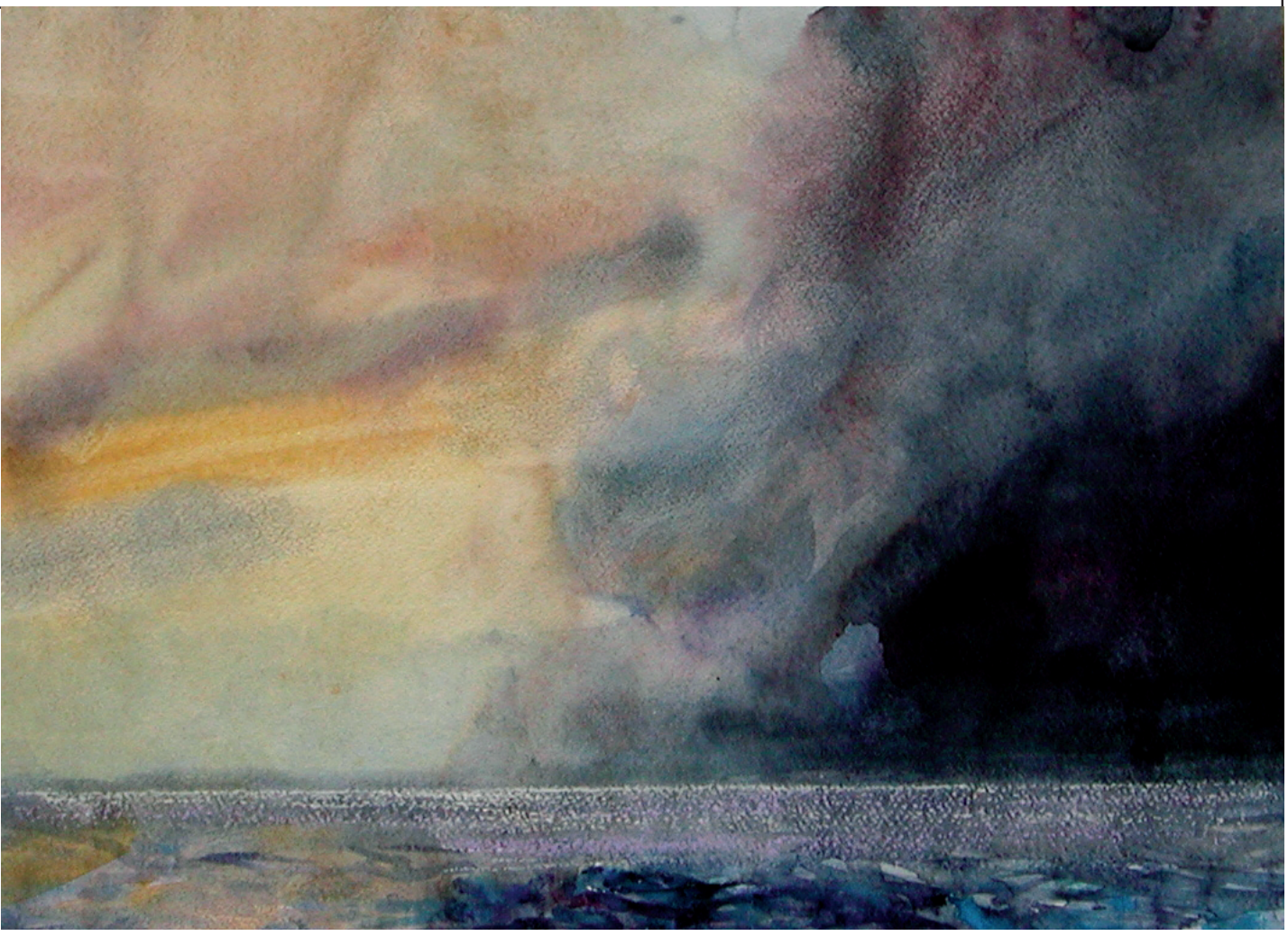
NORWEGIAN MINISTRY OF THE ENVIRONMENT

Report No. 37 (2008–2009) to the Storting

Integrated Management of the Marine Environment of the Norwegian Sea



Ørnulf Opdahl: The Norwegian Sea (watercolour)

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 Norwegian 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 scientific findings.

Ørnulf Opdahl's watercolour was photographed by Silje Gripsrud

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Translation from the Norwegian. For information only.

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Recommendation of 8 May 2009 by the Ministry of the Environment, approved in the Council of State the same day (White paper from the Stoltenberg II Government)

1 Summary

The Norwegian Sea has a rich and varied natural environment that supports high biological production. There are substantial fisheries throughout the year, the most important of which are for Norwegian spring-spawning herring, blue whiting, Northeast Arctic saithe and Northeast Atlantic mackerel. There are also large petroleum deposits in the Norwegian Sea. In September 2009, 12 fields were on stream, and a further two – Morvin and Skarv – were under development but had not yet started production. There is a possibility that wind farms will be established in the Norwegian Sea. The near-shore areas are important in terms of transport. In addition, the Norwegian Sea is an important area for tourism based on enjoyment of the natural environment and for recreational fishing.

The state of the Norwegian Sea environment is generally good. However, management of the area poses considerable challenges, particularly as regards 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 for protection of coral habitats. The Government considers it important to safeguard the ecosystems of the Norwegian Sea over the long term, so that they continue to be clean, rich and productive. The present integrated, ecosystem-based management plan will serve as a basis for these efforts.

The Government intends the management plan to provide a framework for value creation and co-existence between industries through the sustainable use of natural resources and ecosystem services. In addition, ecosystem structure, functioning and productivity must be sustained and the diversity of the natural environment protected. The management plan clarifies the overall framework for both existing and new activities, and also facilitates continued value creation based on the resources of the Norwegian Sea. Until now, the various forms of use of Norway's sea areas and their resources have been assessed and managed in relative isolation. The many different pressures and impacts that affect ecosystems and species have not been taken sufficiently into account, and nor has the principle that the cumulative effects must not exceed sustainable levels. The management plan will thus be used as a tool both to facilitate value creation and to maintain the high environmental value of the area. Commercial activities in the Norwegian Sea area have spin-off effects on employment and value creation in mainland Norway. The white paper therefore describes both environmental conditions in the Norwegian Sea and the importance of the area for commercial activities and social conditions in the four counties that border on the Norwegian Sea. The management plan is also intended to be instrumental in ensuring that business interests, local, regional and central authorities, environmental organisations and other interest groups all have a common understanding of the goals for the management of the Norwegian Sea.

Special caution needed in particularly valuable and vulnerable areas

This white paper continues the system of identifying geographically defined areas within the management plan area that contain particularly valuable environmental assets, which was introduced in the management plan for the Barents Sea–Lofoten area. These areas were selected using predefined criteria. The main criteria were that the area concerned was important for biodiversity or for biological production; secondary criteria included economic importance, social and cultural importance, and scientific value. The vulnerability of particularly valuable areas was assessed in terms of the resilience of species and habitats to external anthropogenic pressures such as fisheries, maritime transport, petroleum activities and long-range transboundary pollution. Eleven particularly valuable areas have been identified in the Norwegian Sea, and their vulnerability has been assessed. The need to maintain ecological goods and services in the areas identified as particularly valuable and vulnerable has determined the Government's choice of spatial management tools.

Cumulative environmental effects

The Norwegian Sea is Norway's largest sea area, and is about three times the size of mainland Norway. Large parts of the water masses and the deep seabed beyond the continental shelf are relatively unaffected by direct pressures from human activity; these are mainly concentrated in the continental shelf areas near the Norwegian coast. Harvesting of biological production by the fisheries has the greatest impact on ecosystems. For certain fish stocks, the cumulative effects have been assessed as so serious that they are vulnerable to even a small increase in human pressures. The greatest cumulative effects are on certain fish stocks, seabird species and seabed habitats. There are also considered to be major effects on corals, sponges and other benthic fauna. Moreover, many seabird populations are declining, and are therefore particularly vulnerable to an increase in cumulative effects. Hazardous substances are having a considerable impact on certain seabird species, particularly in the northernmost parts of the management plan area, and on polar bears. Bioaccumulation of pollutants in fish is another problem, but with our current knowledge it is not possible to say what effects the observed concentrations will have on individuals and stocks. The environmental impacts of any spills and other accidents are additional to those of normal activities and releases of pollutants. In the event of a large oil spill from a blow-out or shipwreck, seabirds and the shoreline are expected to be most seriously affected, while impacts on earlier stages of fish life cycles and coastal seals are likely to be less serious. The Government intends to take action to reduce the cumulative effects of human activities in the management plan area.

Climate change and ocean acidification

There has been growing awareness of the impacts of climate change on the marine environment, and this issue is discussed separately in the white paper. The predicted impacts include changes in sea temperature, ocean currents and sea level. Furthermore, as the atmospheric CO_2 concentration rises, more CO_2 is taken up by sea water, making the oceans more acidic. It is very uncertain how rapidly and in which ways climate change will affect the Norwegian Sea environment. Furthermore, changes may be camouflaged by large natural fluctuations in the period up to 2025. The impacts of ocean acidification are expected to become apparent more quickly, and adverse impacts may be felt before 2025. Calcifying phyto- and zooplankton species, corals and cephalopods are some of the most vulnerable organisms. The Government will strengthen knowledge building and monitoring in this field so that the management regime can be adapted as closely as possible to the predicted changes.

Facilitating the coexistence of different industries

A key purpose of the management plan is to facilitate the coexistence of different industries in the management plan area. Direct conflicts of interests can arise between competing uses of the same area, for example by the fishing industry and the oil and gas industry. Future developments, such as using parts of the Norwegian Sea for wind power production, are included in the chapter on possible conflicts of interests. The plan also gives an account of the processes that are under way to minimise conflicts of interest. The Government will require that commercial activities in the Norwegian Sea are planned and conducted in ways that minimise conflicts of interests.

Risk and risk management

All human activities carry a certain risk of unforeseen incidents. The level of risk associated with an

activity is a combination of the probability of an event occurring and the consequences of the event. Risk analyses are being conducted and preventive measures taken to minimise the risk that commercial activities in the Norwegian Sea will have adverse environmental impacts. The Government considers it important to ensure that there is an emergency response system in place that can prevent and reduce adverse environmental impacts as far as possible in the event that accidents do occur.

Further development of an integrated, ecosystem-based management regime

The present white paper is based on two earlier white papers, *Protecting the Riches of the Seas* (Report No. 12 (2001–2002) to the Storting) and *Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands* (Report No. 8 (2005–2006) to the Storting). It is intended to reinforce and further develop the implementation of an integrated, ecosystem-based management regime for Norwegian sea areas. The Nature Management Act (Proposition No. 52 (2008–2009) to the Storting) and the new Marine Resources Act, which entered into force on 1 January 2009, are important steps in this process.

The management plans for Norway's sea areas set out the overall political and strategic framework and guidelines for management across sectors, and describe the measures that are to be implemented for the conservation and sustainable use of these areas. Norwegian law determines the overall legislative framework (purpose, goals and principles) for management of the sea areas, and lays down which measures can and must be implemented under the legislation. Integrated, ecosystem-based management regimes for sea areas are also being developed internationally. Two EU directives, the Marine Strategy Framework Directive (adopted on 17 June 2008) and the 2000 Water Framework Directive, are particularly important for the protection of Norwegian sea areas, for example against long-range transboundary pollution. The management plan for the Barents Sea–Lofoten area has aroused a great deal of international interest. For example, the European Commission involved Norway in the preparation of the Marine Strategy Framework Directive. The Government will continue the development of an integrated, ecosystem-based marine management regime by following up the present management plan, revising the management plan for the Barents Sea–Lofoten area in 2010 and preparing an ecosystem-based management plan for the North Sea by 2015. The Government will also continue to take part in cooperation in international forums on integrated, ecosystem-based management of the seas.

A knowledge-based management regime

Norway's management plans for sea areas are based on currently available knowledge of ecosystem structure and functioning, and of the impacts of human activity on ecosystems. The Government has therefore attached great importance to building up a sound scientific basis for this management plan. Information has been compiled on environmental conditions, commercial activities in the Norwegian Sea area and social conditions in the counties that border on the Norwegian Sea, in order to establish a common factual basis for action. Thorough scientific investigations have shown that we already have a considerable body of knowledge about the Norwegian Sea and about the marine environment and living marine resources in general. Nevertheless, gaps in our knowledge have been identified in a number of areas. The Government will seek to further strengthen our knowledge of the Norwegian Sea ecosystems and the causes and impacts of environmental pressures in the area.

2 Introduction

2.1 Integrated, ecosystem-based marine management

The foundation for integrated, ecosystem-based management of Norwegian coastal and marine areas was laid in the white paper *Protecting the Riches of the Sea* (Report No. 12 (2001–2002) to the Storting). The term «integrated» is used to mean that the cumulative effects of all human activities on the marine environment are considered. The term «ecosystem-based management» means that the management of human activities is based on the limits within which ecosystem structure, functioning, productivity and biological diversity can be maintained. The concept of the ecosystem approach has been developed and incorporated into a number of international agreements over the past 10–15 years, and the Convention on Biological Diversity (see Box 2.1) has served as an important framework for this process. This approach to marine management was also incorporated into regional conventions, agreements and cooperation forums at an early stage. In the white paper *Protecting the Riches of the Sea*, the ecosystem approach is described as «integrated management of human activities based on ecosystem dynamics. The goal is to achieve sustainable use of resources and goods derived from ecosystems and to maintain their structure, functioning and productivity».

The white paper *Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands* (Report No. 8 (2005–2006) to the Storting), which sets out the plan referred to in this report as «the integrated management plan for the Barents Sea–Lofoten area», was debated in the Storting in spring 2006. This was the first management plan developed for a Norwegian sea area, and both the development process and the plan itself have been used as a model for the development of the present plan. During the Storting debate on the white paper *The Government's Environmental Policy and the State of*

Box 2.1 The Malawi Principles for the Ecosystem Approach (under the Convention on Biological Diversity)

(1) Management objectives are a matter of societal choice.
(2) Management should be decentralised to the lowest appropriate level.
(3) Ecosystem managers should consider the effects of their activities on adjacent and other ecosystems.
(4) Recognising potential gains from management, there is a need to understand the ecosystem in an economic context, considering e.g. mitigating market distortions, aligning incentives to promote sustainable use, and internalising costs and benefits.
(5) A key feature of the ecosystem approach includes conservation of ecosystem structure and functioning.
(6) Ecosystems must be managed within the limits to their functioning.
(7) The ecosystem approach should be undertaken at the appropriate scale.
(8) Recognising the varying temporal scales and lag effects which characterise ecosystem processes, objectives for ecosystem management should be set for the long term.
(9) Management must recognise that change is inevitable.
(10) The ecosystem approach should seek the appropriate balance between conservation and use of biodiversity.
(11) The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices.
(12) The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

the Environment in Norway (Report No. 26 (2006–2007) to the Storting), a strategic objective and national targets for integrated marine and inland water management were adopted (see Box 2.2).

Integrated, ecosystem-based management plans for sea areas clarify the overall framework for both existing and new activities and facilitate coexistence between different industries such as the fisheries industry, maritime transport and the petroleum industry. As a general rule, they apply to sea areas from the baseline and outwards to the open sea, and to pressures and impacts from human activities in these areas. All activities in a sea area are managed according to the principle that the cumulative effects must not exceed a level that will allow ecosystems to be maintained. The management plans also cover the impacts of human activities on coastal areas. The 2006 Water Management Regulations provide a framework for establishing environmental objectives to ensure protection and sustainable use of coastal areas inside the baseline. According to these regulations, management plans for inland and coastal waters are to be drawn up by the competent authority for each river basin district. From 1 January 2010, one of the relevant county governor's offices will be the competent authority for each river basin district. The form of and the process leading up to decisions on the management plans for sea areas and those drawn up under the Water Management Regulations differ in certain respects, but both promote more integrated, ecosystem-based management.

Integrated, ecosystem-based management is a continual process that requires cooperation between the authorities, scientists and stakeholders. Effective mechanisms for cross-sectoral coordination will be an important element of the management regime.

Other important measures for preventing cumulative environmental effects from damaging ecosystems are systematic monitoring of the state of the environment and building up knowledge about pressures exerted by individual sectors and the overall pressures on marine ecosystems. Systematic monitoring of risk trends across sectors also makes it possible to take preventive measures against acute pollution and to ensure an adequate emergency response system.

Box 2.2 Norway's goals for integrated marine and inland water management

Strategic objective

Norwegian coastal and marine areas and inland waters will be managed using an integrated, ecosystem-based approach. Cumulative environmental effects will not exceed a level at which the structure, functioning and productivity of ecosystems and biodiversity are maintained. The water quality in inland and marine waters will be high enough to maintain species and ecosystems and to take account of the requirements of human health and welfare.

National targets

- By 2015, integrated, ecosystem-based management plans will be drawn up for all Norwegian sea areas.
- In accordance with the Water Management Regulations, integrated, ecosystem-based management plans with programmes of measures will be drawn up for at least one sub-district in each river basin district by 2009, and for all Norway's inland and coastal waters by 2015.

2.2 The relationship between the marine management plans and Norwegian legislation

Since the introduction of the management plan for the Barents Sea–Lofoten area, the development of an integrated, ecosystem-based marine management regime has been further strengthened by the Nature Management Act (Proposition No. 52 (2008–2009) to the Storting) and the new Marine Resources Act, which entered into force on 1 January 2009. The management plans for Norway's sea areas set out the overall political and strategic framework and guidelines for management across sectors, and describe the measures that are to be implemented for the conservation and sustainable use of these areas. The Nature Management Act and the Marine Resources Act determine the overall legal framework (purpose, management goals and principles) for the management of sea areas, and the measures that must (duties) and may (powers) be implemented under the legislation. This is described in more detail in Chapter 7.

2.3 Objectives and purpose of the management plan

In addition to more specific targets for management of the Norwegian Sea (see Chapter 9.1), the Government has set the following objectives:

- 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.

Box 2.3 What are ecosystem services?

Ecosystem services are goods, services and processes derived from the environment that are necessary for human survival, welfare and social development. There are four classes of ecosystem services: provisioning services, cultural services, supporting services and regulating services. For example, fish and shellfish that can be harvested, and marine genetic resources and wave power that can be utilised, are provisioning services. Examples of cultural services are aspects of the marine environment that form the basis for tourism or recreation. Supporting and regulating services are necessary for the production of all other ecosystem services. Examples are biodiversity, habitats, the capacity of the sea to cycle nutrients and process hazardous substances, and its role in regulating climate and weather.

Source: UN Millennium Ecosystem Assessment, 2005.

On the basis of these objectives, the purpose of the present management plan is to provide a framework for value creation through the sustainable use of natural resources and ecosystem services in the Norwegian Sea and at the same time maintain the structure, functioning, productivity and diversity of the ecosystems of the area. This requires close coordination between the objectives of the management plan and the legislation that applies to the geographical area of the plan. The management plan is a tool which will be used both to facilitate value creation and to maintain the high environmental value of the area. This means that the framework for activities in the area must be clarified so as to facilitate the sound conduct of activities and coexistence between different industries such as the fisheries and petroleum industries and maritime transport. The management plan is also intended to be instrumental in ensuring that business interests, local, regional and central authorities, environmental organisations and other interest groups all have a common understanding of the goals for the management of the Norwegian Sea.

