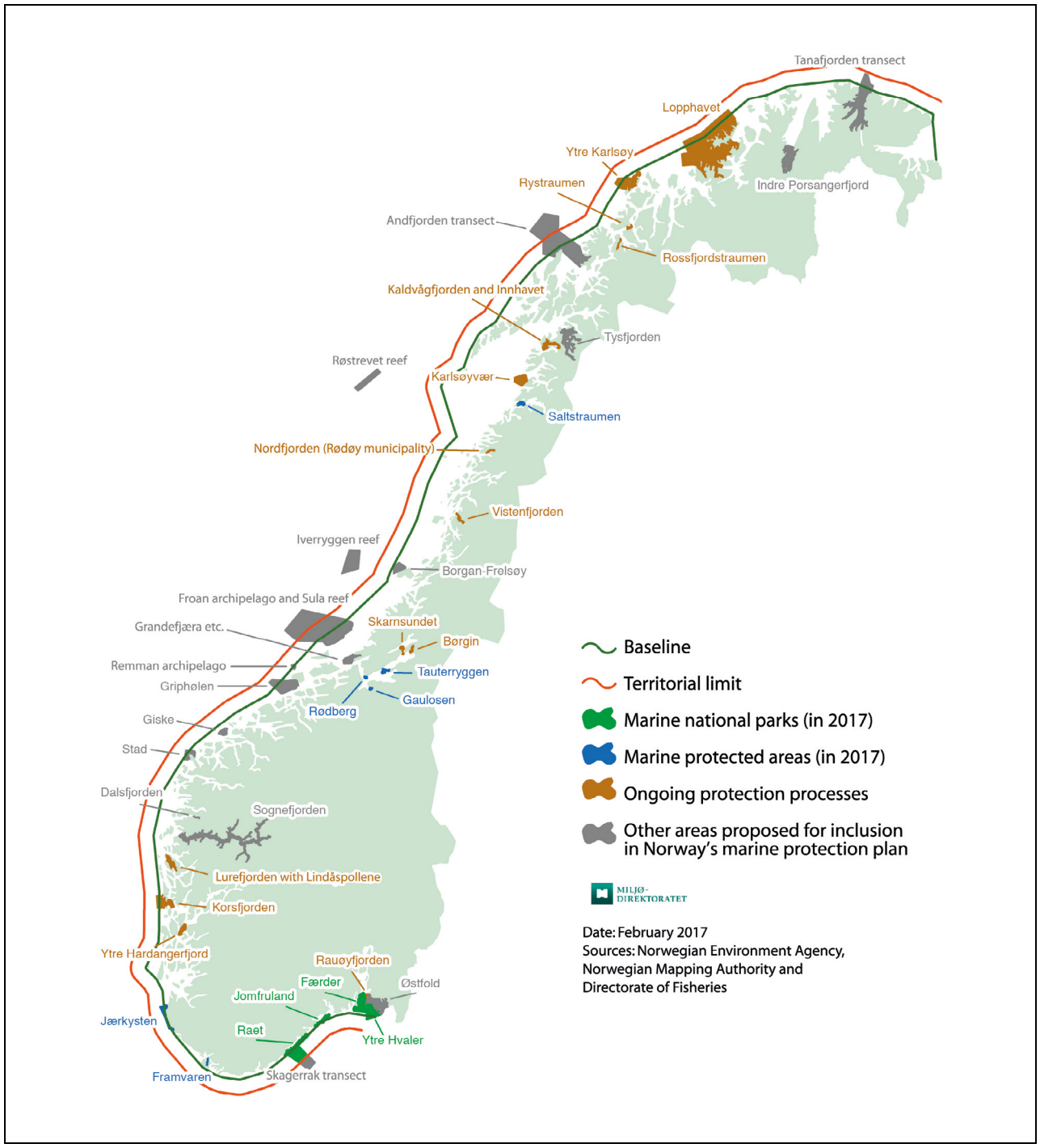

Figure 6.5 Status of areas proposed for inclusion in Norway's marine protection plan.

Source: Norwegian Environment Agency

aged by fisheries activities: Aktivneset, Breisunddjupet, Storneset, and the Sula, Iverryggen and Træna reefs.

A plan for establishing more marine protected areas is being developed. As part of this work, the status of efforts to establish marine protected areas will be evaluated, and any further need for protection to achieve national and international targets will be identified. The findings will form part of the basis for further marine protection efforts both in Norway's territorial waters and outside the 12-nautical-mile limit. Under the management plans for Norway's sea areas, regular assessments of the need for new measures to protect marine species and habitats will be conducted on the basis of existing knowledge.

6.3 Digital mapping tool for Norway's marine areas – better access to digital maps

The overall body of spatial data already available for the Norwegian Sea includes data on various themes, such as species and habitats and industrial activities, and information on the spatial frameworks for conservation and sustainable use in the management plan area and adjoining coastal areas.

Key themes for which spatial data are available today, and that need to be considered together, include environmental information, particularly valuable species and habitats, fisheries, maritime traffic and recommended routes, oil and gas activities, pipelines and cables, renewable energy production such as offshore wind power, and marine protected areas.

The future development of ocean-based industries and the introduction of new management measures in Norway's marine areas must be based on updated knowledge and information about species and habitats and about activities in different sea areas. Reliable and readily available spatial data are therefore essential for the development of potential or emerging activities like mineral extraction, marine bioprospecting, offshore aquaculture and new fisheries. At present it is difficult to estimate the likely scale of such new activities in the Norwegian Sea.

The first version of a digital mapping tool for Norway's sea areas has been developed, which is designed to provide integrated information in mapped form on industrial activities, species and habitats, and regulatory measures.

The consolidated digital mapping tool will be a useful tool for the authorities, the business sector, interest organisations, other users of the sea areas and the general public. The initial stages of work on the mapping tool are described in the North Sea–Skagerrak management plan.

The mapping tool will provide a better overview of decisions and measures relating to Norway's sea areas, both those that are part of the management plan system and those linked to sectoral processes. Spatial data on the content of the scientific basis for the management plans and on developments in marine areas will also be more readily accessible. In addition, the mapping tool will make the management plan process more inclusive process by increasing transparency, and strengthen stakeholder participation in the work on the management plans.

Better access to spatial data will also be useful in meeting needs not related to the management plans, such as the need for integrated information on specific geographical areas.

The digital mapping tool is being developed in close cooperation between the Forum for Integrated Marine Management and BarentsWatch, and is available via the website www.barentswatch.no.

6.4 Knowledge about Norwegian sea areas – mapping of the seabed by the MAREANO programme

The MAREANO programme was begun in 2005 to satisfy the need for more knowledge of conditions on the seabed in Norwegian waters. The programme has provided valuable information through mapping of depth and topography, species diversity, habitat types, chemical conditions and pollutants in sediments, and geological formations on the seabed. Data from the MAREANO surveys are made available on the programme's website and through the Norway Digital programme. In 2016 the International Council for the Exploration of the Sea carried out a technical review of the scientific methodologies used in the MAREANO programme. The review concluded that overall the programme meets high scientific standards and uses sound scientific methods. It also recommended ways of further improving the quality of the programme, which will be followed up.

Mapping of the seabed generates a great deal of new information on the distribution of habitats and species and the pressures and impacts associated with human activity. The information can be used to improve the management regime and provide better protection for vulnerable habitat types. Priority is being given to areas where there are or may be important species and habitat types or natural resources that could be affected by existing or new human activities. In the process of developing the scientific basis for the marine management plans, data obtained through MAREANO has confirmed the environmental value of the areas identified as particularly valuable and vulnerable.

The MAREANO programme has mapped many new coral reefs. As a result of the new information, ten new areas of cold-water coral reefs in Norwegian waters have been given special protection by designation as marine protected areas under section 19 of the Marine Resources Act.

Knowledge acquired through the MAREANO programme is an important basis for sustainable management of the seabed, for example by adding to the knowledge base on vulnerable habitat types such as corals and sponge communities, and reduces the risk of damage to such habitats during fisheries and other activities. Coral reefs and other valuable species and habitats outside the 12-nautical-mile limit have to be protected under existing sectoral legislation.

Knowledge is also needed to ensure a representative selection and ecological coherence when areas in Norwegian waters are protected, and the information gathered through the MAREANO programme is an important part of the knowledge base.

7 Measures for the protection and sustainable use of the ecosystems of the Norwegian Sea

Value creation based on the sustainable use of marine resources is dependent on good environmental status and on species and habitat diversity in the seas and oceans. The OECD report *The Ocean Economy in 2030* emphasises that in order to realise the full potential of the oceans, it is essential to ensure that they are used responsibly and sustainably. The report presents ocean-based industries and properly functioning marine ecosystems as the two equally important main elements of a model of the ocean economy. Norway's marine policy reflects this approach through an integrated management regime that promotes both conservation and sustainable use of ecosystems.

The growing interest in emerging industries in Norway's sea areas is especially pertinent to this update of the Norwegian Sea management plan. There is considerable potential for value creation in emerging ocean-based industries such as marine aquaculture at greater distances from the coast, seaweed and kelp cultivation, renewable energy production and seabed mining. A basic principle of the Government's ocean strategy is to continue the development of industries where Norway has competitive advantages, and at the same time stimulate research, innovation and technology development to promote emerging industries. The management plans increase predictability and facilitate coexistence between industries that are based on the use of Norway's sea areas and their natural resources.

The scientific basis for this update of the management plan concludes that the state of the Norwegian Sea environment is still good, and that the factors posing challenges for management of the area are the same as in 2009. The present document provides updated information on environmental status and trends and on issues it will be important to address in the management regime for the years ahead. These include the impacts of climate change and ocean acidification, marine litter, the decline in a number of seabird populations and the pollution situation.

Knowledge of the marine environment is being strengthened through mapping, monitoring and research in Norway's waters. The Forum for Integrated Marine Management and the Advisory Group on Monitoring are continually improving the knowledge base for management of Norway's marine areas. The Government will follow up the measures set out in the present white paper, among other things through the work of these bodies.

The 2009 management plan set out long-term goals for the management of the Norwegian Sea (see Chapter 2.4). This update of the management plan describes how the measures presented in 2009 have been implemented and assesses the need to maintain them and to introduce new measures.

7.1 A changing climate

Climate change and ocean acidification are expected to result in major changes in the structure and functioning of marine ecosystems. It will be important to identify the changes that can be expected so that appropriate adaptation measures can be implemented. Climate change and ocean acidification are additional to other pressures on the Norwegian Sea, and their growing impacts will result in more marked cumulative environmental effects on many ecosystems.

Carbon is captured and stored in marine habitats such as kelp forests and eelgrass meadows. This is an important process, like carbon uptake in forests, but knowledge about it is limited. These 'blue forests', as they are sometimes called, also have many important ecosystem functions, particularly relating to biodiversity, biological production and protection against erosion.

The Government will:

– enhance knowledge of the effects of climate change and ocean acidification on marine eco-

systems and how they interact with other pressures;
– further develop monitoring of acidification and climate trends and of the impacts on vulnerable calcifying organisms such as plankton and corals;
– build up knowledge about carbon capture and storage in marine plankton and marine vegetation types such as kelp forests and eelgrass meadows.