2.4 Organisation of the work

The preparation of an integrated management plan for the Norwegian Sea began in January 2007, and has been organised by an interministerial Steering Committee for the integrated management of Norwegian maritime areas chaired by the Ministry of the Environment. Other members are the Ministry of Labour and Social Inclusion, the Ministry of Finance, the Ministry of Fisheries and Coastal Affairs, the Ministry of Local Government and Regional Development, the Ministry of Trade and Industry, the Ministry of Petroleum and Energy and the Ministry of Foreign Affairs.

In spring 2007 the Steering Committee established an expert group whose task was to compile the scientific basis for the integrated management plan. The group was chaired by the Directorate for Nature Management, and the other members were the Directorate of Fisheries, the Institute of Marine Research, the Norwegian Coastal Administration, the Norwegian Water Resources and Energy Directorate, the Ministry of Petroleum and Energy, the Norwegian Petroleum Directorate, the Petroleum Safety Authority, the Norwegian Maritime Directorate, the Norwegian Pollution Control Authority and the Norwegian Radiation Protection Authority.

In 2007 the expert group presented five reports that provided a common factual basis for impact assessments: on the environment and natural resources; on maritime transport; on petroleum activities; on fisheries activities; and on commercial activities and social conditions in the counties bordering on the Norwegian Sea. Using these as a basis, impact assessments were conducted in 2007–2008 for fisheries, petroleum activities and maritime transport, which are the activities most likely to affect the state of the environment, the natural resource base and the possibility of engaging in other commercial activities in the management plan area. In addition, the impacts of external pressures such as long-range transboundary pollution, emissions from onshore activities, climate change, ocean acidification and the introduction of alien species were assessed. The cumulative effects were assessed for current (based on 2006) activity levels (normal situation and accidents) and for scenarios for projected levels of activity in the different sectors in 2025 (2025 and 2080 for climate change). If the location and/or levels of activity turn out to be different from those estimated in the assessments, the impacts during normal operations may also differ, and so may the probability and potential impacts of major or minor accidents.

Table 2.1 Five-point scale used to indicate level of impact

Catastrophic	Substantial, extensive loss of ecosystem services and irreversible damage to ecosystems
Major	Serious loss of ecosystem services and considerable risk of irreversible damage to ecosystems and ecosystem functions
Moderate	Isolated but considerable damage to ecosystems and risk of irreversible damage, although this is unlikely
Minor	Isolated cases of minor, reversible damage to ecosystems
Insignificant	No damage to ecosystems

Source: Report on cumulative environmental effects in the Norwegian Sea.

A five-point scale has been used (see Table 2.1) to indicate the expected level of impact on the species groups and habitat types considered in the impact assessments.

All the above-mentioned reports were used as a basis for compiling an assessment of the cumulative environmental effects on the Norwegian Sea and a review of the vulnerability of the particularly valuable areas. In addition, reports on conflicts of interests and knowledge needs and status have been prepared. A further report proposes indicators, reference values and action thresholds for use in an integrated system for monitoring trends in the state of the ecosystem (environmental quality) in the management plan area (see Chapter 9.2). All the documents discussed here, which provide the scientific basis for the management plan, were completed by October 2008. All the documentation is available on the environmental authorities' websites.

To ensure broad participation in the preparation of the management plan, transparent procedures were followed and various interested parties and experts were drawn into the work. Consultations were held on the study programmes for the impact assessments and on the sectoral impact assessments. In November 2008 an open conference on the management plan was held in Ålesund, where the scientific work and the need for measures were discussed in workshops and plenary ses-

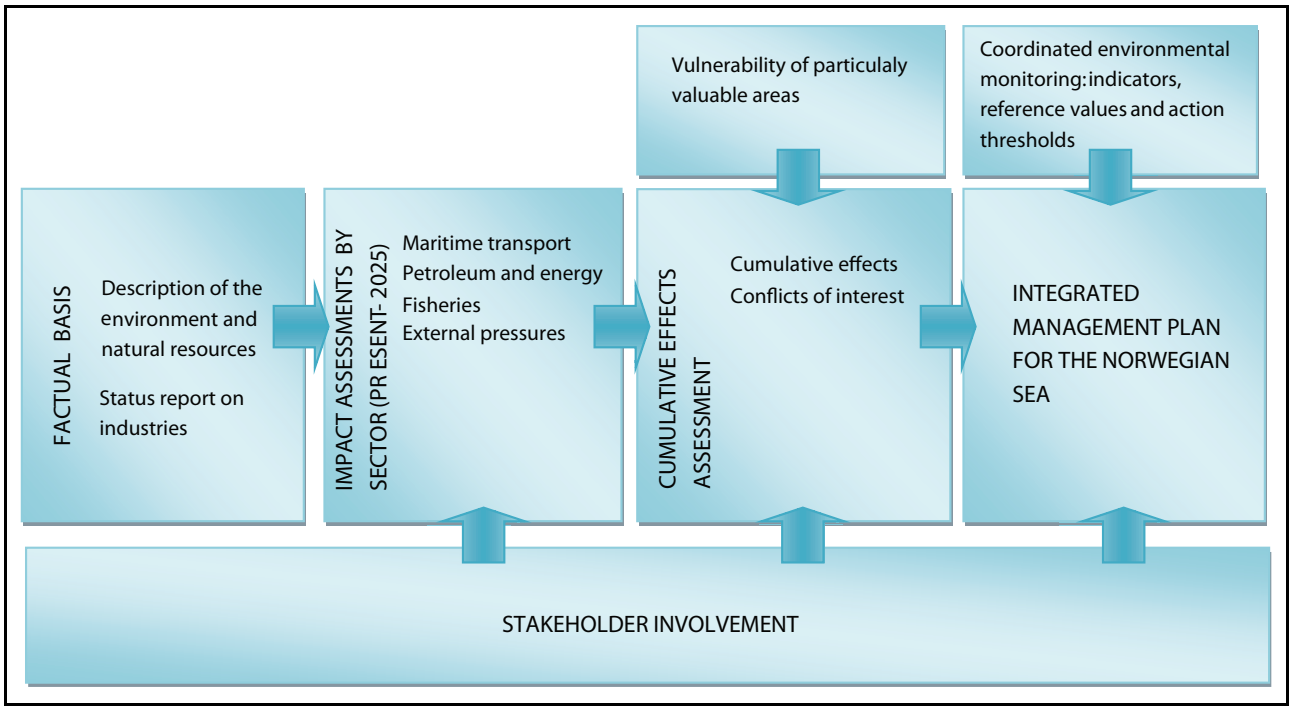

Figure 2.1 Process for drawing up an integrated management plan for the Norwegian Sea

Source: Ministry of the Environment

sions. The conference was attended by more than 200 persons. It was also possible to submit written input and views after the conference.

The present management plan is based on previous knowledge together with all the background documents produced specifically for the plan and other input received since 2007.

2.5 Geographical delimitation, time frame and thematic delimitation of the management plan

The geographical delimitation of the management plan for the Norwegian Sea is based on ecological and administrative considerations. The boundary of the management plan area follows a combination of natural boundaries between marine ecosystems and the boundaries of areas under Norway's jurisdiction. The management plan covers the areas in the Norwegian exclusive economic zone outside the baseline from 62°N at Stad and north to 80°N at Framstredet, northwest of Svalbard, including the deep-water areas west of the Barents Sea and in the fisheries protection zone around Svalbard, and the fisheries zone around Jan Mayen. The scientific basis for the management plan also includes the area of international waters known as the Banana Hole.

The boundary of the management plan area off the Lofoten and Vesterålen Islands has been drawn along the foot of the continental slope, at a depth of about 2 000 metres. In the Barents Sea/Svalbard area, the boundary follows the lower part of the continental slope because of the ecological relationship between the continental slope and the Barents Sea. The background documents and assessments of management challenges and goals in this plan cover the whole of this geographical area. Parts of the area that are in international waters or that are the subject of delimitation consultations with other countries are discussed in the background documents, but the spatial management measures do not apply to these areas. An area inside the baseline in the Vestfjorden has been included in the management plan area for the Norwegian Sea because the thematic scope of the management plans for sea areas includes the important ecological goods and services provided by the Vestfjorden and the types of activities carried out in this area.

Geographically speaking, the waters off the Lofoten and Vesterålen Islands are also part of the Norwegian Sea. However, since there is a close ecological relationship between the spawning areas off Lofoten–Vesterålen and the fish stocks in the Barents Sea, these areas are covered by the integrated management plan for the Barents Sea–

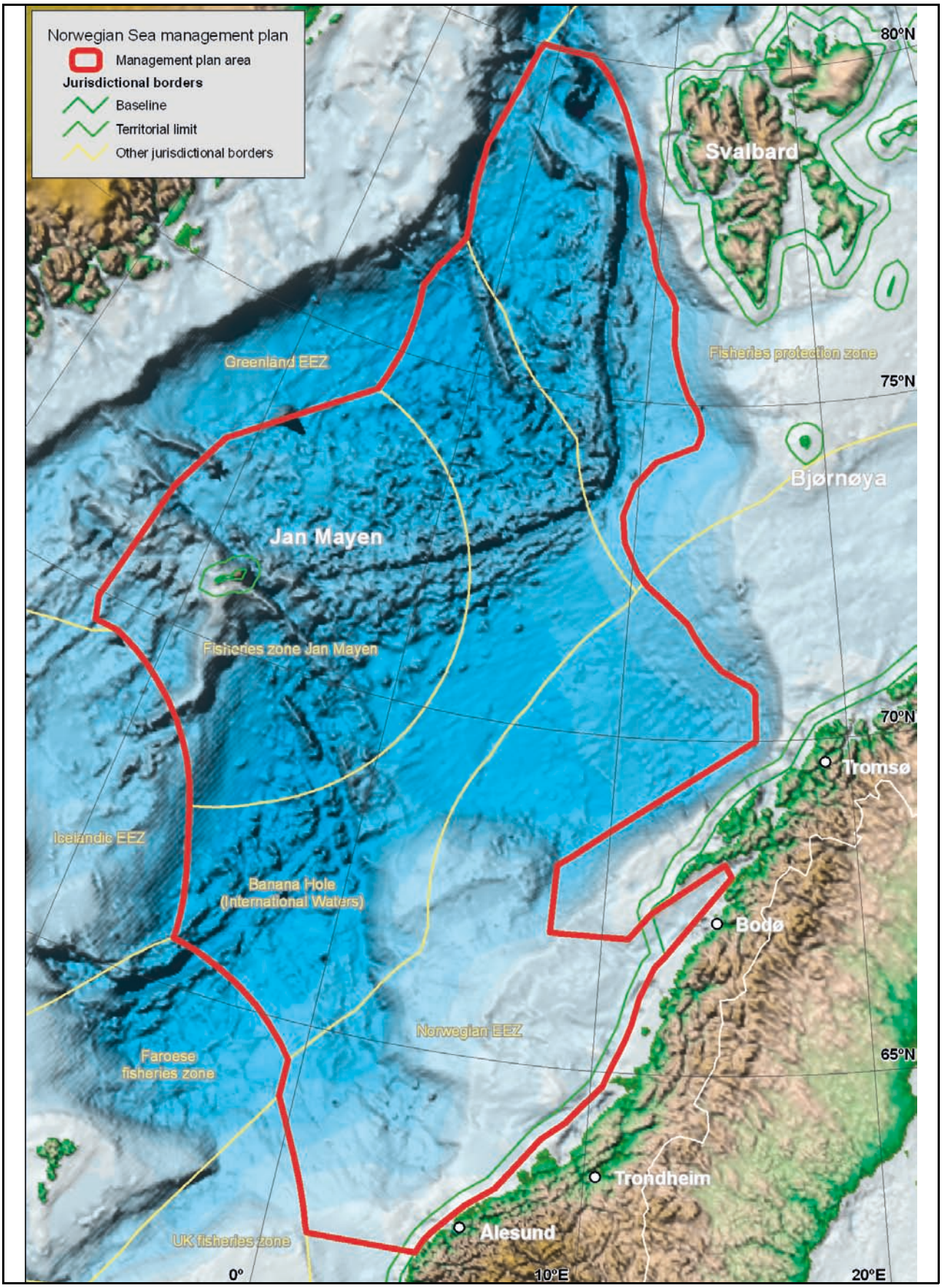

Figure 2.2 Geographical delimitation of the integrated management plan for the Norwegian Sea

Source: Norwegian Hydrographic Service

Lofoten area. An area west of the Barents Sea, in the fisheries protection zone around Svalbard, was also considered during the preparation of the management plan for the Barents Sea–Lofoten area, but it was considered more appropriate to include it in the geographical area of the present management plan because of its close ecological relationship with the Norwegian Sea. However, the assessments and proposed measures for this area described in the management plan for the Barents Sea–Lofoten area will continue to apply.

The present plan will be updated at regular intervals up to 2025 with a view to an overall revision in 2025 for the subsequent period.

Certain thematic and policy areas, such as issues relating to international law, security policy and business policy, are briefly discussed in the present management plan but not considered in depth.

2.6 The Law of the Sea and the international framework for integrated ecosystem-based management

The 1982 United Nations Convention on the Law of the Sea, which Norway has ratified, entered into force in 1994 and lays down fundamental international rules for all maritime activity. It therefore also constitutes the overall legal framework for activities in and the management of the Norwegian Sea. It establishes rights and duties that apply to Norway as a coastal state regarding environmental protection, jurisdiction over maritime transport, and utilisation of living marine resources and petroleum and energy resources.

The Convention also provides the basis in international law for the establishment of Norway's 12-nautical-mile territorial limit and 200-nautical-mile exclusive economic zone, the 200-nautical-mile fisheries zone around Jan Mayen and the 200-nautical mile fisheries protection zone around Svalbard, and for determining the extent of the Norwegian continental shelf. The delimitation lines for the continental shelf and the 200-mile zones between Norway and other coastal states bordering on the Norwegian Sea have essentially been clarified in international agreements, with the exception of the southern part of the Banana Hole. However, in September 2006, Norway, Iceland and Denmark/the Faroe Islands signed agreed minutes establishing a basis for delimitation of the continental shelf in the southern part of the Banana Hole. Final delimitation agreements will be concluded once the Commission on the Limits of the Continental Shelf (CLCS) has made its recommendations. Norway submitted its documentation on the outer limits of the continental shelf in 2006 and the CLCS issued its final recommendations in April 2009. However, since Iceland and the Faroe Islands have not yet submitted their documentation, it will take some time for the extent of their parts of the continental shelf to be determined. Thus it will not be possible to determine the final delimitation line in the Banana Hole in the near future.

Under the Convention on the Law of the Sea, states have the obligation to protect and preserve the marine environment, and must take all measures consistent with the Convention using the best practicable means at their disposal. The Convention emphasises the necessity for global and regional cooperation on formulating and elaborating international rules, standards and recommended practices and procedures for the protection of the marine environment. A good example of regional cooperation is the Convention on the Protection of the Marine Environment of the North-East Atlantic (OSPAR) (see the subsection on OSPAR below).

The Convention on the Law of the Sea gives coastal states the right to establish exclusive economic zones extending up to 200 nautical miles from the baseline, and gives them sovereign rights to natural resources in these zones. The Convention sets out principles for management of such zones and the considerations that apply. Within their economic zones, coastal states must ensure that management and conservation of fisheries resources are based on the best available scientific evidence and that living resources are not endangered by over-exploitation. Where a coastal state does not have the capacity to harvest the entire allowable catch, it must give other states access to the surplus, although in practice this provision is seldom relevant.

The 1995 United Nations Fish Stocks Agreement elaborates on and strengthens important provisions of the Convention on the Law of the Sea. The agreement provides a firm basis in international law for conservation and management regimes (as discussed in Proposition No. 43 (1995–1996) to the Storting on consent to ratification of the agreement), and specifies that management of fish stocks in areas under national jurisdiction and in the adjacent high seas must be compatible and coherent. It also provides a firm basis in international law for applying the precautionary principle to fisheries management and contains provisions for implementing the principle. In addition the agreement requires states to

establish regional cooperation arrangements for fisheries management and provides for more effective enforcement of fisheries regulation. Article 23 states that a port state has the right and duty to take measures to promote the effectiveness of subregional, regional and global conservation and management measures.

The North East Atlantic Fisheries Commission (NEAFC), which is described below, is another example of regional cooperation in this area.

Norway has adopted a number of international agreements and is involved in various cooperation forums whose work is related to management of its marine areas. The most important of these are listed in Box 2.4, and some of the most important international processes and other countries' work on ecosystem-based management are described below under the relevant headings.

Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR)

The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR), which was adopted in 1992, was based on the previous 20 years' experience of implementing the Oslo and Paris Conventions. The convention emphasises the obligation to apply the precautionary and polluter pays principles and to utilise the best available techniques and best environmental practices to prevent and eliminate pollution. By regulating pollution from land-based and offshore (petroleum activities) sources and from dumping or incineration, the convention provides a comprehensive framework for protection of the marine environment against pollution and the adverse effects of human activities. As part of OSPAR's commitment to the ecosystem approach, a new annex, Annex V on protection and conservation of the ecosystems and biological diversity of the maritime area, was adopted in 1998.

OSPAR publishes quality status reports on the marine environment of the North-East Atlantic at regular intervals, most recently in 2000. The next report, Quality Status Report 2010 (QSR 2010), will be presented at the OSPAR Ministerial Meeting in Bergen in 2010. QSR 2010 will be based on an ecosystem approach and will examine all aspects of human influence on the marine environment.

In cooperation with other bodies, including the Helsinki Commission (HELCOM), which is the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, OSPAR has in recent years played an active role in ensuring that the regional seas conventions are used as a platform for the development of integrated management plans in line with the EU's Marine Strategy Framework Directive. The work includes efforts to ensure that the QSR 2010 as far as possible includes the initial assessments required under the Marine Strategy Framework Directive (see section 2.7 below).

The present management plan and its scientific basis will provide important input to QSR 2010, which in turn will form part of the scientific basis for Norway's management plan for the North Sea.

OSPAR's sphere of responsibility does not include fisheries or maritime transport, which are covered by the NEAFC and the IMO respectively. OSPAR works closely with other competent regional organisations and has concluded agreed memorandums of understanding or agreements of cooperation with a number of these, including the NEAFC and the IMO.

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 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 parties to the NEAFC are Denmark, representing the Faroe Islands and Greenland, the EU, Iceland, Norway and Russia. The secretariat is located in London.

The Commission's primary function is to coordinate the regulation of fisheries for stocks that migrate between different countries' exclusive economic zones and international waters. These are mackerel, blue whiting, Norwegian spring-spawning herring and redfish. Coastal state agreements have now been concluded for these stocks, except for redfish, that will make it possible to conclude agreements on their management in the NEAFC as well.

The NEAFC is taking active steps to adapt to developments in the Law of the Sea, in accordance with the precautionary principle and the ecosystem approach, and Norway has played a key role in this process. The NEAFC was the first regional fisheries management organisation to establish port state control rules, which have been shown to

Box 2.4 International agreements and cooperation applicable to the marine environment

An important part of the framework for management of Norwegian sea areas is provided by international agreements and the work of various international organisations. Some of the most important are listed below.