7.2 Spatial management and overall framework for activities

For the ocean-based industries to grow, any spatial overlap between different industries and the challenges associated with this must be properly dealt with. The management plans are a tool for spatial management of Norway's sea areas. Sound knowledge of these areas is an essential basis for finding a balance between conservation and sustainable use across sectors.

Norway is using substantial resources to build up knowledge about the seabed. Mapping of the seabed through the MAREANO programme is expanding our knowledge of the distribution of habitat types and species, and the pressures on them as a result of human activity. The MAREANO programme has registered many new coral habitats and resulted in special protection for new areas of Norwegian waters where there are cold-water coral reefs. A number of these have been designated as marine protected areas under the Marine Resources Act. This will make it possible to improve their management and provide better protection for vulnerable habitat types.

Since the management plan for 2009 was published, spatial management measures relating to shipping along the coast have also been implemented. To improve maritime safety in the Norwegian Sea, new traffic separation schemes and recommended routes outside territorial waters have been established. These have helped to shift shipping further out from the coast, separate traffic streams in opposite directions and establish a fixed sailing pattern. This reduces the likelihood of collisions and groundings and makes it easier to intervene in the event of an accident.

7.2.1 Particularly valuable and vulnerable areas

One important feature of Norway's marine management plans is the selection of particularly valuable and vulnerable areas. These are areas that on the basis of scientific assessments have been identified as being of great importance for biodiversity and biological production in the entire management plan area. The areas identified in the Norwegian Sea management plan area are as follows: the Remman archipelago, the Froan archipelago and Sula reef, the Møre, Halten and Sklinna banks, the Iverryggen reef, the Vestfjorden, Jan Mayen and the West Ice, the edge of the continental shelf, the Arctic front, and the coastal zone. Knowledge about the seabed in the particularly valuable and vulnerable areas of the Norwegian Sea has been improved and the value of these areas has been confirmed through the MAREANO programme.

According to the scientific basis for this update of the management plan, no new results have been obtained that give grounds for altering the delimitation of the particularly valuable and vulnerable areas, which is an important part of the framework for activities in the Norwegian Sea.

The Government will:

– assess whether areas where there are mud volcanoes, hydrothermal vents and methane hydrates meet the criteria for designation as particularly valuable and vulnerable areas.

7.2.2 Marine protected areas

Under the Convention on Biological Diversity (CBD) and the Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention), Norway has international commitments concerning the conservation of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services.

Under the CBD, there is a target 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.

Norwegian implementation of the international target for conservation of coastal and marine areas was discussed in the white paper on Norway's national biodiversity action plan. OK The scientific basis for the management plan and the list of 36 possible marine protected areas identified by a cross-sectoral advisory committee in 2004 are still the basis for work on a network of

marine protected areas under the Nature Diversity Act. The Government is developing a plan for establishing more marine protected areas. As part of this work, the status of efforts to establish marine protected areas will be evaluated, and any further need for protection to achieve national and international targets will be identified.

Four marine protected areas in coastal waters and fjords adjoining the Norwegian Sea have now been established under the Nature Diversity Act, and six marine protected areas have been established under the Marine Resources Act.

The Government will:

- draw up a plan for further work on marine protected areas;
- continue work on the establishment of marine protected areas along the Norwegian Sea coastline.

7.2.3 Deep-sea areas

Distinctive and rare species and habitats have been found during ongoing research activities in deep-sea areas along the Mid-Atlantic Ridge and near the mud volcano Håkon Mosby. It is particularly important to continue to build up knowledge through mapping and research on seabed species and habitat types in these areas. The need to protect distinctive and rare species and habitats in deep-sea areas will be assessed in this context.

The Government will:

- improve knowledge about species and habitats in deep-sea areas;
- assess the need to protect distinctive and rare species and habitats in deep-sea areas.

7.2.4 Seabed mining

There is expected to be growing interest in the commercial extraction of new types of minerals from the seabed in deeper-water areas. This means that legislation will be needed to provide a framework for sound resource management and safe and environmentally sound operations, and to facilitate coexistence with other activities.

The Government will:

- propose new legislation on seabed mining.

7.2.5 Framework for petroleum activities

Knowledge of the environmental impacts of petroleum activities has been improved since the 2009 management plan was published. For example, there is now a better basis for assessing the environmental impacts of acute pollution on fish. Moreover, exploration drilling has been carried out in areas where there are coral habitats. In these areas, special conditions have been imposed to avoid damage. Reports from the operators' monitoring programmes after drilling conclude that there has been only limited sediment deposition on corals and no visible damage to corals or other vulnerable benthic animals.

The 2009 management plan established the overall framework for petroleum activities (announcement of blocks, exploration drilling and seismic surveying). The Government considers that this framework should be retained, with the refinements and amendments listed below, until the next update of the management plan, see Figure 7.1.

The Møre banks:

- The framework for petroleum activities on the Møre banks is retained unchanged. As set out in the four-party cooperation agreement for the period 2013–2017, the framework has not been reassessed. The Government will review the position if there is a political basis for doing so, and will if appropriate raise the matter with the Storting.

Froan archipelago and Sula reef:

- No exploration drilling in oil-bearing formations in the breeding and moulting seasons (1 March–31 August);
- No exploration drilling in oil-bearing formations in the coastal zone between the Froan archipelago and Sula reef in the breeding season for grey seal (1 September–15 November).

Sula reef:

- New production licences must include requirements for any necessary measures to ensure that the Sula reef complex is not damaged by petroleum activities. Operators must be prepared to meet special requirements in order to avoid direct physical damage to the reefs from bottom gear and anchor chains, sediment deposition from drill cuttings and pollution from

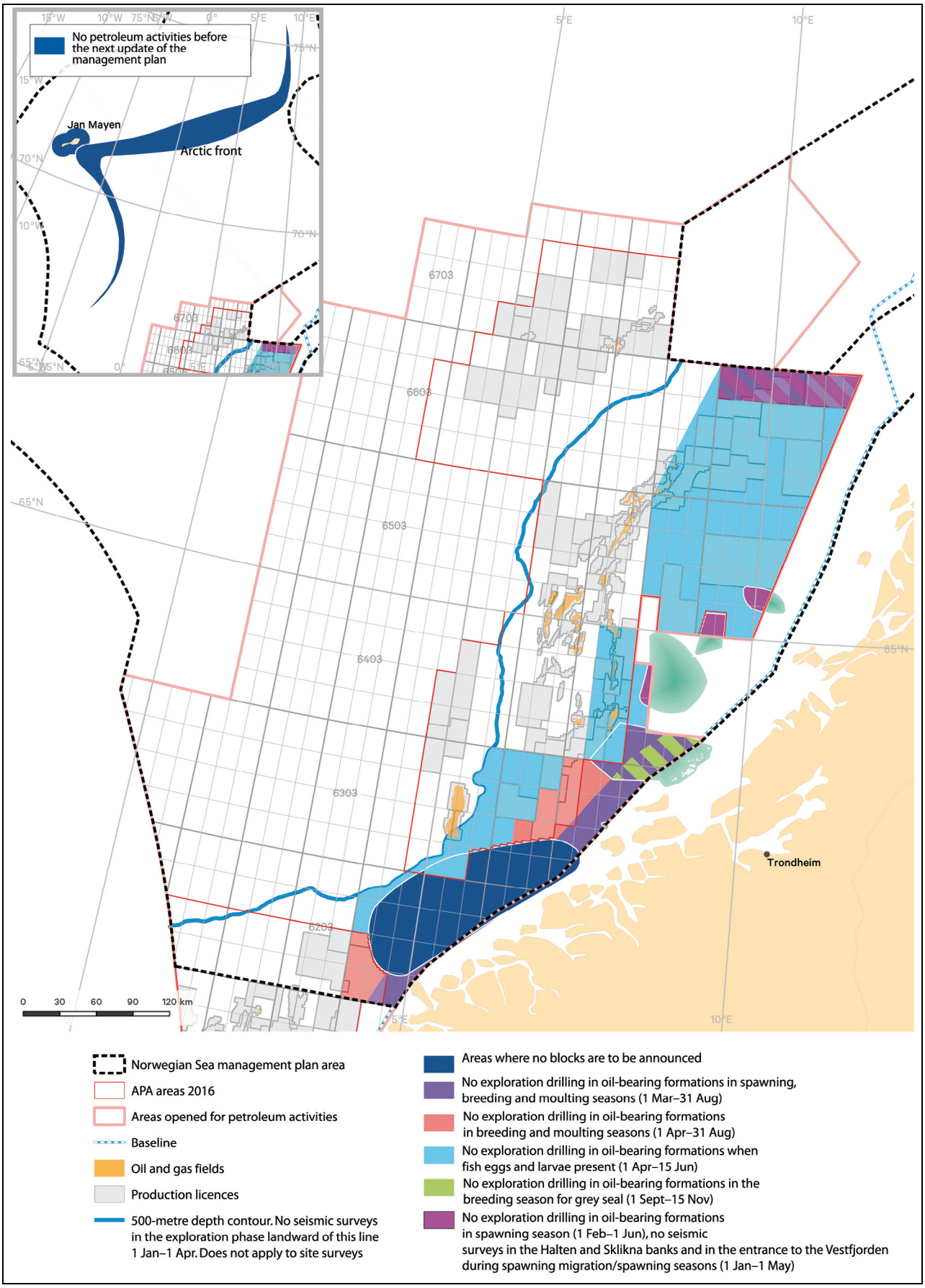

Figure 7.1 Framework for petroleum activities in the Norwegian Sea.

Source: Norwegian Environment Agency

produced water (water associated with the reservoirs that is produced along with the oil or gas).
– Given the risk-based approach of the health, safety and environment legislation, stricter requirements will apply in vulnerable areas to avoid damage.

Iverryggen reef:

– New production licences must include requirements for any necessary measures to ensure that the Iverryggen reef complex is not damaged by petroleum activities. Operators must be prepared to meet special requirements in order to avoid direct physical damage to the reefs from bottom gear and anchor chains, sediment deposition from drill cuttings and pollution from produced water (water associated with the reservoirs that is produced along with the oil or gas).
– Given the risk-based approach of the health, safety and environment legislation, stricter requirements will apply in vulnerable areas to avoid damage;
– No exploration drilling in oil-bearing formations in the spawning season (1 February–1 June.

7.2.6 Digital mapping tool for Norway's sea areas

In autumn 2016, the first version of a digital mapping tool for Norway's sea areas was launched. It is intended to provide integrated information on species and habitats, industrial activities, and the framework and regulatory measures for use of different areas. The digital maps will show species and habitats such as corals, kelp forest, spawning areas and seabird colonies, and industrial activities such as fisheries, shipping and petroleum activities. In addition, they will indicate areas where new activities may be developed, for example possible areas for offshore wind power development. The digital mapping tool will be important both for the authorities and for business and industry in ensuring sound management of marine areas and a good basis for planning new activities. The digital mapping tool is intended to simplify the work of updating and revising the management plans, and could ensure a more inclusive process by increasing transparency, and strengthen stakeholder participation in the work on the plans. Some other European countries have already begun to use similar tools. The digital mapping tool is being developed in close cooperation between the Forum for Integrated Marine Management and BarentsWatch, and is available via the website www.barentswatch.no.