Global level

- The United Nations Convention on the Law of the Sea (UNCLOS, 1982), which provides the overall legal framework for management of sea areas.
- The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters (1972), together with the 1996 Protocol.
- The International Maritime Organisation (IMO) has adopted a number of conventions relating to protection of the marine environment, including the International Convention for the Prevention of Pollution from Ships (MARPOL), the International Convention for the Safety of Life at Sea (SOLAS), the International Convention on the Control of Harmful Anti-Fouling Systems (2001) and the International Convention for the Control and Management of Ships' Ballast Water and Sediments (2004, not yet in force).
- The Convention on the Continental Shelf (1958).
- The Convention on Long-Range Transboundary Air Pollution (1979).
- The United Nations Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) (1995).
- The United Nations Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (Fish Stocks Agreement) (1995).
- The Convention on Biological Diversity (CBD, 1992) is a global agreement on conservation and sustainable use of biological diversity and the equitable sharing of the benefits arising out of the utilisation of genetic resources.
- The Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention, 1979). The objective of the Convention is to conserve terrestrial, marine and avian migratory species throughout their range.
- The Convention on International Trade in Endangered Species (CITES) regulates international trade in wild animals and plants.
- The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention, 1971). Although it originally focused on wetlands as waterfowl habitats, the Convention now deals with a very wide range of wetland issues, including integrated water resources management and poverty issues.
- The Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention, 1991). The objective of the Convention is to prevent, reduce and control significant adverse transboundary environmental impacts.
- The International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC Convention, 1990).
- The Convention on the Transboundary Effects of Industrial Accidents (1992).
- The Stockholm Convention on Persistent Organic Pollutants (2001).

Box 2.4 cont.

Regional level

- The Convention on the Protection of the Marine Environment of the North-East Atlantic (OSPAR, 1992) regulates all sources of pollution and aims to protect the biodiversity and marine ecosystems of the North-East Atlantic.
- The objective of the Convention on Future Multilateral Co-operation in the North East Atlantic Fisheries, and the North East Atlantic Fisheries Commission (NEAFC, 1980) established pursuant to the Convention, is to promote the conservation and optimum utilisation of the fishery resources of the North-East Atlantic area.
- The Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention, 1979) was adopted to conserve wild plant and animal species and their natural habitats, especially species and habitats whose conservation requires cooperation between states, and to promote such cooperation.
- The Arctic Council (1996) is an intergovernmental forum for promoting cooperation, coordination and interaction between the circumpolar Arctic States. The member states are Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden and the US. Environmental concerns are at the core of the cooperation, and a working group has been established on the Protection of the Arctic Marine Environment (PAME). Working groups have also been established for the Arctic Contaminants Action Program (ACAP), the Arctic Monitoring and Assessment Programme (AMAP), the Conservation of Arctic Flora and Fauna (CAFF) and Emergency Prevention, Preparedness and Response (EPPR).
- The Agreement for Cooperation in dealing with Pollution of the North Sea by Oil and Other Harmful Substances (Bonn Agreement, 1983).
- The Nordic Council of Ministers (1971) is a cooperation forum for the governments of the Nordic countries, which deals among other issues with the marine environment and its integrated management.
- The European Maritime Safety Agency (EMSA) is mainly concerned with issues relating to maritime safety, environmental protection and acute pollution by ships. It also supports the pollution response systems of member states.

be an effective tool for combating illegal, unreported and unregulated fishing (IUU). The organisation has also implemented a comprehensive system for satellite tracking of fishing vessels in the North-East Atlantic. Norway has played an active role in the process of implementing operational rules on the protection of sensitive marine ecosystems within the NEAFC area. The rules are based on the UN Resolution calling on states to restrict bottom fishing in vulnerable marine ecosystems and the FAO guidelines on the management of deep-sea fisheries on the high seas. As early as 2004 the NEAFC closed a number of vulnerable areas to bottom trawling and fishing with fixed gear.

The International Whaling Commission (IWC)

The purpose of the International Convention for the Regulation of Whaling is to provide for the proper conservation of whale stocks and thus make possible the orderly development of the whaling industry, on the basis of scientific findings. The IWC was established to fulfil this purpose.

The IWC decided at its meeting in 1982 to introduce a temporary moratorium on commercial whaling from 1985/86. This provision was to be kept under review, based on the best scientific advice, and according to the wording of the moratorium, «by 1990 at the latest the Commission will undertake a comprehensive assessment of the effects of this decision on whale stocks and will consider modification of this provision and the establishment of other catch limits.» Norway

entered a reservation in accordance with Article V (3) of the Convention, and is therefore not bound by its provisions. Norway also entered a reservation against the 1985 IWC decision to define the North-East Atlantic minke whale stock as protected, since there was no scientific basis for the decision. Thus Norway is not bound by this decision either. Norwegian whaling, which takes place mainly in the management plan area, has therefore been conducted since 1992 on a national autonomous basis and according to a national management regime established by the Government in line with the relevant IWC provisions and using the IWC's Revised Management Procedure. It should be noted that the IWC has not managed to comply with the comprehensive assessment provision or to modify it, so that 19 years later the text still remains unchanged. Given that this is a sunset provision, in Norway's view the decision no longer applies to any of the parties to the convention, including those that, unlike Norway, lodged no reservation at the time.

The North Atlantic Marine Mammal Commission (NAMMCO)

NAMMCO was established in 1992, with Norway, Iceland, Greenland and the Faroe Islands as members. Canada, Japan and Russia have observer status. The purpose of the commission is cooperation on the conservation, management and study of marine mammals in the North Atlantic area.

One of the reasons for the establishment of NAMMCO was that the IWC was not fulfilling its management obligations under the Whaling Convention. The commission has focused mainly on small cetaceans, seals and walruses, which are outside the IWC's field of responsibility, but the commission does advise the IWC on management of populations managed by the IWC. In practice the commission functions as a supplement to the IWC, and there is close cooperation between the scientific committees of the IWC and NAMMCO.

NAMMCO has become a competent and effective body and the member countries have improved their management of several marine mammal populations.

One of the main functions of the commission is to investigate how marine mammals respond to changes in the marine environment and how these mammals interact with important commercial fish stocks. The commission is expected to continue to give priority to ecosystem-based management of marine resources in the North Atlantic.

The International Council for the Exploration of the Sea (ICES)

All countries bordering the North Atlantic and the Baltic Sea are members of the International Council for the Exploration of the Sea (ICES), which was established in 1902. ICES coordinates and promotes marine research, provides information on the marine ecosystem of the North Atlantic, including the ocean climate and the status of living marine resources, and advises on their harvesting potential. Scientific advice from ICES is vital to the management of joint fish stocks and the management regimes of the individual member countries. The scientific basis for advice is compiled by a number of expert groups, which cover all areas of marine research and in which researchers from all the member countries may participate. Together they form a body of expertise on the composition of marine ecosystems and the factors that influence them. Scientific advice from ICES is based on the ecosystem approach. The advisory process is open and transparent, and observers have access to it at almost every level. ICES' advice on fish stocks is crucial to fisheries management and forms an agreed frame of reference for international quota negotiations. ICES also provides advice and research findings to other organisations like OSPAR, and is one of the main contributors to the OSPAR quality status report for the North-East Atlantic (OSPAR QSR 2010). It publishes an annual climate report and a biannual plankton report for the North Atlantic area.

2.7 Work on integrated, ecosystem-based marine management in the EU and other countries

The European Union (EU)

The EU is also taking an integrated approach to marine management and sea-related activities, under which the cumulative effects of activities in all sectors and industries on the marine environment are considered together. The EU's maritime policy focuses on a wide of policy areas that include the environment, maritime transport, fisheries, aquaculture, climate and energy, and research. Maritime spatial planning is used as a tool for reconciling competing maritime economic activities and for integrated coastal zone planning. The maritime policy also proposes specific actions covering different aspects of maritime transport, for example a strategy for ship dismantling. The European Maritime Safety Agency (EMSA) is providing

important technical assistance in this field, in particular through its responsibility for ensuring an optimal pollution preparedness and response system for maritime transport, and for investigating illegal spills. As part of the follow-up to its maritime policy, the EU is also adopting an Arctic Strategy.

The EU's Marine Strategy Framework Directive, adopted on 17 June 2008, is described as the environmental pillar of the organisation's maritime policy. It sets out procedural and general requirements for member states' systems for protection and use of the marine environment, and thus establishes a joint framework for management of all European marine waters. The directive does not, however, contain specific requirements regarding commercial and other activities that could have impacts on the marine environment.

Marine regions have been established under the Directive, and these may be divided into subregions and subdivisions. The North-east Atlantic Ocean is designated as a marine region, while the Greater North Sea, including the Kattegat and the English Channel, is a subregion.

The aim of the Directive is to achieve good environmental status in all European marine waters by 2020 at the latest. Coherent and coordinated strategies are to be developed for each marine region with the following main elements:

a) Determination of good environmental status: by 2012 member states must:
   i. determine good environmental status for each marine region or subregion;
   ii. establish environmental targets and associated indicators;
   iii. make an initial assessment of the current environmental status of the waters and the environmental impact of human activities in the whole marine region concerned.
b) Monitoring: by 2014 a coordinated monitoring programme must be established and implemented.
c) Programme of measures: by 2015 at the latest an integrated programme of measures designed to achieve or maintain good environmental status by 2020 must be established, which will enter into operation by 2016 at the latest.

Countries sharing a marine region or subregion will be required to cooperate to ensure that the measures are coherent and coordinated across the marine region or subregion concerned. Existing regional structures and cooperation forums such as OSPAR and HELCOM (see section 2.6 above), and the Barcelona and Black Sea Conventions will play a key role as platforms for the implementation of the Directive in the relevant regions and subregions.

The Directive also provides for more rapid action than set out in the normal timetable «where the status of the sea is so critical as to necessitate urgent action». The Baltic Sea, which suffers from extensive eutrophication, is an example of a marine area to which this provision is highly applicable.

The European Commission and the various EU presidencies have actively involved Norway in the development of the Marine Strategy Directive. The work on management plans in Norway, especially the integrated management plan for the Barents Sea–Lofoten area, has been presented several times in EU forums, and has to some extent served as a model for the development of the marine strategies currently being drawn up under the Directive. The EU is also maintaining close contact with the regional seas conventions in this process. For example, the conventions are independently represented in the EU work on elaborating the Directive's general environmental goals and requirements.

The way Norway should be associated with the directive is currently under consideration.

Sweden

Marine environmental protection, especially improving the state of the Baltic Sea environment, has high priority in Sweden. In October 2008 an EU-financed analysis of the costs and benefits in the event that measures are taken or are not taken in this sea area, a parallel to the Stern Review on climate change, was submitted to the Riksdag. Sweden is taking steps to promote more integrated marine management through OSPAR, the Nordic Council and the EU. The marine environment will be a priority area when Sweden takes over the EU presidency in autumn 2009.

The UK

The need for a new approach and new legislation for the management of sea-based activities has been pointed out in a number of British studies and reports in recent years, starting with the Marine Stewardship Report of 2002. As a result the British Government introduced the Marine and Coastal Access Bill in 2008, which proposes a new marine planning system for the strategic management of the seas around the UK. This includes a new marine licensing system, new measures for the conservation of marine biodiversity and the devel-

opment of a series of marine plans. Under the provisions of the Bill, it will be possible to designate marine conservation zones in all United Kingdom sea areas, including the exclusive economic zone and the UK sector of the continental shelf. The aim is that the UK should fulfil its commitment under the Convention on Biological Diversity to establish an ecologically coherent network of well-managed marine protected areas by 2010, and its commitment to protect habitats and species under the EU's Habitats Directive and wild birds under the Wild Birds Directive.

Canada

A key element of the Canadian Oceans Act, which was passed in 1997, is an integrated, ecosystem-based approach to management of the Canadian oceans. The Act was followed in 2002 by Canada's Oceans Strategy, which is a policy framework for marine management. National guidelines have been developed for identification of ecologically and biologically important areas, species and features of the marine environment, and for drawing up conservation goals for integrated management plans in defined ecoregions. In 2005 Canada adopted an Oceans Action Plan with a budget for the first of a series of phases extending up to 2012. Canada has also increased support for development and implementation of regional integrated management plans for Canadian sea areas.

The first multi-year, strategic-level plan is the Eastern Scotian Shelf Integrated Management (ESSIM) Initiative. The Eastern Scotian Shelf is a sea area of over 300 000 km^2 off the east coast of Nova Scotia. ESSIM is implemented through existing jurisdictional, management and regulatory regimes and processes and specific action plans. There are working groups on sector-specific, cross-sectoral and topic-based measures (for example fisheries, marine spatial planning and waste reduction respectively). Canada is also developing a number of other integrated management plans for sea and coastal areas that will be discussed and agreed on with stakeholders and approved by state and federal authorities.

Centres of expertise, including one for developing a state of the oceans reporting system, have been established to work on national priority areas of marine management.

Australia

In 2004 Australia published the South-East Regional Marine Plan, and in 2005 it was decided that marine bioregional plans should be developed for all Australia's marine regions by 2012. The plans have been brought directly under federal environmental legislation, and will be key documents in cooperation and consultation with stakeholders on the use of the marine regions. Each of the five regions – South-east, South-west, North-west, North and East Marine Regions – will have its own marine bioregional plan. The planning process, which is at different stages for the various regions, involves the creation of regional profiles that describe the key features of each region (habitats, species, natural processes, and so on). They also set out the objectives for subsequent work on developing the final Marine Bioregional Plan. Regional profiles were completed for the North and North-west Regions in 2008, and the final plans for these regions are expected to be released in 2010. They will identify a wide range of measures, including the establishment of marine protected areas in each region.

3 Ecosystems and the status of biological diversity and habitats in the Norwegian Sea

3.1 The ecosystems of the Norwegian Sea

Oceanographic conditions

The management plan area covers approximately 1.17 million km^2, stretching from shallow bank areas on the continental shelf (50–300 metres) to deep-water areas down to 4 000 metres. The average depth of the Norwegian Sea is about 1 800 metres, and it is dominated by two deep-water basins, the Norwegian Basin and the Lofoten Basin, at depths of between 3 000 and 4 000 metres. It is separated from other sea areas further west by the Jan Mayen Ridge and Mohn's Ridge, which run south and north-east from Jan Mayen.

Current patterns in the Norwegian Sea are largely determined by the seabed topography. The underwater ridge between Scotland and Iceland, which marks the southern boundary of the Norwegian Sea, is generally shallower than 500 metres. Warm, saline Atlantic water flows into the Norwegian Sea along two main paths, between the Faeroe Islands and Shetland, and between the Faeroe Islands and Iceland. The warm water flows northwards into the Barents Sea and the Arctic Ocean, but also spreads more widely into the Norwegian Sea. Cold, less saline water from the Iceland Sea flows into the southern part of the Norwegian Sea. In the south-western Norwegian Sea, the upper water layer is therefore relatively cold, whereas it is relatively warm in the rest of the Norwegian Sea.

The climate of the Norwegian Sea is highly variable, both on a seasonal scale and from year to year. The large interannual variations are to a large extent explained by variations in the temperature of the inflowing Atlantic water, in the volume of cold Arctic water flowing in from the west, and in the heat loss from the sea to the atmosphere. Warm Atlantic water flowing into the Norwegian

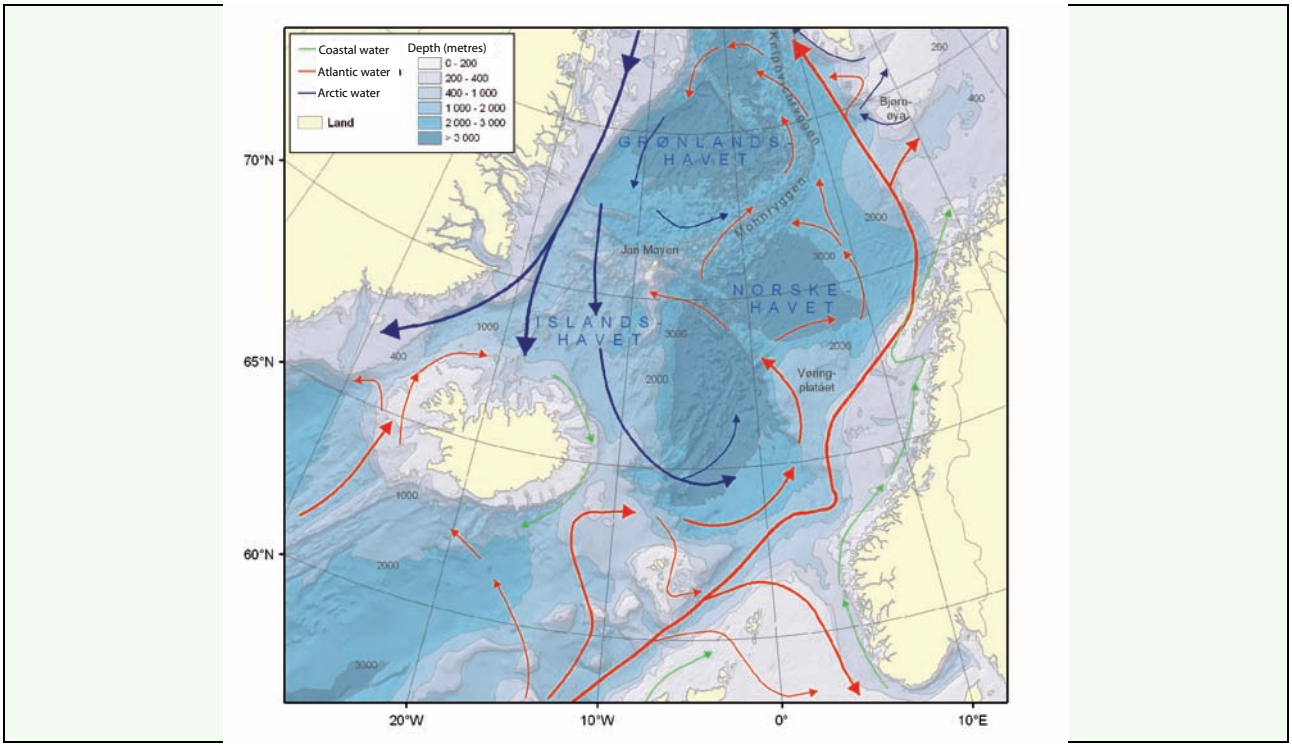

Figure 3.1 Map of the ocean currents flowing into and out of the Norwegian Sea

Source: Institute of Marine Research/Norwegian Coastal Administration

Box 3.1 Definitions

Ecosystem: a dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit.
Source: Convention on Biological Diversity (CBD)

Biological diversity: ecosystem, species and intra-species genetic variability, and the ecological relationships between ecosystem components.
Source: Nature Management Act

Biological, geological and landscape diversity: includes all diversity that is not largely a result of human influence.
Source: Nature Management Act

Alien organism: an organism that does not belong to a species or population that occurs naturally in an area.
Source: Nature Management Act

Habitat type: a relatively homogenous environment, including all plant and animal life and environmental factors that operate there.
Source: Norwegian Biodiversity Information Centre

Sea loses a great deal of heat to the atmosphere, and this is of crucial importance for the mild climate of northwestern Europe. The inflow of warm Atlantic water also keeps the Norwegian Sea free of ice and results in high biological production.