The Government will:

– continue to develop the digital mapping tool for the sea areas covered by the management plans.

7.3 Measures to ensure good environmental status and sustainable use

7.3.1 Protecting particularly valuable and vulnerable areas

According to the scientific basis for this update of the management plan, the target of conducting activities in particularly valuable and vulnerable areas in such a way that their ecological functioning and biodiversity are not threatened has been achieved for the Sula reef, the Iverryggen reef, the Arctic front, and Jan Mayen and the West Ice. A lack of knowledge makes it uncertain whether the target has been achieved for the Møre, Halten and Sklinna banks, the coastal zone and the edge of the continental shelf.

The Government will:

– improve the knowledge base on the particularly valuable and vulnerable areas so that better assessments of their environmental status and progress towards targets can be made.

7.3.2 Ensuring sustainable harvesting of fish stocks

To meet Norway's obligations and safeguard its interests as a fisheries nation, the Marine Resources Act establishes a management principle requiring the authorities to make regular evaluations of whether fisheries are biologically sound and sustainable. This requirement also applies to smaller stocks that are not included in the annual quota regulation system. It is up to the fisheries management bodies to determine which measures are most suitable. In their assessments, they must give weight to an ecosystem approach that takes into account habitats and biodiversity and is in line with the precautionary principle.

The goals for sustainable management have been achieved for most of Norway's fish stocks.

Specific management measures have been established for vulnerable stocks, for example golden redfish, blue ling and hooded seal, all of which are classified as endangered on the Norwegian Red List.

In future, there may be interest in harvesting new species and species at lower trophic levels in the food chains. Any harvesting of new species will be deferred until there is sufficient information about stock sizes and impacts on ecosystems, and will be based on a precautionary approach.

Illegal, unreported and unregulated fishing (IUU fishing) in the Norwegian Sea has been brought under control through international efforts since the 2009 management plan was published. Inspection and enforcement measures both at sea and of international landings will be continued.

There is little regulation of fishing tourism and recreational fishing in Norway. Work is in progress on a proposal for legislative amendments and regulations relating to fishing tourism companies. The purpose of this proposal is to obtain a better overview of the resources harvested by the fishing tourism industry and facilitate tourism in coastal areas.

The Government will:

- build up knowledge about the impacts on ecosystems of harvesting new species and harvesting at lower trophic levels;
- continue to incorporate the principles of conservation and sustainable use into action taken to follow up the management principle set out in the Marine Resources Act;
- adopt regulations relating to fishing tourism companies, including provisions on registration and the reporting of catches.

7.3.3 Preventing damage to benthic marine species and habitats

Coral reefs and gorgonian forests provide many important ecosystem functions, especially related to biodiversity and biological production. The species *Lophelia pertusa* builds some of the largest cold-water coral reef complexes that are known to exist. Norway is considered to be a core area for the species, since 30 % of all records are from Norwegian waters.

Sponges are another group of sessile benthic animals, and areas where there are sponge communities also have a rich associated fauna including fish and invertebrates.

Bottom fishing is the activity that has most impact on the vulnerable benthic fauna. Since the 2009 management plan was published, measures have been taken to reduce the impacts on coral reefs and other vulnerable benthic communities in the Norwegian Sea, among other things by establishing marine protected areas. According to plan, data on coral reefs and other vulnerable benthic fauna from the MAREANO programme, investigations carried out by commercial operators and from other sources will be collated and the information will be made available to all users of the ocean in the course of 2018. Information of this kind will make it easier for the fishing fleet to exercise caution in the vicinity of coral reefs and other vulnerable benthic fauna.

To make it possible to draw clearer conclusions about the impacts of petroleum activities on corals and sponge communities, assessment of long-term effects on these species are needed.

The Government will:

- compile existing information on vulnerable benthic fauna and make it available to ocean users;
- continue efforts to protect coral reefs and other vulnerable benthic fauna against the use of bottom gear, and assess the ecological relationships between protected areas;
- facilitate the continued development of fishing gear that has less environmental impact in order to minimise impacts on the seabed.

7.3.4 Safeguarding species and habitat types

There is still a lack of knowledge about the ecological relationships between different parts of marine ecosystems and about marine habitats that are particularly important for the structure, functioning and productivity of ecosystems.

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. There are currently viable populations of species such as herring, mackerel, saithe and blue whiting, while the status of species such as ling, spiny dogfish, greater argentine and the coral species *Lophelia pertusa* and *Paragorgia arborea* is uncertain. Blue ling, golden redfish and hooded seal are all classified as endangered. There is a very limited research catch of hooded

seals. No directed fishery for blue ling or golden redfish is permitted.

The Government will:

- improve knowledge of the structure and functioning of marine ecosystems;
- take the necessary steps to maintain viable populations and improve the conservation status of endangered and vulnerable species as part of the management of the Norwegian Sea.

7.3.5 Improving the situation for seabird populations

Knowledge about seabirds is being built up through the SEAPOP mapping and monitoring programme, including the SEATRACK module, which aims to map the non-breeding distribution of seabirds. Populations of a number of seabirds in the Norwegian Sea have shown a considerable decline. For the common guillemot, kittiwake and puffin, the goal that populations should be viable is considered not to have been achieved.

A national action plan for seabirds is to be drawn up, and in this connection various policy instruments and measures will be considered, including whether certain seabirds should be designated as priority species. Knowledge about mechanisms and ecological interactions in ecosystems that are important for seabird populations needs to be further developed. Work on seabirds was also discussed further in the white paper on Norway's national biodiversity action plan.

The Government will:

- draw up a national action plan to improve the situation for seabird populations, including an assessment of whether certain species of seabirds should be designated as priority species under the Nature Diversity Act;
- continue to build up knowledge about seabirds through the mapping and monitoring programme for seabirds, SEAPOP.

7.3.6 Alien species

There are currently few alien species in the Norwegian Sea, but climate change and increasing maritime activity, including shipping, are increasing the risk of the spread and establishment of new alien species that may be harmful to the natural ecosystem. A number of alien species have become established along the coast, including the Pacific oyster (*Crassostrea gigas*) in the northern part of Møre og Romsdal, showing that there is a potential for the spread of such species. Little is known about the occurrence and ecological effects of many alien species.

The Government will:

- improve knowledge about the spread and impacts of alien species in Norwegian waters.

7.3.7 Reducing pollution

Monitoring shows that the pollution status of the Norwegian Sea is still generally good, even though considerable quantities of hazardous substances are transported into the areas with air and ocean currents. Releases of environmentally hazardous substances and oil from activities within the management plan area also add to the pollution load.

Concentrations of oil and environmentally hazardous substances measured in sediments and the water column are low, but certain hazardous substances bioaccumulate and are found at relatively high levels in particularly vulnerable species at the top of food chains. Studies carried out since the 2009 management plan was published show that concentrations of hazardous substances in some fish species, edible crab, seabirds and marine mammals give cause for concern. There is a lack of knowledge about new environmentally hazardous substances and about the combined impacts of different substances at population level. Continued efforts are needed to reduce inputs of oil and hazardous substances into the Norwegian Sea.

Noise pollution has been receiving growing international attention since the 2009 management plan was published. More knowledge is needed about the impacts of underwater noise in the Norwegian Sea.

The Government will:

- improve knowledge about the sources and impacts of hazardous substances in marine organisms;
- seek to reduce inputs of hazardous substances to the Norwegian Sea, among other things through stricter international rules on their use and release;
- continue work on the zero-discharge targets for the oil and gas industry;

– build up knowledge about the impacts of underwater noise on fish and marine mammals, and establish a monitoring programme for underwater noise as part of the marine management plans.

7.3.8 Safe seafood

The concentrations of contaminants in seafood are generally below the maximum permitted levels, and seafood from the Norwegian Sea is generally considered to be safe. However, there are elevated levels of certain hazardous substances in some species, and more knowledge is needed about the impacts of plastic pollution.

The Government will:

– ensure that seafood is safe, among other things by continuing the monitoring programme for undesirable substances in seafood;
– improve knowledge about undesirable substances and nutrient content in species that are little used or that have not previously been used for food and feedstuff production;
– strengthen the knowledge base on the presence and effects of microplastics in the marine environment and in seafood.

7.3.9 Combating marine litter and microplastics

Marine litter, particularly plastics and microplastics, is a rapidly growing problem and is having increasingly serious impacts on the seas and on people's use of them throughout the world. Civil society, the business sector, the public administration and politicians have all become much more aware of this issue in recent years. We have learnt more about the distribution, sources and impacts of marine litter, but there are still gaps in our knowledge. Measures to reduce inputs and to clean up litter have been made more effective.

Although Norway has a well-developed waste management system and inputs of litter from both land-based and marine Norwegian sources are limited, more needs to be done to reduce inputs and clean up litter.

Measures to prevent Norwegian waste from entering the marine environment and to clean up litter are an integral part of Norway's waste management policy. The Government will discuss such measures, including the follow-up of analyses of action to deal with marine litter and microplastics, in a forthcoming white paper on waste management policy and the circular economy. The Government also discusses international efforts to deal with marine litter and microplastics in the white paper on the place of the oceans in Norway's foreign and development policy.

The Government will:

– intensify monitoring of marine litter in Norwegian sea areas: this will include obtaining more data on marine litter on the seabed and further developing the monitoring system under the marine management plans;
– strengthen research on and monitoring of marine litter and microplastics, in Norwegian sea areas, and consider establishing monitoring of microplastics;
– take steps to enable the voluntary sector, other non-state actors and municipalities to make the best possible contribution to clean-up operations and other measures to reduce marine litter;
– consider whether to expand the organisation responsible for outdoor recreation areas along the coast, beach clean-up and information work to new geographical areas, where removal of beach litter will be an important task;
– establish new arrangements to encourage the delivery of end-of-life leisure craft to approved facilities;
– review the introduction of a system enabling fishermen and others who retrieve litter from the sea to deliver it free of charge in port. These arrangements will be based on experience gained from the Fishing for Litter project and will draw on accumulated knowledge;
– review proposals for a producer responsibility scheme for the fisheries and aquaculture industry;
– continue the annual retrieval programme for lost fishing gear to prevent 'ghost fishing' and reduce marine litter;
– continue the removal of abandoned mussel cultivation facilities along the coast;
– review measures for further reduction of marine litter from the fisheries and aquaculture industry, including measures to reduce losses of gear;
– continue surveys and clean-up of discarded batteries on the seabed near lighthouses;
– enhance the implementation of OSPAR's Marine Litter Regional Action Plan;
– play a part in international cooperation on research and knowledge building as regards

microplastics in the marine environment, including the development of standardised definitions, measurement methods and indicators;
- strengthen Norway's role in international and regional cooperation to deal with marine litter and microplastics, particularly through cooperation within the UN system, OSPAR, the Nordic Council of Ministers, the North East Atlantic Fisheries Commission (NEAFC) and the Protection of the Arctic Marine Environment Working Group (PAME), and by seeking to influence the EU.