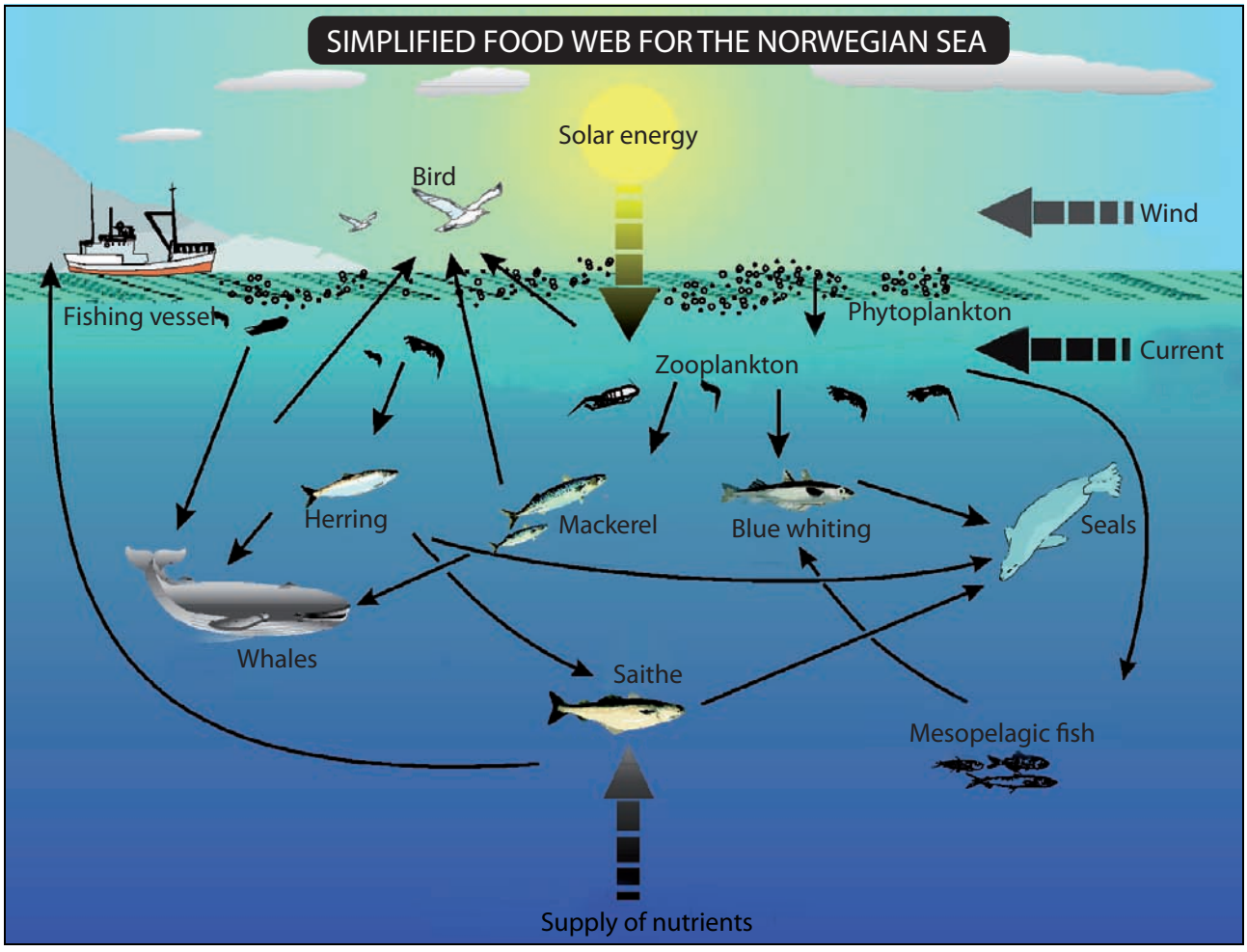

Figure 3.2 Interactions in the marine ecosystem of the Norwegian Sea

Source: Institute of Marine Research

Ecological conditions

The Norwegian Sea ecosystems, like all natural ecosystems, are constantly changing. This would be the case even without any influence from human activity. Biological production is high in the Norwegian Sea, and biomass is very high. Production is believed to be particularly high in the front zones between current systems. Ocean currents carry small organisms such as phytoplankton, zooplankton, eggs and larvae in and out of the Norwegian Sea.

Sunlight, carbon dioxide (CO_2) and nutrients in the water masses provide energy and food for the growth of phytoplankton and seaweeds (primary production), and zooplankton species feed on phytoplankton. Both phytoplankton and to some extent seaweed and kelp also provide food for microorganisms and other grazing species in the food web. Zooplankton species, mainly copepods, amphipods and krill, are a key food source for many fish stocks and marine mammals in the Norwegian Sea. Copepods, including the dominant species *Calanus finmarchicus*, use the deep-water basins for overwintering and shelter from predators. They are found in surface waters for a short period in spring and summer, when they graze on phytoplankton and spawn, hatch and develop. During the brief, intense spring bloom, there is a huge quantity of planktonic algae in the surface layer. Plankton not only provides nutrition for species in the water column, but also for ecosystems on the seabed. Dead planktonic organisms and remains sink towards the bottom and provide food for organisms that feed on small particles. Plankton is the most important basis for the food chains of the Norwegian Sea.

Figure 3.3 A school of herring, one of the key species in the Norwegian Sea

Photo: Erling Svensen

Most species in the Norwegian Sea feed on organisms at several levels in the food web. For example, saithe eat both plankton and other fish, and the largest krill species (planktonic crustaceans) feed on both phyto- and zooplankton. Whales and seals live on both zooplankton and fish, with variations between species. Certain species, for example *Calanus finmarchicus* and herring, are key species in the Norwegian Sea. Food chains, and probably the productivity of ecosystems, would change considerably if such species were to disappear. *C. finmarchicus* makes up a large proportion of the total animal biomass in the Norwegian Sea, and is an important element of food chains, for example as food for large fish stocks. Herring are prey for a wide range of species, from cod and saithe to whales and seabirds, and their roe and milt are also important food for fish, several seabird species and a variety of benthic animals and microorganisms.

While current knowledge of the ecosystems in the water masses of the Norwegian Sea is generally good, knowledge of ecosystems on the seabed is much poorer. In general, habitats vary with depth, the underwater landscape and other geological, physical and chemical conditions. The large deep-water basins contain level areas where there is a varied deep-water fauna but a limited biomass. Biological production is high in the shallow bank areas on the continental shelf.

Some areas of the seabed have been surveyed in connection with planning and environmental impact assessment of petroleum activities. This has among other things resulted in the discovery of the Sula coral reef. Information from fishermen on bycatches of corals has also provided useful data for mapping of coral habitats. On the basis of information from all these sources, the Institute of Marine Research has carried out further surveys of selected coral reef complexes.

Coral reefs provide a habitat for many species, and support high biodiversity. At present, little is known about their role in ecosystems, but research is being carried out for example on their importance for fish. Corals also play a role in the CO_2 balance in the sea since they deposit carbon as carbonate in their skeletons, but little is known about the importance of this process.

Relatively little is known about other seabed habitats in the Norwegian Sea below the depths to which sunlight penetrates, and about their role in larger-scale ecosystems. These include gorgonian forests, sponge communities, seamounts, mud volcanoes, cold seeps and black smokers. The Håkon Mosby mud volcano is an exception, and extensive

studies have been carried out here. Surveys off the Lofoten and Vesterålen Islands under the MARE-ANO programme suggest that further work in the Norwegian Sea is likely to reveal other little-known habitats on the seabed. Little research has been done on the ecological importance of seabed habitats for life in the water column.

More is known about the ecological importance of seaweeds and kelp forests. These are found on suitable hard-bottom substrates in the coastal zone. Seaweed communities and kelp forests are highly productive areas, and are important nursery and feeding areas for fish and feeding areas for several seabird species.

3.2 Description of ecosystems and status of biological diversity and habitats

Our knowledge of the status of biological diversity and habitats in the Norwegian Sea is most complete for ecosystems in the water column and for fish, seabirds and marine mammals.

There appears to be a slowly declining trend in biomass, the largest proportion of which consists of plankton, in both Atlantic and coastal water in the Norwegian Sea. The most important fish stocks, such as Norwegian spring-spawning herring, blue whiting, Northeast Atlantic mackerel and Northeast Arctic saithe, are at satisfactory levels. On the other hand, stocks of deep-water species – redfish (*Sebastes marinus* and *S. mentella*), Greenland halibut, tusk, ling and blue ling – have declined in recent years. There has also been a decline in the breeding populations of several seabird species that feed in the open sea. This decline has been most dramatic for Atlantic puffin and common guillemot, which feed on pelagic fish species, but a population decline has also been registered for northern fulmar, lesser black-backed gull (subspecies *Larus fuscus fuscus*) and black-legged kittiwake, which are surface feeders.

In the southern part of the management plan area, the kelp forests are in good condition, but in the northern part they have been severely depleted by overgrazing by sea urchins. However, re-establishment of *Laminaria hyperborea* has been registered as far north as Vega (Nordland) in the last few years. Both coral reefs in good condition and damaged reefs have been registered. The overall status of coral reefs in the Norwegian Sea is unknown. The same applies to other benthic biodiversity and habitats. The state of the Norwegian Sea environment is generally good.

3.2.1 Zooplankton – description and status

Most of the animal biomass in the Norwegian Sea consists of zooplankton, largely small crustaceans such as the copepod *Calanus finmarchicus*, pelagic amphipods and krill. Zooplankton, and especially adult *C. finmarchicus*, are a key food source for fish such as herring, blue whiting, mackerel and saithe. A number of marine mammals that occur in the Norwegian Sea also graze on zooplankton. Most species in the Norwegian Sea feed on organisms at several levels in food chains, and zooplankton are also food for other zooplankton species. For example, the largest krill species eat other zooplankton species as well as phytoplankton.

There appears to be a slowly declining trend in biomass in both Atlantic and coastal water in the Norwegian Sea. Better estimates of plankton biomass are needed.

3.2.2 Benthic habitat types – description and status

Corals form habitats such as coral reefs, coral rubble and gorgonian forests. The coldwater corals in the Norwegian Sea are generally found at depths of 200–500 metres. The reefs that have so far been found on the continental shelf in the Norwegian Sea (see Figure 3.4) include the largest known coldwater coral reefs. These are complex three-dimensional structures that provide suitable habitats for many sessile and free-swimming organisms. Coral reefs support high biodiversity, and the commonest fish species are tusk, ling and redfish. A great deal of work remains to be done on the role of coral reefs in the ecosystem and for the natural resource base.

It has previously been estimated that about 30–50 % of Norwegian coral reefs have been damaged or destroyed by bottom trawling. New discoveries provide a basis for revising this estimate. The protected Røst and Sula reefs are considered to be in very good condition, and the protected Iverryggen reef to be in good condition, but with damage to some parts of the area dating from before it was protected. The reefs in the Træna Deep are also in good condition. Knowledge about the role of gorgonian forests in the ecosystem and their distribution and status is even less complete than for coral reefs.

Sponges can occur in dense communities that are habitat-forming and may have similar ecological functions to those of gorgonian forests. There are known to be sponge communities in parts of the Barents and Norwegian Seas, but there is no

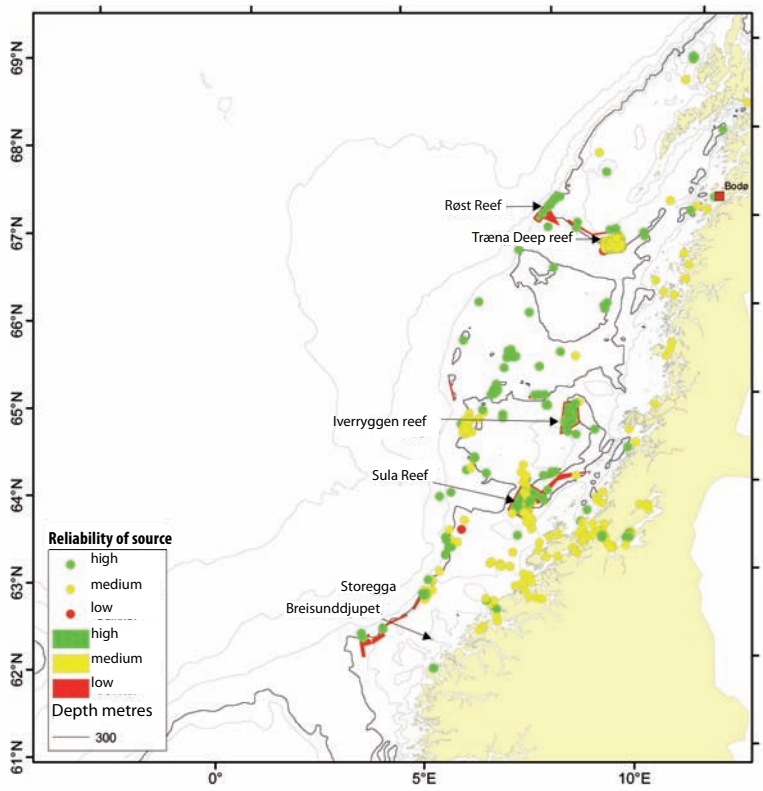

Figure 3.4 Registered coral reefs in the Norwegian Sea

Source: Institute of Marine Research

detailed information on their distribution. However, sponge communities have been registered in the Tromsøflaket bank area and along the edge of the continental shelf in the Norwegian Sea. Redfish and a rich benthic fauna are often found in areas where there are sponge communities. Little work has been done on the ecological importance of sponge communities, but it is reasonable to assume that they are important for both fish and invertebrates. Sponges are among the groups of particular interest in connection with bioprospecting.

Seamounts are most often found on deep-sea ridges, but there are also isolated seamounts or groups of them on abyssal plains. In the Norwegian Sea, most seamounts are found along the continuation of the Mid-Atlantic Ridge from Jan Mayen and northwards. The fauna associated with seamounts in the Norwegian Sea has not been investigated. However, studies of seamounts in adjacent areas have revealed a rich benthic flora including sponges, bryozoans, tube worms, molluscs, echinoderms and bristle worms. The summits of the seamounts in the Norwegian Sea are at much greater depths (550–2 100 metres) than is usual in other sea areas.

Mud volcanoes: The largest mud volcano in the North Atlantic, Håkon Mosby, lies at a depth of 1 270 metres between Svalbard and the Norwegian coast. Mud and methane gas flow upwards from deeper layers in the volcano and are discharged, supporting an ecosystem containing an assemblage of species adapted to life with no sunlight (including microorganisms and a special group called the Pogonophora or bearded worms). Research is being carried out on the processes taking place in the mud volcano and how methane is metabolised in the ecosystem.

Cold seeps and black smokers are the two main types of vents on the seabed. Cold seeps are places where gases (hydrogen sulphide, methane or other gases) or hydrocarbon fluids are vented from the seabed at the same temperature as the surrounding water. Pockmarks are a type of cold seep found in many places in Norwegian waters, for example the Nyegga area of the Norwegian Sea (see Figure 3.5). In these areas, characteristic food chains may be formed in which bacteria support a wide range of more complex animals such as bearded worms, sea spiders, crustaceans, fish and feather stars.

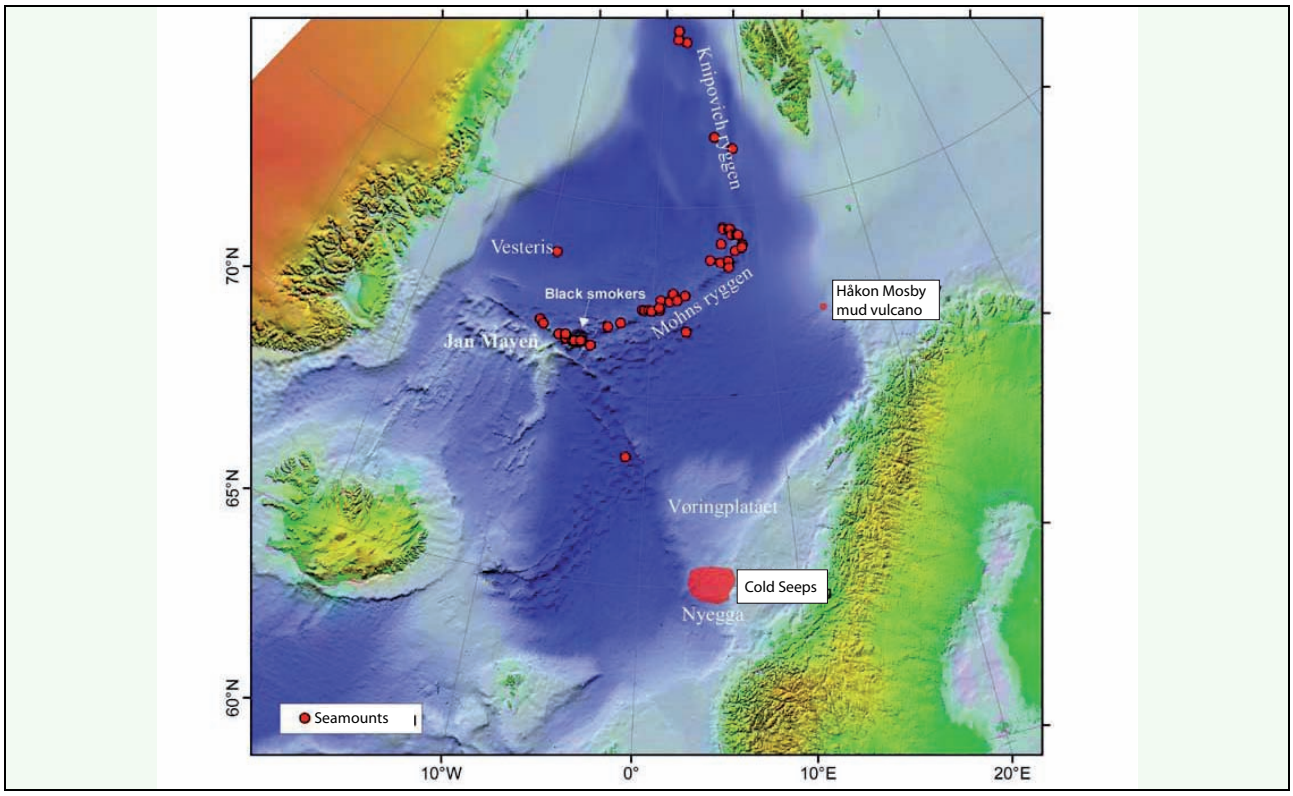

Figure 3.5 Registered seamounts (higher than 1 km) in the Norwegian Sea. The Håkon Mosby mud volcano and an area of cold seeps (Nyegga) are also shown

Source: Institute of Marine Research

The Earth's crust consists of rigid tectonic plates, which move in relation to each other. Where they are moving apart, new crust is formed on the seabed, and this process has given rise to an oceanic volcanic ridge stretching northwestwards from Jan Mayen and between Svalbard and Greeland. Along this ridge, there is volcanic activity in the form of black smokers. Very hot water (400 °C) containing dissolved sulphur and iron and other metals gushes out from these structures. As with cold seeps, bacteria are the first stage in the food chains supported by black smokers. A number of new species and characteristic communities have been found around black smokers in other sea areas. At present, very little is known about these habitats in the Norwegian Sea.

Seaweed communities and kelp forests: Norway has the largest seaweed communities and kelp forests in Europe, and it is estimated that a total area of about 10 000 km^2 along the Norwegian coast is covered by seaweed and kelp. This is about the same as the total area of cultivated land in Norway.

Laminaria hyperborea grows to a particularly large size to form dense kelp forests along the west coast of Norway. Kelp forests are highly productive ecosystems with a rich variety of epiphytic algae, fish and smaller animals. The kelp forests in the southern coastal parts of the Norwegian Sea are dense and productive, whereas those further north have been severely depleted by sea urchin grazing (see Figure 5.4). However, in the last few years re-establishment of *L. hyperborea* has been registered as far north as Vega. *L. hyperborea* grows on hard bottom and forms kelp forests from the low-tide level and down to a depth of about 20–25 metres, while individual plants can grow down to a depth of 40 metres in clear coastal waters. Kelp forests are an important habitat for coastal fish species, nursery areas for several fish species, and important feeding areas for seabirds. They are for example important for juvenile gadids (fish of the cod family) and wrasses, and as foraging areas for cormorants, shags and black guillemots during the breeding season.