7.3.10 Maritime safety and the preparedness and response system for acute pollution

Since the 2009 management plan was published, the likelihood of maritime accidents has been reduced through preventive measures. For example, traffic separation schemes and recommended routes have been introduced, and monitoring of shipping in Norwegian waters has been considerably expanded. At the same time, Norway's capacity to prevent and limit environmental damage in the event of acute pollution has been strengthened through various preparedness and response measures. Governmental emergency response equipment has been renewed and supplemented, and emergency plans and the organisation of response operations have been updated. Together, these improvements in maritime safety and the preparedness and response system for acute pollution mean that the environmental risk associated with shipping in the management plan area has been reduced since 2009.

In June 2016, the Government presented a white paper on maritime safety and the preparedness and response system for acute pollution (Meld. St. 35 (2015–2016)). A number of the measures discussed in the white paper will improve maritime safety and the preparedness and response system for acute pollution in the Norwegian Sea. These measures are presented in Box 5.3 of the present white paper.

The Government will:

- Follow up the measures presented in the white paper on maritime safety and the preparedness and response system for acute pollution, in line with the decisions made by the Storting during its consideration of the white paper.

7.4 Strengthening the knowledge base – mapping, research and monitoring

Maps of ecological information, mapping marine habitat types and the seabed – MAREANO

The MAREANO programme has registered many new coral reefs, and as a result, ten new areas of cold-water coral reefs in Norwegian waters have been given special protection by designation as marine protected areas under the Marine Resources Act. Knowledge acquired through the MAREANO programme, for example about vulnerable habitat types such as coral reefs, gorgonian forests and sponge communities, is important for sustainable management of the seabed.

As described in the white paper on Norway's national biodiversity action plan, the Government will strengthen initiatives to map Norwegian nature and establish maps of ecological information for Norway. In marine areas, as elsewhere, the new Norwegian system for classifying habitats, ecosystems and landscapes developed by the Norwegian Biodiversity Information Centre will be used for all mapping initiatives.

Knowledge development generally

Efforts are continuing to build up knowledge about ecosystem-based management and learn more about the structure and functioning of marine ecosystems. Basic knowledge about marine ecosystems, natural fluctuations and the impacts of human activity is needed to develop an integrated ecosystem-based marine management regime. More knowledge and a better understanding is needed of ecosystem function and of the impacts on ecosystems of climate change, ocean acidification, pollution and marine litter, particularly plastic and microplastics. Better methods of estimating cumulative environmental effects on marine ecosystems should be developed.

There is still a need to build up more knowledge about the socioeconomic and legal aspects of managing the marine environment.

It is difficult to assess progress towards some of the management goals for Norway's sea areas because of gaps in our knowledge. In such cases, continued knowledge building is crucially important.

To make it possible to evaluate progress towards the goals set in the marine management plans, a system for coordinated monitoring of environmental status has been established, based

on a representative set of indicators. The first status report on the Norwegian Sea environment, based on monitoring of these indicators, was presented in 2012, followed by an update in 2016. The indicator set needs to be further developed to include more pressure and impact indicators, and coordinated with relevant work under OSPAR.

The Government will:

- continue the MAREANO programme for mapping of the seabed in Norwegian waters; .
- when mapping marine habitat types, take into use the Norwegian system for classifying habitats, ecosystems and landscapes developed by the Norwegian Biodiversity Information Centre;
- further develop the monitoring system for ecosystems and environmental status in Norway's sea areas, and coordinate it with OSPAR's monitoring system;
- build up knowledge about ecosystem-based management and the structure and functioning of marine ecosystems; .
- improve knowledge about the prevention of accidents that may result in pollution;
- improve knowledge about socioeconomic issues related to management of the marine environment.

7.5 Transparency, information and knowledge-sharing

All information on work on Norway's marine management plans is published on the website www.havforum.no. This is intended to be an important information channel and to promote transparency and participation in work on the management plans.

Information about the state of the environment is updated regularly on the website www.miljostatus.no, which is Norway's channel for dissemination of information on environmental status and trends. Thematic maps for marine and coastal areas are also available here, and supplement the written information on the marine management plans and the state of the environment.

The portal www.barentswatch.no provides a user-friendly overview of information on climate, environment and maritime transport for all ocean users. BarentsWatch is a monitoring and information system that provides access to quality-assured information on northern coastal and marine areas.

The Government will:

- Continue the development of digital systems for information related to Norway's marine management plans.

7.6 Further development of the management plan system – changes to how often they are updated and revised

During its consideration of the white paper on Norway's national biodiversity action plan, the Storting emphasised that the management plans must be updated and revised regularly so that they provide an up-to-date framework for ecosystem-based management. Revision of each management plan at least every 12 years, including steps to obtain new data and more knowledge, and an update to check progress towards targets and assess the use of policy instruments every four years, will ensure that Norway's marine management plans provide a predictable but dynamic framework and that the balance between the various user interests and environmental considerations is updated.

The Government will implement this system from the next parliamentary period. This will mean that at least one white paper on marine management is submitted to the Storting in each parliamentary period.

The Government will:

- publish a revised management plan for the Barents Sea – Lofoten area in 2020;
- revise the integrated, ecosystem-based management plans for Norway's sea areas at least every 12 years and update them every four years.

7.7 International cooperation

Norway advocates international cooperation on the marine environment that reflects the principles of integrated, ecosystem-based management and topics such as sustainable fisheries management, climate change, ocean acidification and marine litter. Norway will continue its efforts to ensure that these and other ocean-related topics are given sufficient priority in international cooperation on climate and the marine environment. Norway's role in international cooperation on the

marine environment is further discussed in the white paper on the place of the oceans in Norway's foreign and development policy.

The Government will:

- continue cooperation on the marine environment in OSPAR;
- strengthen the cooperation on management measures in NEAFC, including the work on protection of vulnerable areas against fisheries activities;
- strengthen Nordic cooperation on the marine environment.

8 Economic and administrative consequences

This white paper focuses mainly on the further development of existing policy instruments and measures. Management of Norway's sea areas is to be based on the best possible knowledge, and the intention is to strengthen the knowledge base for ecosystem-based management of the Norwegian Sea 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 Norway's official instructions for planning and management of central government programmes and projects.

Measures announced in this white paper will be funded within the budgetary framework applicable at any given time. Follow-up of measures in the years to come will depend on economic developments and the budget situation.

To give greater predictability in work on the marine management plans, they will be updated and revised more regularly. The development of a digital mapping tool to present information on the management plans should make this information more accessible to the public administration and to 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 Climate and Environment

r e c o m m e n d s :

that the Recommendation from the Ministry of Climate and Environment concerning the update of the integrated management plan for the Norwegian Sea dated 5 April 2017 should be submitted to the Storting.

Appendix 1

Indicators used in the monitoring system for the Norwegian Sea

Indicators	Links to www.miljostatus.no (in Norwegian only)
Ocean climate	
Ocean acidification	http://www.miljostatus.no/havforsuring-i-norskehavet/
Temperature, salinity and nutrients	http://www.miljostatus.no/temperatur-norskehavet/
Transport of Atlantic water	http:// www.miljostatus.no/atlanterhavsvann-norskehavet/
Plankton	
Biomass of phytoplankton	http://www.miljostatus.no/biomasse-planteplankton-norskehavet/
Species composition of phytoplankton	http://www.miljostatus.no/artssammensetning-planteplankton- norskehavet/
Timing of spring bloom of phytoplankton	http://www.miljostatus.no/varoppblomstring-norskehavet/
Species diversity, zooplankton	http://www.miljostatus.no/artsmangfold-dyreplankton-norskehavet/
Biomass of zooplankton	http://www.miljostatus.no/dyreplanktonbiomasse-norskehavet/
Fish	
Norwegian spring-spawning herring	http://www.miljostatus.no/norsk-vargytende-sild/
Mackerel	http://www.miljostatus.no/makrell-norskehavet/
Blue whiting	http://www.miljostatus.no/kolmule-norskehavet/
Northeast Arctic saithe	http://www.miljostatus.no/nordostarktisk-sei/
Tusk	http://www.miljostatus.no/brosme/
Ling	http://www.miljostatus.no/lange/
Greenland halibut	http://www.miljostatus.no/blakveite-norskehavet/
Golden redfish	http://www.miljostatus.no/vanlig-uer-norskehavet/
Beaked redfish	http://www.miljostatus.no/snabeluer-norskehavet/
Seabirds	
Kittiwake	http://www.miljostatus.no/krykkje-norskehavet/
Common guillemot	http://www.miljostatus.no/lomvi-norskehavet/
Puffin	http://www.miljostatus.no/lunde-norskehavet/
Shag	http://www.miljostatus.no/toppskarv-norskehavet/

Indicators	Links to www.miljostatus.no (in Norwegian only)
Common eider	http://www.miljostatus.no/arfugl-norskehavet/
Marine mammals	
Hooded seal	http://www.miljostatus.no/klappmyss-norskehavet/
Alien species	
Alien species	http://www.miljostatus.no/fremmede-arter-norskehavet/
Threatened species and habitat types	
Threatened species and habitat types	http://www.miljostatus.no/truede-arter-i-norskehavet/
Pollutants	
Pollutants in Norwegian spring-spawning herring	http://www.miljostatus.no/forurensning-sild-norskehavet/
Pollutants in shrimps	http://www.miljostatus.no/forurensning-reker-norskehavet/
Pollutants in sediments	http://www.miljostatus.no/forurensning-sedimenter-norskehavet/
Pollutants in coastal cod	http://www.miljostatus.no/forurensning-torsk-norskehavet/
Inputs of hazardous substances from the atmosphere	http://www.miljostatus.no/miljogifter-luft-norskehavet/
Hazardous substances in Greenland halibut	http://www.miljostatus.no/miljogifter-blakveite-norskehavet/
Hazardous substances in mussels along the coast	http://www.miljostatus.no/forurensning-blaskjell-norskehavet/
Hazardous substances in tusk	http://www.miljostatus.no/miljogifter-brosme-norskehavet/
Hazardous substances in hooded seal	http://www.miljostatus.no/miljogifter-klappmyss/
Hazardous substances blue whiting	http://www.miljostatus.no/miljogifter-kolmule-norskehavet/
Hazardous substances in shag eggs	http://www.miljostatus.no/miljogifter-toppskarvegg-norskehavet/
Radioactive pollution in seawater	http://www.miljostatus.no/radioaktiv-forurensning-sjovann-norskehavet/
Inputs of hazardous substances via rivers	http://www.miljostatus.no/elvetilforsler-norskehavet/
Human activity	
Fish mortality	http://www.miljostatus.no/fiskedodelighet-norskehavet/
Inputs of oil from oil and gas installations	http://www.miljostatus.no/tilforsler-av-olje-norskehavet/

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