Knotted wrack is the most important of the seaweed species, and the biomass along the Norwegian coast is estimated at 1.8 million tonnes. The largest stands are found in protected to moderately exposed areas along the coast, down to a depth of about two metres.

Laminaria hyperborea and knotted wrack are the only macroalgae that are used commercially in

Norway. They are harvested almost entirely from inside the baseline. Knotted wrack is harvested along the coast from Frøya (Nord-Trøndelag) to the Vesterålen Islands and used in the production of seaweed meal and extract, and the harvest is just under 20 000 tonnes per year. *L. hyperborea* is harvested from Rogaland to Sør-Trøndelag, and alginate is extracted for use as a food additive and for other purposes. The Institute of Marine Research monitors trends in the status of kelp forests by sampling at fixed sites every year.

3.2.3 The most important fish stocks – description and status

The Norwegian spring-spawning herring stock is migratory, and at certain times of year schools of herring can be found across large parts of the Norwegian Sea. They arrive at the spawning grounds in January/February and spawn on the coastal banks from Egersund (Rogaland) to the Vesterålen Islands between February and April. The main spawning grounds are off Møre og Romsdal and Nordland. Herring require a suitable substrate for spawning, since the fertilised eggs become attached to the substrate. After about three weeks, the eggs hatch and the herring larvae rise to the surface, where they drift northwards with the currents to the main nursery area in the Barents Sea.

The Norwegian spring-spawning herring stock is the largest herring stock in the world, and is the most important fish stock in the Norwegian Sea in both ecological and commercial terms. It provides food for other species at all levels of the food chain. Large quantities of energy are transferred from the open sea to coastal waters with herring roe and milt. Fishing of juvenile Norwegian spring-spawning herring in the Barents Sea is completely prohibited. Herring is also important as food for human consumption. It is rich in oil, and is exported to many different countries.

Figure 3.6 Fish swimming above a kelp forest

Source: Institute of Marine Research

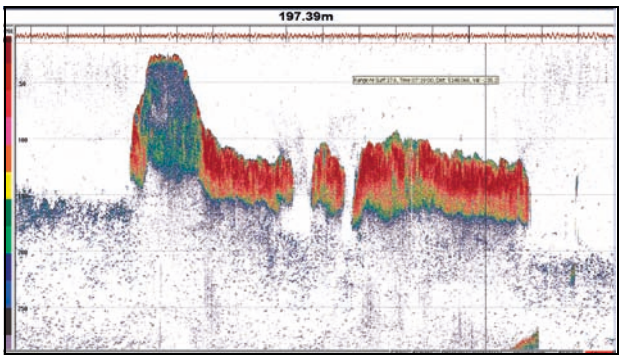

Figure 3.7 On 17 November 2005, the research vessel Johan Hjort registered a school of herring off Andenes in the Vesterålen Islands that was 5 500 metres long and estimated at 230 000 tonnes

Source: Institute of Marine Research

The total allowable catch (TAC) set for 2009 is more than 1.6 million tonnes, which is the same as the recommended TAC. Norway's quota is just over 1 million tonnes.

The blue whiting is a small pelagic gadid, generally found in schools in the mesopelagic zone. It is one of the most numerous fish species in this zone of the Northeast Atlantic. The main spawning area for the Atlantic stock is west of the British Isles, outside the management plan area, but some blue whiting also spawn in the Norwegian Sea, along the edge of the continental shelf northwards towards the Tromsøflaket bank area. The stock is in relatively good condition, but the fishing mortality is too high after several years of catches above the level recommended by the International Council for the Exploration of the Sea (ICES). Recruitment to the stock has been weak since 2005.

The saithe is another gadid. It is both pelagic and demersal, and is found at depths of 0–300 metres. The saithe stock north of 62°N is in good condition. Saithe spawn on the coastal banks from the North Sea to the Lofoten Islands in winter, with a peak in February. The most important spawning grounds in Norwegian waters are near the Lofoten Islands, Halten bank, the Møre banks and the Tampen and Viking banks in the North Sea. Eggs and larvae drift northwards with the currents, and young saithe congregate in the coastal zone from Western Norway to the south-eastern part of the Barents Sea. The saithe is the most important

predatory fish in the Norwegian Sea. It is often found at high density in areas where the current patterns result in concentration of prey species. Large saithe are believed to be an important predator on herring both along the coast and far out to sea. Low fishing pressure over the last 10 years has had a positive effect on recruitment and stock development. The reproductive capacity of the stock is good, and it is being harvested sustainably. Since herring are an important prey species for saithe, the good condition of the herring stock is presumably contributing to the satisfactory development of the saithe stock.

The mackerel is a fast-swimming, pelagic, schooling species that can undertake long migrations. Mackerel do not spawn in the Norwegian Sea, and development from larvae to juveniles therefore takes place outside the management plan area, but the Norwegian Sea is an important feeding area for the species in summer and autumn. Its feeding distribution in the Norwegian Sea has been expanding in recent years, and the species has been observed north of 75°N. The mackerel stock reached a minimum in 2003, but is now increasing again. The spawning stock has risen from 1.7 million tonnes in 2002 to 2.5 million tonnes in 2007. It is now above the precautionary level, and the stock is classified as having full reproductive capacity. However, ICES considers that the stock is being harvested at increased risk. There is considerable uncertainty about the stock level because of illegal landings, discards and slippage of whole catches or parts of catches. The North Sea component of the mackerel stock is still depleted and needs protection. Mackerel is one of the fattiest fish in this area, and is rich in omega-3 fatty acids.

Northeast Arctic cod and *Northeast Arctic haddock* are mainly found in the Barents Sea. However, these stocks spawn on and along the edge of the continental shelf in the Norwegian Sea, and eggs and larvae drift northwards along the coast. Their roe and milt, together with herring larvae, are therefore an important part of the diet of other species. Cod has always been one of Norway's most important export products, and Norwegian stockfish produced from cod is used as an ingredient in cooking all over the world.

The redfish *Sebastes marinus* is a long-lived, slow-growing species that lives at depths of 100–500 metres on the continental shelf from the North Sea to the Barents Sea, along the coast and in some areas in the fjords. Its spawning grounds are on and along the edge of the continental shelf from Shetland north to Andøya (Nordland), and the most important areas are Storegga (the edge of the continental shelf off Møre og Romsdal), the Halten Bank and off the Vesterålen Islands. Recruitment to the stock has been poor since the early 1990s, and it is now at a historical low, due to the increasingly weak year classes over the last 10 years. This situation is expected to persist for many years, and the *S. marinus* stock is classified as vulnerable.

S. mentella is also a long-lived, slow-growing species of redfish, which is found at depths of 400–600 metres along the continental slope northwards from Shetland, around Svalbard and in the Barents Sea. The stock also undertakes feeding migrations into the Norwegian Sea at depths of 300–450 metres. The spawning grounds stretch along the edge of the continental shelf from Shetland to the Tromsøflaket bank area. ICES has not defined reference points for the stock, but investigations suggest that the immature component is at a historical low. *S. mentella* is classified as vulnerable.

The *Greenland halibut* is a large Arctic flatfish that lives in cold waters. Northeast Arctic Greenland halibut spawn mainly in autumn and winter at depths of 500–800 metres from the Vesterålen Islands and northwards to Bjørnøya and Spitsbergen. Adult fish are found along the edge of the continental shelf from UK waters to Franz Josef Land and in the deeper parts of the Barents Sea. The Greenland halibut is a very valuable commercial species. The stock has been growing slowly in recent years, but is still low. ICES has recommended maintaining a TAC of less than 13 000 tonnes in 2009.

Greater argentine are found in both the Western and the Eastern Atlantic. In the Eastern Atlantic, they occur from the British Isles to Svalbard, in deeper parts of the North Sea, and west to Iceland and the east coast of Greenland. In these areas, they are most commonly found at depths of 200–600 metres. In spring, greater argentine concentrate along the continental slope and in deeper areas of the continental shelf, while at other times of year they are more widely distributed.

Ling and *blue ling* are two gadids that live above hard or sandy bottom in warm, relatively deep areas of the continental shelf, on the bank areas and in the fjords in the management plan area. They also range from Biscay to Iceland, the Skagerrak and Kattegat and the southwestern Barents Sea. Ling is found mainly at depths of 300–400 metres, but can range between 60 and 1000 metres. Blue ling is found at slightly greater depths. The main spawning grounds are in the North Sea, Storegga, near the Faeroe Islands and on the banks west of the British Isles and southwest of

Iceland. ICES bases its advice on registered landings of each country's catches. In the case of blue ling in the area covered by the management plan, ICES has pointed out that trends in catches indicate that the stocks are seriously depleted. The species is therefore considered to be vulnerable.

Tusk is a demersal gadid species, which prefers rocky bottom on the continental shelf and continental slope at depths of 100–1 000 metres. It ranges from Ireland to Iceland and Greenland, and is also found in the Skagerrak, the western part of the Barents Sea and in the fjords. There are known spawning grounds off the coast of south and central Norway and south and south-west of the Faeroe Islands and Iceland. Tusk is caught together with ling in longlining and as a bycatch. The status of the stock is unknown.

Norwegian coastal cod is of marginal importance in the Norwegian Sea. There are several stocks distributed from Stad at about 62°N to the border with Russia, but about 75 % of the overall stock is found north of 67°N, and therefore outside the management plan area. Coastal cod are found from the kelp zone down to about 500 metres. They spawn in the inner parts of most fjords, in tributary fjord arms of the larger fjord systems, but also further out in the same areas as Northeast Arctic cod.

Atlantic salmon is of no commercial value in the Norwegian Sea, since salmon fishing in the open sea is not permitted. However, this is the most important nursery area for salmon. There are indications that salmon are taken as a bycatch in pelagic trawling in the Norwegian Sea, but there have been few studies of this. Salmon is managed through the North Atlantic Salmon Conservation Organization (NASCO).

Cephalopods are predators that feed on crustaceans, molluscs and fish. Twenty species have been registered in Norwegian waters. The most important species in the Norwegian Sea are the European flying squid (*Todarodes sagittatus*) and the boreoatlantic gonate squid (*Gonatus fabricii*). Flying squid used to be fished commercially in the Norwegian Sea. The gonate squid is an important prey species for most marine mammals in the area and for many fish species. Juvenile squid that live near the surface are also important for some seabird species. Our knowledge of squid in the open sea, particularly in deep water, is limited.

There are several shrimp stocks and a separate capelin stock in the bank areas around Jan Mayen (and in Icelandic and Greenland waters).

3.2.4 The most important seabird populations – description and status

The Norwegian Sea is important for some of the largest seabird populations in the Northeast Atlantic, several of which are considered to be very valuable at both the national and the international level. Seabirds are wholly or partly dependent on the sea for food. The most typical seabirds (fulmars, gannets, cormorants, auks and many gulls and terns) spend most of the time at sea and forage entirely at sea. A number of seabirds are slow-maturing, and have low reproductive rates but long life spans. As predators, they are at the top of food chains, and their long life makes them vulnerable to hazardous substances. Slow sexual maturation and a low reproductive rate make them vulnerable to changes in food supplies. Thus, the state of seabird populations can be a good indicator of the state of the marine environment.

The Norwegian Sea serves several ecological functions for North Atlantic seabirds. It is a wintering and passage area for many species, while others spend much of the year in the area. The northern parts are feeding grounds for populations that breed further north and east. About 1.6 million seabirds use the area during the breeding season (this does not include the seabird colonies on the Røst archipelago). The most important breeding colonies are on Jan Mayen and Runde island (Møre og Romsdal). In addition, roughly one million seabirds breed on Røst, including about 866 000 puffins. Birds from the colonies on Røst forage in parts of the Norwegian Sea and the Vestfjorden throughout the year. There are also many smaller seabird colonies along the coast of Norway. The most numerous species that breed on the mainland are puffin, common eider and herring gull. Fulmar,

Figure 3.8 Puffin carrying herring

Photo: Tomas Aarvak

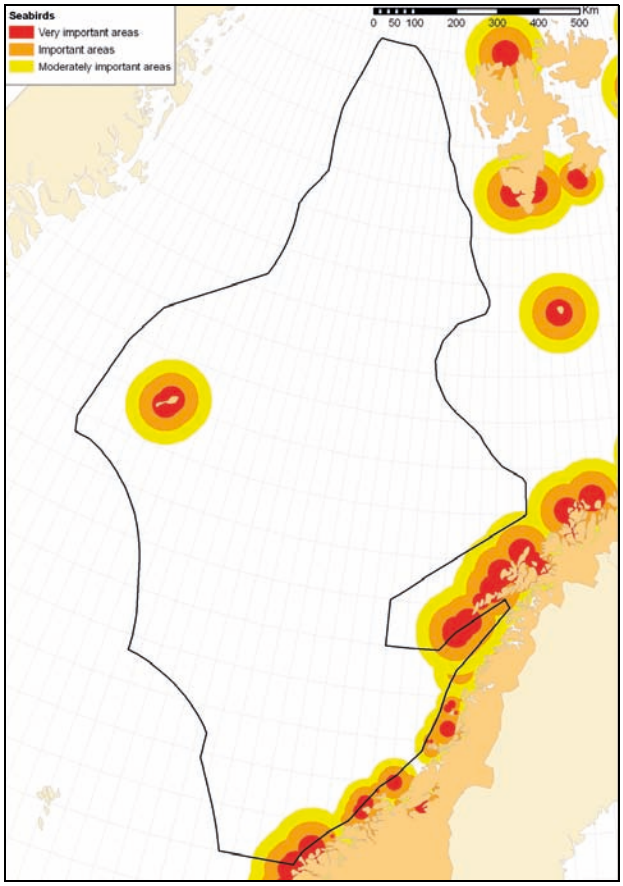

Figure 3.9 Seabird colonies in the Norwegian Sea
Source: Directorate for Nature Management

Brünnich's guillemot and little auk are the commonest species on Jan Mayen.

There are large seasonal variations in the distribution of seabirds in the Norwegian Sea. Divers, grebes, cormorants, marine diving ducks (common eider, king eider, long-tailed duck) and gulls dominate in winter along the mainland coast. The distribution of pelagic species in winter is probably highly dynamic and dependent on the distribution of their prey. In spring, birds migrating back to breeding areas and wintering populations are the dominant elements. Many species return to their breeding sites early in spring. In summer, most seabirds present in the area are either breeding populations or sexually immature birds and other non-breeders.

Pelagic species (including most auks, kittiwakes and fulmars) may forage at great distances from their breeding colonies, whereas coastal species have a more limited radius of action and are dependent on finding food closer to their breeding sites. During autumn, the seabird populations move southwestwards in the Norwegian Sea. At the end of the breeding season, still flightless chicks of common guillemot, Brünnich's guillemot and razorbill are accompanied by one of the parents (usually the male) as they swim away from the colonies and out to the open sea. Auks moult at sea in early autumn, with particularly large concentrations off Røst and Runde. During the moult, they are flightless and extremely vulnerable to all forms of human disturbance. Most ducks and geese moult before migrating southwards.

Common guillemot: Numbers at most breeding colonies have dropped by 90 % since the early 1980s. The breeding population on Runde reached a record low in 2005. In contrast, the population on the Sklinna archipelago has risen, probably because of immigration from other areas. The mainland population is considered to be critically endangered. If the present negative trend continues, it is probably only a matter of time before the species ceases to breed at many sites.

Puffin: The population of this species has also shown a dramatic decline over the past 20–30 years. Most birds belonging to the Norwegian population breed in colonies from Røst and northwards. The breeding population on Røst has declined to only 27 % of the 1979 level (corresponding to a drop of more than one million pairs of puffins), but this is still one of the largest colonies in Europe. The breeding population on the Sklinna archipelago has declined by 60 % since 1980 due to breeding failure because of food shortages. The species is classified as vulnerable.

The fulmar population on Røst has declined by 15 % per year for the past 10 years, and the population on Runde has declined by more than 10 %.

Certain sub-populations of lesser *black-backed gull* (subspecies *Larus fuscus fuscus*) have shown a positive trend in the last 10 years, but the overall population is still only 25 % of the pre-1980 level. This may be related to food shortages and the collapse of the herring stock in the 1980s. Another possible explanation is high levels of hazardous substances in wintering areas in East Africa.

There has been a decline in the *kittiwake* population along the coast throughout the management plan area. The most dramatic decline is on Runde, where numbers have dropped by 75 % since 1980. The species is classified as vulnerable.

Most *coastal diving species* have shown a different trend. The cormorant population declined in the period 1985–87, but has since risen sharply at most colonies along the coast. The shag population has also shown a positive trend in the past 10 years after a dramatic decline in the mid-1980s. The trend for the breeding population of common eider has varied from one area to another.

3.2.5 The most important marine mammal species – description and status

Blue whales, fin whales, humpback whales and *minke whales* all pass through the management plan area on migration between breeding areas in warmer waters (where they spend the winter months), and summer feeding grounds near the arctic front and the marginal ice zone. They use the Norwegian Sea mainly as a feeding area. *Sperm whales* and *northern bottlenose whales* feed along the continental slope, while species such as *porpoises* and *killer whales* are common in waters nearer the coast. There are also several important areas for the coastal seals (*grey seal* and *common seal*) along the Norwegian coast, while ice-covered waters north of Jan Mayen are an important habitat for hooded and harp seals.

The following species are currently harvested in the Norwegian Sea: minke whale, harp seal, common seal and grey seal. The Norwegian minke whale quota for 2009 is 885 animals, 135 of which are to be from the central Atlantic stock in the Norwegian Sea. Harp seals are harvested in the West Ice, and the quota for 2009 is 40 000 animals. Hooded seals were also harvested until 2006, but since then hunting of this species has been prohibited because of uncertainty about stock status. Coastal seal populations in Norway are relatively small compared with those in neighbouring countries. Hunting of both grey and common seals is permitted, and the quotas for 2009 are 1 040 and 860 animals respectively.

3.3 Particularly valuable and vulnerable areas

Within the management plan area, certain areas have been identified as being particularly valuable in terms of the environment and natural resources. A particularly valuable area is a geographically defined area that provides ecological goods and services of particular value, assessed on the basis of the proportion of a population or habitat it contains at international, national or regional level, and taking into account capacity for recovery, population status and Red List classification. Areas were selected using predefined criteria. The main criteria were that the area concerned was important for biodiversity or for biological production. In addition, a number of secondary criteria were evaluated, including some that were not purely biological (for example economic, social and cultural importance, and scientific value).

Box 3.2 Vulnerability

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

An assessment of the vulnerability of an area is generally based on which species and habitats occur naturally in the area and their productivity. Factors such as seasonal variations, distribution patterns, age/stage of the life cycle, behaviour and biological characteristics are used to determine the vulnerability of a particular species. Vulnerability to environmental pressures is assessed on the basis of the likely impacts of different pressures on the development and survival of a species or population. Some species are particularly vulnerable at times of the year when most of the population is concentrated in a limited area (for example fish during spawning and seabirds during the breeding season). The vulnerability of habitats depends on factors such as the substrate type (for example sand or rock), whether it contains sessile or motile species, and whether the habitat type is rare. Certain areas dominated by long-lived, habitat-forming species such as corals and sponges may be particularly vulnerable to certain environmental pressures because habitat formation is a very slow process. Areas where biological production is high may be particularly vulnerable at certain times of year (for example when eggs and larvae (the early stages of fish) are present). Vulnerability can be measured at individual, population, community and ecosystem level. For management purposes, impacts at population, community and ecosystem level are most important.

The vulnerability of valuable areas to various environmental pressures has also been assessed on the basis of the species and habitats that occur naturally in each area and their productivity. The vulnerability of a habitat or species to different environmental pressures varies, and has been assessed on the basis of the likely impacts of different pressures on species or habitat development and survival. There may also be temporal and spatial variations in vulnerability (see box 3.2).

Eleven particularly valuable areas have been identified in the Norwegian Sea. These areas meet at least one of the two main criteria for selection, i.e. importance for biodiversity and importance for biological production. Some areas were also selected on the basis of secondary criteria (e.g. high concentrations of individuals/species, distinctiveness, undisturbed areas, or economic importance). The selected areas are of very different kinds, but their common features are that they are important for more than one species, generally meet more than one of the selection criteria and have already been recognised as valuable. It is not possible to delimit the particularly valuable and vulnerable areas precisely, but Figure 3.10 indicates their approximate extent.

The areas selected and their vulnerability to specific environmental pressures are further described below. The discussion of vulnerability focuses on potential direct pressures, regardless of the actual level of activity in the Norwegian Sea today. Vulnerability to specific pressures will vary from one valuable area to another, since they are defined as valuable on the basis of the presence of different species and habitats. All eleven areas are to some extent vulnerable to the accumulation of pollutants, the introduction of alien species, climate change, ocean acidification and the combined impacts of all human pressures.

3.3.1 The coastal zone

The coastal zone includes a wide range of areas where oceanographic conditions vary widely. The southernmost section (Stad (62°N) to Runde island), the coast of Sør- and Nord-Trøndelag (including the Froan, Vikna and Sklinna archipelagos), 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.

Coastal areas with islands and skerries support a rich bird life, and there are large numbers of breeding and overwintering seabirds along the whole coastline. Coastal species of seabirds are dependent on shallow-water areas where they can find food, whereas pelagic species forage further out to sea and use considerably larger areas. The section of the coastal zone 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) are considered to be particularly valuable for seabirds. Runde island supports one of the most important seabird colonies in the southern half of Norway, with large numbers of auks, including common guillemots, a species classified as critically endangered. The lesser black-backed gull (subspecies *Larus fuscus fuscus*) also breeds all along the coastal zone, with the most important breeding populations in Sør- and Nord-Trøndelag and the southern part of Nordland. Although some sub-populations have increased in numbers, the subspecies as a whole has shown a dramatic decline and has almost disappeared from Norway. The Froan archipelago is a key feeding area for seabirds both in the breeding season and at other times of year, and there are several large cormorant colonies.

Marine mammals such as the grey seal, common seal, common porpoise and killer whale occur all along the coastal zone. The coastal seals are stationary, particularly during the breeding season and the moult, and congregate at specific localities during these periods. Whelping and moulting areas are critical and vulnerable habitats for these species. The Froan archipelago is considered to be a particularly valuable whelping area for grey seals. Grey seals are only gregarious during the whelping and moulting seasons, whereas common seals live in colonies throughout the year. Porpoises live in small groups and are also relatively stationary. The distribution of killer whales, on the other hand, varies through the year. In winter they are found mainly in coastal waters, while in summer they are more widely distributed in the Norwegian Sea and Barents Sea. One component of the killer whale population in the Norwegian Sea follows the same migration pattern as Norwegian spring-spawning herring. In years when herring overwinter in the Vestfjorden (including the fjord arm Tysfjorden), killer whales therefore congregate in the same areas.

Kelp forests are an important habitat for many marine organisms in the coastal zone. There are rich stands of *Laminaria hyperborea* in the southern part of the management plan area, but further north the kelp forests have been severely depleted by sea urchin grazing.

The Vestfjorden, between the Lofoten Islands and mainland Norway, has historically been one of the main spawning areas for Northeast Arctic cod. For most of the period 1970–2000, the Vestfjorden, including the fjord arms Ofotfjorden and Tysfjorden, was also the main overwintering area for Norwegian spring-spawning herring. Although its importance has declined in recent years, the Vestfjorden is potentially a very important area for major fish stocks. It is also particularly important for seabirds, especially those from the seabird col-

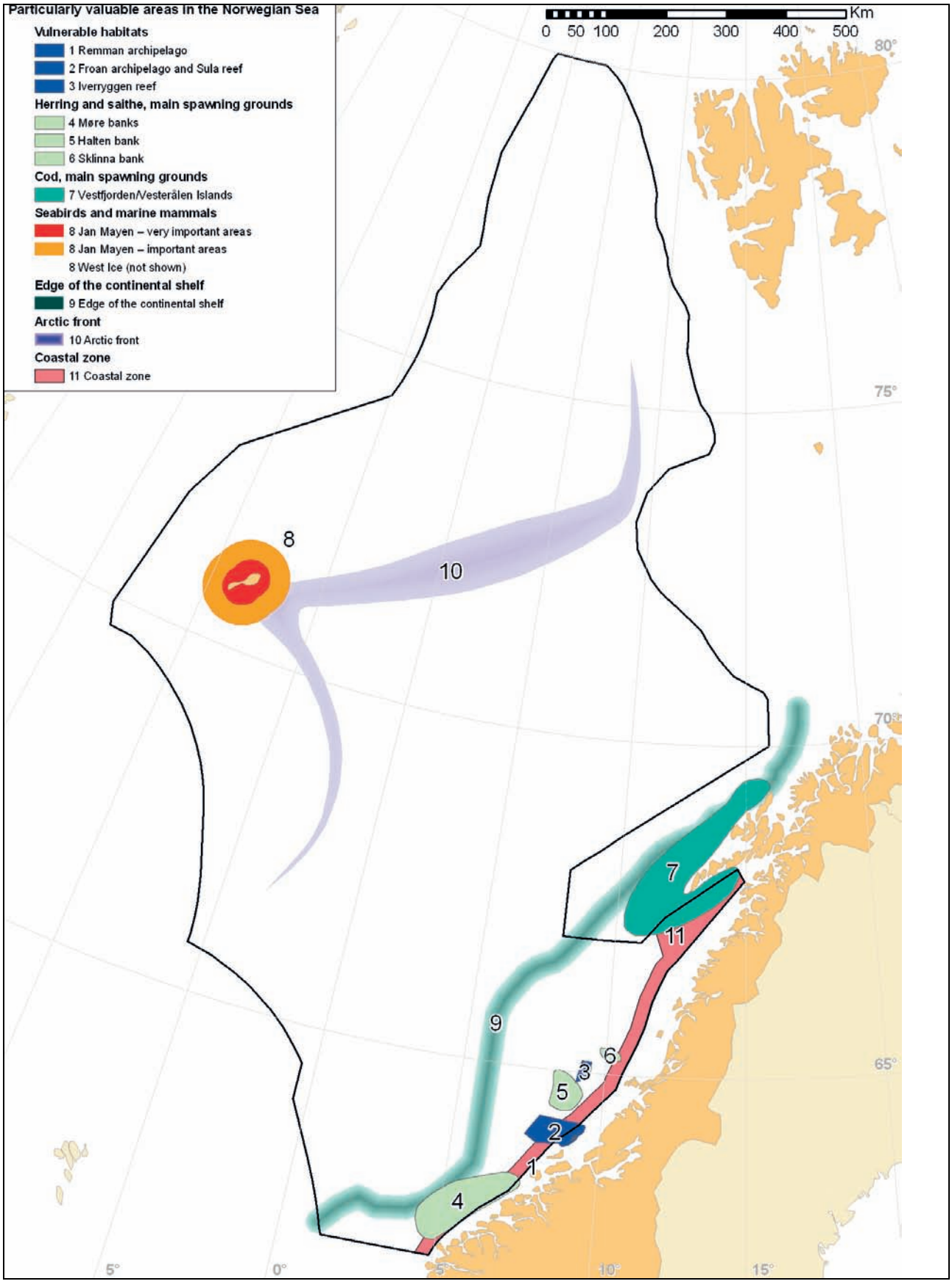

Figure 3.10 Particularly valuable and vulnerable areas in the Norwegian Sea

Source: Directorate for Nature Management/Institute of Marine Research

onies on Røst. The area is further described in the management plan for the Barents Sea–Lofoten area.

Species and habitats in the coastal zone are vulnerable to oil pollution, discharges of waste, bycatches, and expansion of recreational activities, and if several such pressures are acting together, they become even more vulnerable. There are large numbers of seabirds in the coastal zone throughout the year. The southernmost section (Stad (62°N) to Runde island), the Froan and Vikna archipelagos, the southern part of Nordland and the Vestfjorden are for example important for coastal diving species and auks all year round (as foraging, overwintering, breeding and moulting areas). Seabirds are such a varied group that vulnerability is often assessed for ecological groups with similar behaviour in terms of habitat use, foraging and food choices. Vulnerability to environmental pressures such as oil spills, overfishing and waste varies from one ecological group to another. Vulnerability to oil, for instance, is often specified for particular ecological groups and certain times of year. Species that forage by diving from the surface are considered to be vulnerable to oil spills throughout the year. This applies particularly to auks such as guillemots and puffins, divers, cormorants and marine ducks (pelagic and coastal diving species). The vulnerability of other ecological groups is considered to be higher at specific times of year (surface-feeding species). Seabirds may also be vulnerable to near-shore wind farms.

3.3.2 The Møre, Halten and Sklinna banks

The continental shelf provides a productive environment with high biodiversity. It is relatively narrow off the coast of Møre og Romsdal, but widens considerably off Nord- and Sør-Trøndelag and Nordland. The continental shelf includes front zones, areas with strong currents and retention areas. Various species use it for spawning, feeding, as a nursery area or for overwintering, and drift trajectories for fish eggs and larvae pass through it. Three shallow bank areas on the continental shelf are considered to be particularly valuable: the Møre, Halten and Sklinna banks.

Norwegian coastal water and Atlantic water dominate the water masses in this area. The main current of Atlantic water follows the edge of the continental slope northwards, while the coastal water forms a wedge on top of and on the coastal side of the denser Atlantic water. Further north, the distinction between the two water masses becomes less clear. The Norwegian coastal current is an important transport route, carrying fish eggs and larvae from the spawning areas northwards to nursery areas along the coast and in the Barents Sea. There are large concentrations of fish larvae on the bank areas in spring, as the coastal water has a longer residence time in these areas. The Møre, Halten and Sklinna banks are all important spawning and nursery areas for Norwegian spring-spawning herring and saithe. The Halten and Sklinna banks are also highly productive retention areas for drifting fish eggs and larvae.

The bank areas also support a rich bird life as a result of the large stocks of pelagic fish species such as herring. Seabirds generally eat a variety of fish, but some of them are more specialised and dependent on particular fish species. There may be wide variations in food preferences through the year, between years and between regions. Auks, petrels, cormorants and gannets spend most of the time at sea and forage entirely at sea.

In spring, and particularly in the second quarter of the year, fish eggs and larvae of the most important Northeast Atlantic stocks are concentrated in the bank areas. At individual level, fish eggs and larvae are vulnerable to oil in the water column. Herring spawn on the seabed and are dependent on a suitable substrate. The herring spawning grounds on the Møre, Halten and Sklinna banks are vulnerable to physical disturbance, for example caused by bottom gear, anchor chains, fixed installations, dumping of rock or discharges of drill cuttings. Seismic surveys will also affect fish during spawning and spawning migration.

3.3.3 The Sula reef and the Iverryggen reef

There are large coral reef complexes on the continental shelf off Central Norway. The Sula reef and the Iverryggen reef are considered to be particularly valuable.

The Sula reef is a major *Lophelia* reef complex, and supports fish species including redfish, ling, tusk and saithe. Another important reef complex, the Iverryggen reef, lies on the continental shelf on the north-east slope of the Halten Bank. Both of these areas have been proposed for inclusion in Norway's national marine protection plan, and they are protected against bottom trawling.

The coral reefs on the continental shelf off Central Norway are large, spatially complex biological structures, which makes them suitable habitats for many sessile and free-swimming organisms. Coral reefs support high species diversity and high fish

densities, and the most common fish species are tusk, ling and redfish.

Coral reefs are vulnerable to physical disturbance of the seabed.

3.3.4 The edge of the continental shelf

The edge of the continental shelf is the transitional area between the relatively shallow continental shelf and bank areas and the deep-water areas of the Norwegian Sea, and runs all the way from Stad to northwestern Svalbard. The area supports high biological production and diversity, large concentrations of many fish and seabird species, and many coral reefs. It is therefore considered to be particularly valuable.

There is vigorous mixing of the water masses in convergence belts in the front zone between the Norwegian coastal water and the Atlantic water, and this results in enhanced biological production and large quantities of zooplankton and pelagic schooling fish species. Seabirds utilise the high biological production, and the edge of the continental shelf is an important feeding area, particularly for auks and pelagic species such as fulmar and gannet. The large concentrations of zooplankton also make the area an important feeding ground for baleen whales, and it is particularly important for fin whales in the south and for blue whales west and north of Svalbard. Moreover, there are important spawning grounds for deep-water species such as redfish (*Sebastes marinus* and *S. mentella*), Greenland halibut and greater argentine in various areas.

The strong currents along the edge of the continental shelf provide highly suitable conditions for sponge communities and coral reefs. The Røst reef is a coral reef complex on the edge of the continental shelf 110 km west of Røst in the Lofoten Islands. This is the largest known cold-water coral reef, and is therefore particularly valuable. The area was further described in the management plan for the Barents Sea–Lofoten area.

The edge of the continental shelf is a large area with many different species and habitats, which vary in their vulnerability to different environmental pressures. For example, some fish stocks are vulnerable to excessive harvesting, benthic communities to physical disturbance, seabirds to oil pollution (all year round) and bycatches, and Greenland halibut and redfish to oil when eggs and larvae are present.

3.3.5 The arctic front

The arctic front is the zone where warm Atlantic water meets cold, less saline Arctic water. The eastern extent of the front is variable in the southern Norwegian Sea and more stationary further north. Front zones are valuable both because they are limited areas with a high concentration of biological production and because they support high biodiversity. Nutrients are released in or transported to the upper water layers, where they support high primary production (phytoplankton production). This results in high production of zooplankton such as krill and copepods, which in turn are food for other organisms higher up the food chain, including fish, seabirds and marine mammals.

High biological production makes this an important feeding area for several whale species, including blue whale, fin whale, minke whale and northern bottlenose whale. Further north, the marginal ice zone stretching further northwards to the Fram Strait north-west of Svalbard is also important for the same species, and also for species that are more permanently associated with ice-covered waters, such as the bowhead whale.

Seabirds and marine mammals are vulnerable to oil spills and substances that are liable to bioaccumulate. Different species may vary in their vulnerability at different times of year (see further details on seabird vulnerability in section 3.2).

3.3.6 Areas near Jan Mayen and the West Ice

Jan Mayen lies in a front zone where the north-flowing North Atlantic Current meets a branch of the south-flowing East Greenland Current. These waters support high production and large numbers of zooplankton, fish, seabirds and marine mammals. Jan Mayen is exceptionally important for seabirds, with 300 000 breeding pairs and several colonies. The most numerous species are fulmar, little auk, Brünnich's guillemot and kittiwake. Jan Mayen and its waters out to the territorial limit are considered to be of high conservation value, and a protection plan is being drawn up.

The West Ice, the area of drift ice that forms each winter north of Jan Mayen, is a whelping area for harp seal and hooded seal. It is of crucial importance for the populations of these seal species because it is the only part of the Norwegian Sea where large stable areas of ice form in winter. The West Ice is vulnerable to climate change, and the area of winter ice has been shrinking in recent years. Outside the breeding season and the moult, both harp seal and hooded seal make long feeding

migrations to Svalbard, along the edge of the continental shelf in the Norwegian Sea, and to East Greenland. A marked decline has been observed in the number of hooded seal pups born, and the species is therefore considered to be vulnerable.

Several whale species, including the bowhead whale, narwhal and beluga whale, are associated with the marginal ice zone all year round in the northern Norwegian Sea, and feed on the rich zooplankton and fish resources.

Harp seals and hooded seals are vulnerable to oil spills, particularly during the breeding season. The areas near Jan Mayen and the West Ice are important breeding, moulting and feeding areas for seabirds (especially in the period April-December). Different species may vary in their vulnerability at different times of year (see further details on seabird vulnerability in section 3.2)

3.4 The underwater cultural heritage

The underwater cultural heritage includes all traces of human activity that are now in or under water, for example remains from shipwrecks, and other traces of human activity in and near the sea. Adverse impacts on the cultural heritage are usually irreversible, so that any damage results in a permanent loss of value. The impacts of environmental pressures on the cultural heritage depend on the type and scale of pressure, and on the type of cultural heritage affected, its state of preservation and the nature of the surrounding environment. The Norwegian cultural heritage authorities have only very limited information on the underwater cultural heritage of the Norwegian Sea. This has not been systematically surveyed and registered in the same way as the cultural heritage on land.

4 Commercial and social importance of the Norwegian Sea

4.1 Value creation in industries associated with the Norwegian Sea

4.1.1 Fisheries, aquaculture and safe seafood

For centuries, fisheries have been a key source of income and the foundation for culture along the coast, and today Norway is one of the world's largest exporters of seafood from capture fisheries and aquaculture. It is also a major supplier of technology and knowledge-based services for this sector. Statistics show that exports of Norwegian seafood increased in 2008, to a total of 2.3 million tonnes and a value of NOK 3.9 billion.[1] Employment in this sector declined until 2006, but since then the trend seems to have levelled off and stabilised. One of the most important reasons for the success of this sector, and a precondition for future growth, is Norway's sustainable management of these natural resources and maintenance of clean, productive sea areas.

For a number of small settlements along the coast of the Norwegian Sea, the marine sector is the most important industry in terms of settlement and employment, see Figure 4.1. In its broadest sense, the sector comprises fisheries and aquaculture, which includes everything from fish farming, whaling and sealing to manufacturing and export activities and marine services and suppliers.

The four counties bordering on the Norwegian Sea account for a major share of Norway's total

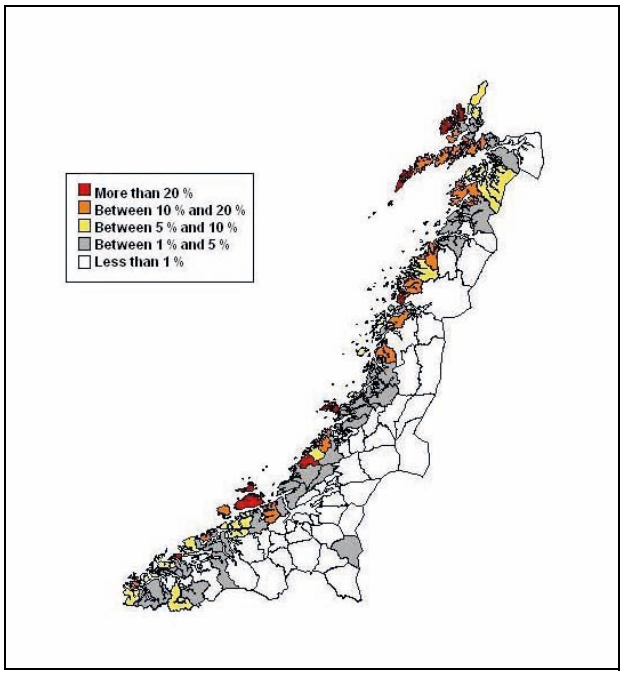

Figure 4.1 Employment in fishing, fish farming and fish processing in 2007 as a percentage of total employment in the counties of Møre og Romsdal, Sør-Trøndelag, Nord-Trøndelag and Nordland.

Source: Ministry of Local Government and Regional Development, based on figures from Statistics Norway

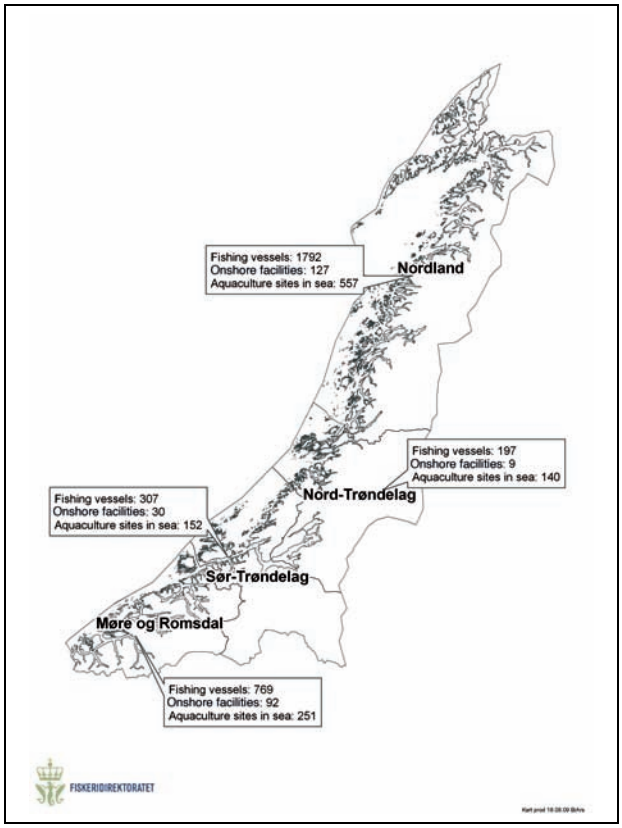

Figure 4.2 Number of vessels, onshore facilities and approved aquaculture sites in the counties bordering on the Norwegian Sea.

Source: Directorate of Fisheries

[1] Figures supplied by the Norwegian Seafood Export Council and Statistics Norway.

Table 4.1 Employment in the fishing fleet, aquaculture and fish processing by county in 2007

	Møre og Romsdal	Sør-Trøndelag	Nord-Trøndelag	Nordland	Total
Fishing fleet	2 723	509	318	3 183	6 733
Fish farming	647	410	347	727	2 131
Fish processing	2 084	979	352	2 246	5 661
Total	5 454	1 898	1 017	6 156	14 525

activities in this sector. In 2007 approximately 44 % of vessels were registered in one of these four counties. Figure 4.2 gives an overview of the number of vessels, onshore facilities and approved aquaculture sites in Møre og Romsdal, Sør-Trøndelag, Nord-Trøndelag and Nordland.

Of the four counties bordering on the Norwegian Sea, Møre og Romsdal and Nordland have the largest numbers of people employed in fishing and aquaculture.

Commercial importance of fishing and aquaculture – spin-off effects

A study of the spin-off effects of this industry conducted in 2008 showed that in 2006 fishing and aquaculture in Norway accounted for a total of 43 375 person-years.[2] The industry contributed NOK 38.9 billion to the gross domestic product (GDP) and had a production value of NOK 101.7 billion.[3] This amounted to approximately 1.8 % of both Norway's GDP and total employment in the country.

The core activities in fishing and aquaculture (fishing, fish farming, fish processing and wholesaling) accounted for 22 600 person-years. Core activities in the whole country contributed NOK 23 billion to GDP, with a production value of NOK 63 billion. In addition, the spin-off effects of the industry represented 20 600 person-years, a contribution to GDP of NOK 15.9 billion and a production value of NOK 38.7 billion. The sums are more or less equally divided between the direct effects for subcontractors and the indirect effects on the business sector in general.

In total, fishing accounted for 13 200 person-years in 20069, 9 700 of which came from core activities. Fish farming accounted for a total of 12 500 person-years, approximately 27 % of which came from core activities, while the rest were accounted for by spin-off activities. Fish processing accounted for approximately 12 400 person-years, 8 200 of which came from core activities.

Box 4.1 Lovund – swimming against the current

While a number of small settlements along the coast are suffering from depopulation and closures, Lovund is experiencing the opposite. This small island in the outer skerries off the coast of Helgeland has doubled its population since 1970, and in 2007 had a permanent population of approximately 390. The average age is under 30 and childcare facilities have had to be expanded in recent years. Local enthusiasm and fish farming are among the main reasons for this trend. The industry is highly structured and this, together with local patriotism and the determination of the local population, has enabled the community to do well throughout the recent economic fluctuations. A number of up-to-date businesses associated with fish farming have been built up over the last couple of decades: fish from fish farms over a large area are slaughtered on the island, packed in locally produced Styrofoam boxes and loaded onto locally produced pallets before being exported to many different parts of the world. The fishing village is considered one of the most attractive on this coast, the surrounding landscape is magnificent and there are opportunities for canoeing, puffin-watching and mountain hikes. Facilities include visitors' berths, accommodation in fishermen's cabins and a centre for coastal culture.

[2] SINTEF Fisheries and Aquaculture conducted an analysis of the spin-off effects of fishing and aquaculture in 2008.

[3] County-specific data on value creation from the marine sector can be misleading because such data are often registered for companies whose official addresses are elsewhere than the main production site. The figures therefore apply to the country as a whole.

The total contribution to GDP from fisheries was approximately NOK 10.8 billion in 2006, approximately NOK 7 700 billion of which came from core activities in the fishing fleet. The contribution of fish farming to GDP in 2006 was approximately NOK 13.8 billion, approximately NOK 7.3 billion of which came from activities associated with hatcheries and fish farms.

In 2006 fish farming contributed NOK 10.2 billion to GDP, and wholesaling NOK 3.1 billion.

Risks to the reputation of Norwegian seafood

The seafood industry in Norway has built up a good reputation thanks to the cold clean waters off the coast, and Norwegian seafood is marketed in over 20 important seafood markets as a healthy, safe, high-quality food. One condition for continuing this favourable trend is that Norway manages its natural resources sustainably and maintains clean and productive sea areas.

A survey conducted in 2008 showed that consumers in the most important Norwegian seafood markets attach great importance to safe, secure food. Pollution of various kinds in the sea and coastal zone could cause consumers to question whether fish from the Norwegian Sea is safe to eat or to use as raw material for feed. Spills of oil, radioactive waste or pollutants from petroleum activities or maritime transport, or other accidents could also threaten the reputation of Norwegian seafood. The level of environmentally hazardous substances in fish can also be affected by long-range transboundary transport of pollutants. For some substances it takes only a small increase to have a negative impact on seafood safety and reputation. Other factors that are directly or indirectly related to the operation of fish farms, such as disease and escapes, will also have a substantial impact on the future development of the industry. In order to ensure seafood safety in Europe, the EU has set limit values for a number of priority substances, which also apply in the EEA. Thus it is important to survey and document the status of Norwegian wild fish stocks in terms of limit values and seafood safety in both domestic and external markets. Such work is extensive and resource-consuming, and in order to obtain adequate data, baseline studies of the most important commercial species have been started.

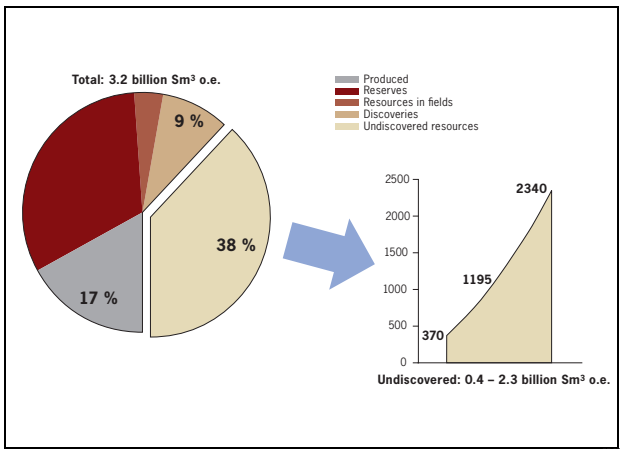

Figure 4.3 shows the distribution of estimated resources in the Norwegian Sea, including a range of uncertainty for undiscovered resources.

Source: Norwegian Petroleum Directorate

4.1.2 Petroleum activities and wind power

Petroleum resources in the Norwegian Sea

A total of 2.0 billion standard cubic metres of oil equivalents (Sm^3 o.e.) has been proven in the Norwegian Sea, 0.6 billion of which has already been produced. The remaining recoverable reserves amount to approximately 1.0 billion Sm^3 o.e., 66 % of which is gas. Contingent resources and discoveries amount to 0.4 billion Sm^3 o.e. In 2008 the total volume of petroleum production in the Norwegian Sea was 64 million Sm^3 o.e. Nine new discoveries have been made in the Norwegian Sea, most of which contain gas. Undiscovered resources in the area are estimated at 1.2 billion Sm^3 o.e. (expected value). The Norwegian Petroleum Directorate estimates total discovered and undiscovered resources on the Norwegian continental shelf at approximately 13 billion Sm^3 o.e. «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. The estimates do not include the area of overlapping claims in the Barents Sea or the continental shelf around Jan Mayen.

Relatively shallow areas of the Norwegian Sea – the Trøndelag Platform, the Halten and Dønn Terraces and the area along the Møre coast – have been gradually opened for petroleum activities since 1979. The first exploration well was drilled in 1980 and the first discoveries were made on the Halten Terrace in 1981. The deep-water areas in

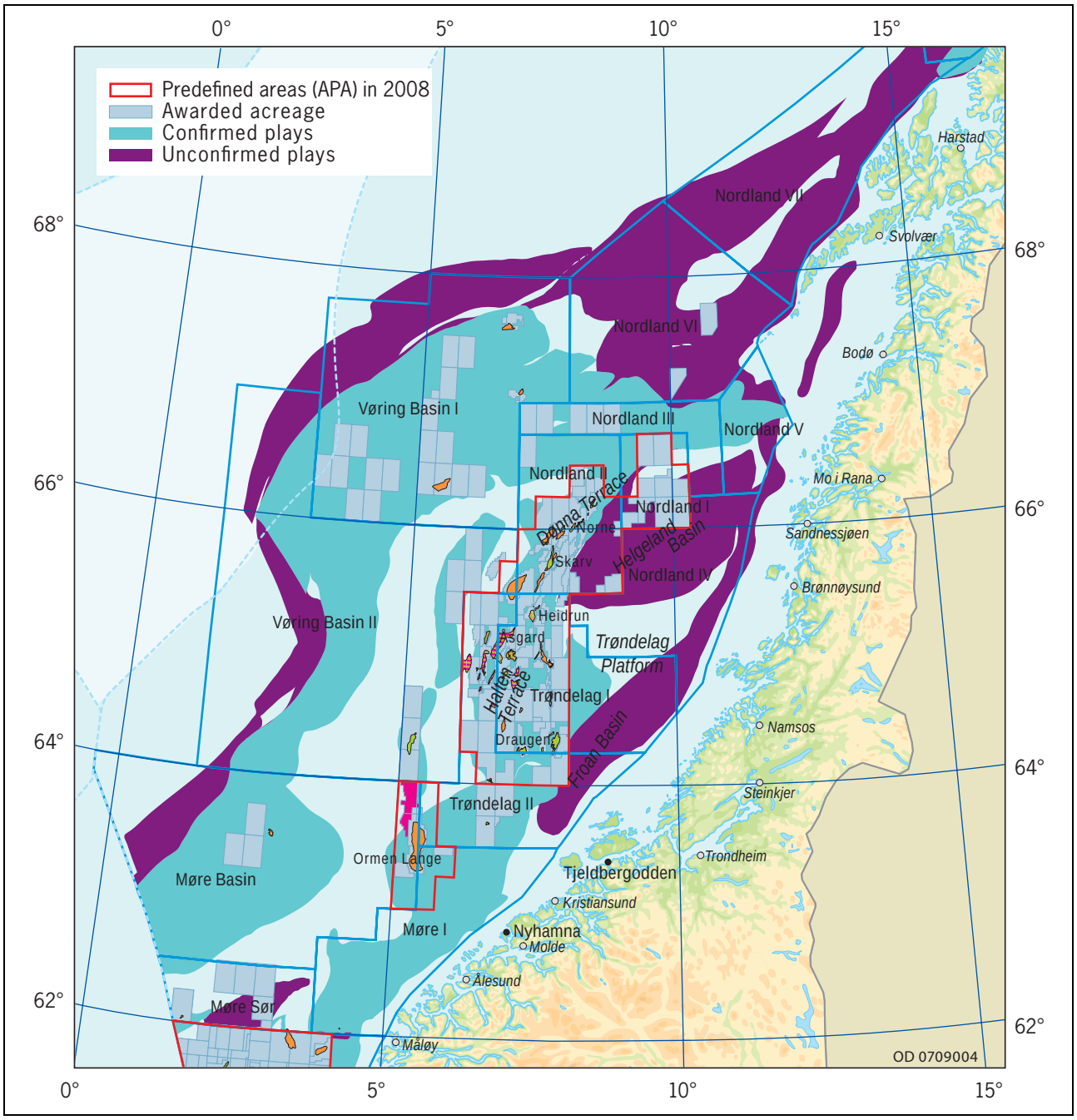

Figure 4.4 Overview of plays and petroleum activities in the Norwegian Sea.

Source: Norwegian Petroleum Directorate

the Møre and Vøring Basins were opened for petroleum activities in 1994. As of 2009, 166 exploration wells have been drilled in the Norwegian Sea. Estimates of remaining reserves have increased as a result of reserve upgrades in several of the fields in the Norwegian Sea.

Activity has been greatest on the Halten and Dønn Terraces off Sør-Trøndelag, Nord-Trøndelag and Nordland. Most of the discoveries and almost all the developed fields are to be found in this area. The Draugen field was the first in the Norwegian Sea to be developed, and production started in 1993. To begin with, exploration activities concentrated on oil, but since gas transport infrastructure was established there has been growing interest in exploration for gas. The Halten and Dønn Terraces are the most mature area and also the area where the largest remaining undiscovered resources are expected to lie.

Large parts of the Møre and Vøring Basins have a depth of more than 1000 m, which initially proved an obstacle to petroleum activities. There

was considered to be a high likelihood of gas discoveries in this region, and in 1997 the gas field Ormen Lange, in the eastern part of the Møre Basin, was discovered.

Exploratory drilling in deep-water areas has mainly resulted in gas discoveries. There has been little exploration in the most westerly parts of the deep-water areas, and resource estimates are very uncertain.

Small petroleum discoveries have been found along the Møre coast and further small to medium-sized discoveries are expected to be made near shore off the coast of Møre og Romsdal and the northernmost part of Sogn og Fjordane.

There has been very little exploration activity in the nearshore areas known as the Froan Basin off Nord-Trøndelag and the Helgeland Basin off Nordland. It may be possible in the future to refine gas from coal-bearing formations in more nearshore areas of the Trøndelag Platform.

Small to medium-sized oil or gas discoveries can be expected on the Trøndelag Platform (especially the Halten Terrace), and it is still possible

Box 4.2 Lessons learnt from activities in the Norwegian Sea

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 2006 Møreforsking Molde conducted a survey of employment in petroleum-related industries and estimated this at 25 700 person-years altogether in Møre og Romsdal. The maritime business cluster accounted for the largest share of person-years: 11 500. Since the early 1970s, the maritime industry has grown to become an international industry with an export share of 70 % and is considered to be extremely innovative. It has become less dependent on activities on the Norwegian continental shelf.

There are over 100 major suppliers to the petroleum sector, and their petroleum-related turnover was approximately NOK 3.6 billion in 2008, a growth of 53 % since 2005. Employment ncreased by 85 % in the same period, to 2 130 person-years. The total spin-off effect on employment of petroleum-related activities in the Kristiansund region is estimated at just over 3 500 person-years in 2008, as compared with 2 000 person-years in 2005.

Figure 4.5 Ormen Lange

Source: StatoilHydro (Photo: Eilev Leren, StatoilHydro)

In recent years the increase in suppliers of technical services has been particularly large, which has resulted in a strong growth in knowledge-based jobs in this region

The development of the Ormen Lange field in the Norwegian Sea is one of the largest and most complicated industrial projects that has ever been carried out in Norway.

Gas from the Ormen Lange field, which is about 100 km north-west of Kristiansund in the Norwegian Sea, is piped through two multiphase pipelines to Nyhamna on the island of Gossa in Møre og Romsdal. The gas is processed for export through Langeled, a 1200-kilometre long transport pipeline, to the reception centre in Easington on the east coast of England. Langeled is the world's longest offshore gas pipeline. Production started in October 2007 and the field will be able to meet up to 20 % of UK gas demand for up to 40 years.

Møreforsking has estimated the value of contracts for Ormen Lange at NOK 38 billion. The Norwegian share was estimated at 70 %, 11.5 % of which was accounted for by companies in Central Norway. The value of contracts that went to this region during the development phase was NOK 3.2 billion, a great deal higher than was estimated in the impact assessment for the project. Møreforsking estimated the total spin-off effects at NOK 400 million in addition to locally-awarded contracts. The study also emphasised that development of the field has increased the competence of local suppliers.

that large gas discoveries will be made in the Møre and Vøring Basins.

The continental shelf around Jan Mayen is a completely new exploration province, where little is currently known about the geological conditions. More seismic data are required, and shallow core drilling should be undertaken to assess the possibilities. Areas likely to contain petroleum resources extend into the waters around Iceland, and the Icelandic authorities have announced a licensing round for blocks in their waters.

Commercial activities associated with the petroleum industry

Today the petroleum industry is well established in the Norwegian Sea, with substantial national, regional and social spin-off effects. The industry is extremely profitable for Norway as a whole. The sales value of petroleum deposits in the Norwegian Sea for 2007 was approximately 2006 NOK 125 billion, and total employment in petroleum-related activities in 2007 was estimated at approximately 25 000 person-years.

The revenues from petroleum activities in the Norwegian Sea in the period up to 2025 are estimated at NOK 2 240 billion, with a net cash flow of NOK 1 370 billion. This equals an annual net cash flow of between NOK 50 million and NOK 100 million. Petroleum activities on the Norwegian continental shelf have resulted in the development of a substantial petroleum-related supply industry that employs a large number of people. The Norwegian continental shelf is an important market for this industry, and provides many opportunities for petroleum companies and suppliers to develop new technologies that can be sold on the international market. Further investment in petroleum activities in the Norwegian Sea would stimulate value creation and employment in the petroleum-related supply industry and in the Norwegian economy as a whole.

Petroleum activities in the Norwegian Sea are expected to create 25 000–40 000 person-years of employment in the country as a whole during the period 2007–2025. This includes jobs in supplier industries and spin-off effects in the form of jobs in these companies' subcontractors and in suppliers to these subcontractors. At the regional level the average annual effect on employment is estimated at 4000 person-years, gradually increasing during the management plan period. It is important to provide good conditions for further development that will result in positive local and regional spin-off effects in the form of jobs, expertise and supplier industries.

Estimates of the effects on the broader Norwegian economy of petroleum activities in the Norwegian Sea indicate that the supply of Norwegian goods and services will amount to NOK 283 billion (at 2006 prices) in the period 2007–2025. At the national level, supplier industries are expected to account for 60 % of total investment (6 % of which will be regional) and 88 % of the operations and maintenance market (30 % of which will be regional). This shows that Norwegian offshore-related industries are already very competitive and this situation is expected to continue in the time ahead. It also shows that the operational phase is the most important in terms of the regional business sector, while investment in activities in the Norwegian Sea is important for maintaining service and supplier industries in the rest of the country.

Commercial activities associated with wind power production

Wind power production is a sector with strong growth internationally, and over the last 10 years installed wind power capacity has increased by almost 30 % per year worldwide. At present the majority of wind farms are onshore.

The development of offshore wind farms is substantially more costly and technically more complex than onshore development. However, the limited availability of suitable onshore sites is expected to result in an increase in offshore development. The technical and cost-related problems may to some extent be compensated for by the stronger wind resources at sea, and the fact that it will be possible to build larger wind turbines offshore than onshore.

At present existing and planned offshore wind farms are mainly based on fixed installations in shallow water, i.e. with a typical depth ranging from 10–30 m to approximately 50 m. Wind power can be exploited to a much greater extent if turbines are built in deeper water. This applies particularly to Norwegian waters. The theoretical potential for the development of offshore wind power at depths of up to 60 m in Norwegian waters is estimated at approximately 800 TW/year, and the theoretical potential for depths of 60–300 m is estimated at approximately 13 000 TW/year. Reliable and competitive floating wind power technology is necessary for development at greater depths, but it is not clear when such technology will be sufficiently mature. These projections are based on the

assumption that no large-scale developments of wind power at greater depths will be undertaken during the management plan period and that large-scale developments of wave power are unlikely to be undertaken during this period.

A number of other factors also influence where and to what extent large-scale offshore wind farms are likely to be built in Norwegian waters. Wind resources and the need to develop infrastructure for the transmission of power to land and increase the capacity of the onshore grid are critical factors here. The projections include overall estimates of these factors. The development of wind farms in the area of the management plan is expected to take place off the coast of Central Norway. It is believed that fixed wind installations can be built in this area without the necessity for constructing new large transmission lines on shore. It is considered fairly unlikely that wind farms will be established further north during the management plan period. This is partly because grid capacity is limited and partly because there seems to be considerable potential for developing renewable energy infrastructure onshore in this area with acceptable impacts on the environment and the community.

There is considerable potential for industrial development in the onshore and offshore wind farming sector in the Norwegian Sea region, especially Central Norway. In addition to good wind resources, a large number of businesses associated with the maritime and oil and gas industries are located in the region, and their expertise could be transferred to the wind power industry. For example, the development of wind power offshore will require dedicated vessels designed for assembling and maintaining wind turbines. There are also a number of companies that produce wind power technology in the region, and two research centres have been established under the research organisation SINTEF for the purpose of developing new technology for offshore wind power generation. The supplier network for oil and gas (LOG) is developing networks in the wind power sector, partly as a result of demand by wind power developers.

4.1.3 Shipping

Maritime transport is in general safer and more environmentally friendly than road transport, and the Government is seeking to ensure that more traffic is transferred from road to sea. Ship traffic in the management plan area is related to commercial activities, and the volume of maritime transport is determined by the settlement patterns and

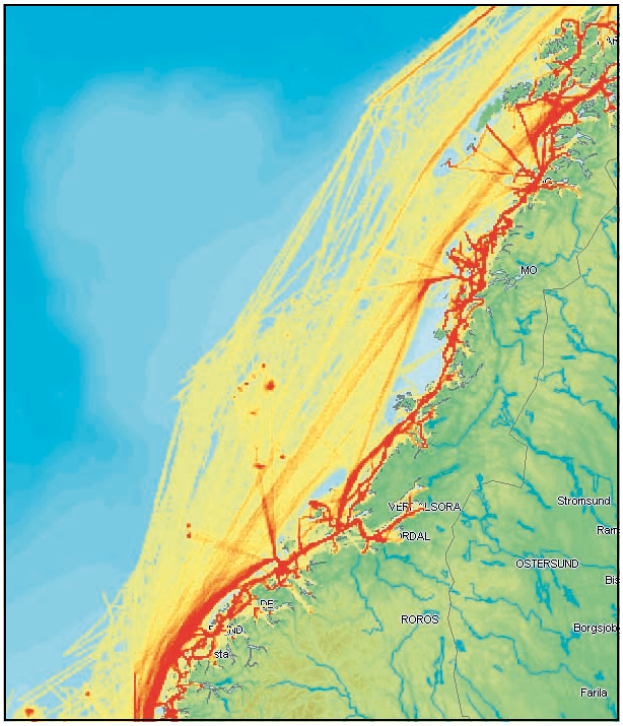

Figure 4.6 Ship traffic in October 2008, based on AIS data.

Source: Norwegian Coastal Administration

industrial structure along the Norwegian Sea coastline and north of the management plan area. Shipping has always been a key determinant of settlement along the coast. It transports goods and passengers, and is a source of jobs and a commercial activity in its own right. There are great variations in the volume of traffic in the Norwegian Sea.

Table 4.2 Numbers of calls at the largest ports relevant to the management plan area in 2007

PORT	NO OF CALLS 2007
Ålesund	3 662
Molde and Romsdal	2 381
Kristiansund and Nordmøre	5 571
Trondheimsfjorden interkommunale	1 584
Indre Trondheimsfjord	929
Brønnøy	455
Mo i Rana	1 139
Bodø	1 706
Narvik	585
Tromsø	2 048
TOTAL	20 060

Source: Statistics Norway

Ship traffic intensity is particularly high along the coast between Røst and Stad, while traffic in the rest of the Norwegian Sea is small compared with the coastal traffic.

In 2006 about 18 300 vessels, including fishing vessels, passed Stad. Cargo ships accounted for 59 % of the traffic and tankers for 17 %. Twenty per cent of the tankers were large, with a gross tonnage of over 50 000.

The volume of shipping is influenced by general economic developments in Norway and in the rest of the world. The expansion of petroleum activities in northwestern Russia, in the Norwegian Sea and in the Barents Sea will lead to growth in ship traffic through the Norwegian Sea. The strong economic growth up to 2008 has also resulted in growth in the maritime transport and other maritime industries.

The numbers of calls at selected large ports also give an indication of the volume of ship traffic in the area.

Ships that load and unload at Norwegian ports along the coast of the Norwegian Sea, whether they are sailing northwards or southwards, normally sail in the main fairway or the landward traffic stream (see Figure 4.7). The largest volume of traffic is north to Trondheim, and there is a larger volume of traffic in the main fairway than in the landward traffic stream.

Cargo ships, most of them with a gross tonnage of less than 5 000, account for 67 % of the traffic in the main fairway. Hurtigruten, other passenger vessels, ferries and cruise ships account for about 18 % of the traffic in the main fairway, but only make up 2 % of the landward traffic stream along the mainland coast. Hurtigruten accounts for most of the ship passages by passenger vessels in this size category. Few vessels with a gross tonnage of over 10 000, apart from passenger ships, sail in the main fairway past Rørvik.

Cargo ships, most of them with a gross tonnage of 1 000 to 5 000, make up 83 % of the landward traffic stream along the mainland coast. In contrast to the traffic in the main fairway, the number of relatively small vessels (gross tonnage less than 1 000) is insignificant.

Most of the outer traffic stream in the open sea along the mainland coast consists of cargo ships and tankers that are sailing past the management plan area. North-going ships in the outer traffic stream pass relatively close to Stad in the south, while their routes begin to spread outwards

Box 4.3 Sailing patterns and traffic density

Shipping in the management plan area follows four main patterns.

The main fairway

The main fairway is in Norway's internal waters, and runs through both sheltered and exposed waters.

Traffic along the mainland coast in the open sea that does not follow the main fairway

This can be divided into traffic streams (landward and outer), depending on whether the ships sail inside or outside a line drawn between Stad and Røst.

Seagoing routes

These are followed by vessels that do not sail along the coast, generally ships in international traffic.

Offshore traffic

This refers to traffic to offshore installations, which crosses the main north–south traffic streams along the mainland coast.

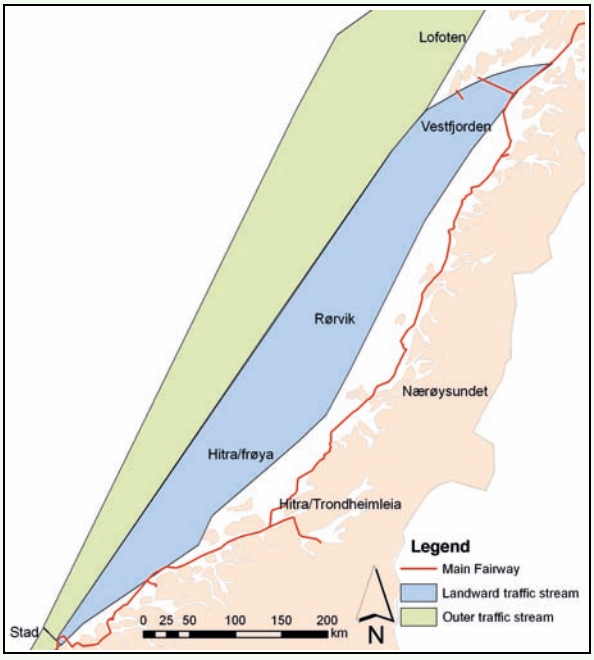

Figure 4.7 The main fairway and the landward- and outer traffic streams along the mainland coast.

Source: Norwegian Coastal Administration

towards the Lofoten and Vesterålen Islands. Ships calling at Russian ports account for about half the total volume of traffic, and most of these are cargo ships and tankers. Tankers calling at Russian ports are usually large, most of them with a gross tonnage of more than 25 000.

Through the IMO, Norway has adopted routeing measures off the coast of North Norway between Vardø and Røst as from 1 July 2007, which consist of a series of traffic separation schemes joined by recommended routes. The measures apply to tankers of all sizes and cargo ships in international traffic with a gross tonnage of more than 5 000. These measures have altered the sailing patterns of a considerable number of ships in the management plan area, which now have to revise their routes to take account of the traffic separation schemes. Ships from the North Sea on their way to the Barents Sea now pass close to the coast at Stad, after which they head for the traffic separation scheme off Røst.

Seagoing routes lie further out to sea than the route followed by the outer traffic stream along the mainland coast and generally do not run parallel with the Norwegian coast. These routes cover a large area and have a relatively small volume of traffic. Figures from the COAST database show that almost 800 vessels a year sail this part of the Norwegian Sea. The traffic consists of ships sailing to and from Svalbard and between Iceland and ports north of Mo i Rana. Traffic from ports on the west coast of England sail west of Shetland to Russian and North Norwegian ports or the oil platforms in the Norwegian Sea. This only accounts for a very small part of the total volume of traffic in the management plan area.

There are currently 12 oil and gas fields on stream in the Norwegian Sea. Gas is transported from the fields by pipelines and oil in tankers. The installations depend on regular supplies from land, and ships from the main supply bases sail along fixed routes to and from the fields. There are two main supply bases for the Norwegian Sea: Kristiansund and Sandnessjøen. Approximately 600 sailings per year deliver supplies to these installations, crossing the north–south traffic flows. There is also shuttle tanker traffic to and from oil platforms. In 2006, 238 cargoes of crude oil were shipped from the installations in the Norwegian Sea.

The movements of fishing vessels in the management plan area depend on where fishing is taking place, on the fishery and on the season. Much of the activity of the smaller fishing vessels naturally takes place within a reasonable distance from the closest port where the fish can be sold. The activity of the seagoing fishing fleet is less influenced by where the vessels deliver their catches, since these vessels have a greater action radius than the small vessels. From August until the end of the year, most Norwegian and foreign fishing vessels sailing to and from the herring fishing grounds in the Norwegian exclusive economic zone are to be found in the sea areas and fishing banks west and north-west of Troms and around the Lofoten and Vesterålen Islands. In January the site of activity changes, since the herring begin their spawning migration southwards towards the Møre banks. Fishing on these banks ceases at the end of February or at the latest by mid-March. Generally traffic from these fisheries is mainly to and from the onshore facilities at Værøy, Svolvær, Lødingen, Bodø, Træna, Uthaug, Ellingsøy, Harøysund and Måløy, but also to those south and north of the management plan area. From January to the end of April a great many trawlers and vessels fishing with conventional gear sail to and from the fisheries and between fishing grounds. During these months most of the activity takes place around the Lofoten and Vesterålen Islands and on the Halten and Møre banks. The largest volume of fishing vessel traffic for the year as a whole is generally to and from the Møre banks. Traffic to and from other fisheries in the management plan area, both in coastal waters and in the open sea, is more sporadic.

Commercial activities associated with shipping

Norway's connection with the sea has for centuries been a source of commercial activities in the shipping and fisheries sectors. Today Norway is the fifth largest shipping nation in the world. The Norwegian commercial fleet consisted in 2007 of 1 314 ships, 746 of which were registered in the Norwegian Ordinary Ship Register (NOR).[4]

Since shipping is an international industry it is difficult to estimate how much Norwegian shipping activity is included in maritime activities in the counties in the management plan area. However it is estimated that about 70 % of the tonnage in Norwegian waters at any time is Norwegian owned.[5]

The growth of the commercial fleet has led to a parallel growth in the land-based maritime industry. Natural conditions in many places along the coast are suitable for shipyards, which for many years dominated commercial activities in this sector.

[4] Source: Statistics Norway
[5] Det Norske Veritas Report No. 2007–1651

Norwegian shipping operates in most shipping markets and occupies a leading place worldwide in a number of offshore markets such as the rig and supply markets.

Petroleum activities stimulate innovation among land-based maritime industries. Shipyards build both vessels and installations for the offshore industry, and these activities in turn provide a market for subcontractors, service deliverers and other related industries. This is an important part of the Norwegian maritime cluster, which includes companies all over the country and has groups of segments in different parts of the country.

Maritime industries are capital-intensive, which makes them vulnerable to macroeconomic fluctuations. After many years of economic expansion the maritime industries have experienced strong growth, apart from the shipbuilding industry, where profitability has been poor in spite of the favourable economic climate. The financial crisis will worsen conditions for many companies, and cutbacks and restructuring will become increasingly necessary in the course of 2009 and 2010.

The maritime sector in Møre og Romsdal is large, with a total of about 170 companies, including shipyards, service deliverers, producers of equipment and shipping companies. These companies have a total turnover of approximately NOK 25 billion a year and employ 13 000 persons. The sector is largely targeted at offshore activities and the different parts of the sector are closely interrelated; for example many of the shipyards and equipment producers supply local shipping companies. This close relationship results in a high degree of innovation and high-quality products, and the sector occupies a leading position worldwide.

An analysis conducted by the consulting company Menon Business Economics showed that value creation in the maritime sector in Møre og Romsdal in 2005 amounted to just under NOK 8 billion, of which 40 % was contributed by shipping companies, 34 % by equipment producers, 18 % by shipyards and 8 % by service deliverers.[6]

According to the analysis, the key maritime institutions in Sør- and Nord-Trøndelag were the Norwegian University of Science and Technology and the research institute MARINTEK at SINTEF. The shipbuilding industry and the offshore sector, both Norwegian and foreign, make use of MARINTEK's expertise and ocean laboratories for testing new vessels. The Ministry of Trade and Industry has made a commitment (NOK 8 million) to a pilot project for developing the next generation of maritime research and innovation centres (the World Ocean Space Center). There are 180 maritime companies in Sør- and Nord-Trøndelag, and value creation in the maritime industry is equally divided between four main groups: equipment producers, shipyards, shipping companies and service deliverers.

The maritime sector in North Norway consists mainly of fisheries, and owners of fishing vessels are the largest contributors to value creation. Equipment suppliers and maritime service deliverers each accounted for 23 % of value creation in this sector in 2006, shipping companies for 47 % and the shipbuilding industry for 7 %.[7] The largest single company in the sea transport sector is Hurtigruten, with a turnover of NOK 3.8 billion in 2007.[8]

One of the objectives of the Government's maritime strategy is that Norwegian shipping should become a more environmentally friendly and more competitive alternative to road transport, enabling a larger volume of goods to be transported by sea. The strategy has five priority areas: globalisation and national policies; environmentally sustainable maritime industries; maritime competence; maritime research and innovation; and short sea shipping. The strategy contains 54 measures, and a progress report will be delivered in spring 2009. The environment is a maritime research and innovation area that has especially high priority.

4.1.4 Tourism

The magnificent scenery along and off the Norwegian coast already attracts large numbers of tourists. Tourism in the management plan area is based on the natural environment – a rich resource that unlike many other resources is difficult to measure in terms of money. Viable coastal communities and the spectacular scenery are tourist attractions in themselves, and value creation in the tourist industry therefore depends on maintaining rich, clean sea areas. Tourists are attracted to the area by the possibilities it offers for fishing, eating fresh seafood and observing marine mammals and seabirds. Hurtigruten is one of Norway's best-known brand names abroad, and the route along the coast is an experience that has been described as «the world's most beautiful sea voyage». This means that the environmental value of the seas is essential to tourism in the coastal zone.

[6] Source: Maritim verdiskapingsbok 2007

[7] Source: Maritim verdiskapingsbok 2007

[8] Source: Hurtigruten Quarterly Report of 25 August 2008

The tourist industry covers a wide range of activities and sectors, a large proportion of which involve sales to travellers. Transport, accommodation and restaurant services, travel and tour companies, and companies offering attractions and activities of various kinds are all part of the tourist industry.

Tourism is a strongly expanding industry both in Norway and internationally. Few countries have as long and varied a coastline as Norway, and the coast and fjords have great potential in terms of tourism. Encouraging tourist industries promotes development in coastal communities and creates new, interesting jobs that can halt or limit the depopulation that is depleting many coastal municipalities.

The coast is also an important element in the Government's tourism strategy, which was launched on 18 December 2007, and the coast and coastal culture are a key element in Innovation Norway's branding strategy for promoting Norway as a tourist destination. The number of sports fishermen visiting Norway has increased enormously in the last few years, and it is estimated that foreign sports fishermen bring in over NOK 3 billion a year. In 2007 Innovation Norway therefore launched a campaign promoting coast and deep-sea fishing that targeted specific markets. However, such initiatives must be weighed against the impacts of the resulting pressure on fish resources. Sports fishing results in a substantial harvest of coastal species, even though foreign tourists are only permitted to fish using a rod and handline. The efforts of the Government and Innovation Norway, together with other efforts such as the development of national tourist roads and measures under the Government's action plan for coastal culture, will all have an impact on the tourist industry in the coastal zone of the management plan area; for example five out of 18 national tourist roads that are being developed or planned are in this area (Andøya, Lofoten, Helgelandskysten Nord, Helgelandskysten Sør and Atlanterhavsvegen). One of the main measures in the Action Plan is to promote enthusiasm and spread knowledge about the cultural heritage along the coast that can be used as a resource for value creation in tourism and other sectors.

4.2 Population, employment and value creation in the counties bordering on the Norwegian Sea

4.2.1 Population and settlement

On 1 January 2007, Møre og Romsdal had a population of just over 245 000, well over half of whom lived in settlements along the coast. The population has been increasing steadily over a long period, with the strongest growth along the Sunnmøre coast. Much of the value creation in Møre og Romsdal takes place in the coastal zone, which has a long historical tradition of commercial activity based on the Norwegian Sea, predominantly fisheries and shipping. These have now been supplemented by other industries in the coastal zone; for example, the southern part of Møre og Romsdal has a large maritime sector. Shipbuilding and manufacturing of machinery and other equipment are now more important drivers of business development than fisheries. The maritime cluster in coastal Møre og Romsdal plays a leading role worldwide in the development, building and operation of technically advanced ships in the oil industry. There are also petroleum-related activities onshore in the county, such as the methanol plant on Tjeldbergodden and the processing plant for the gas field Ormen Lange at Nyhamna.

On 1 January 2007, Sør-Trøndelag had a total population of almost 279 000 people, and the number continues to rise. The population is mainly concentrated in the five municipalities around Trondheim, where 72 % live today and which is the area of strongest growth. The coastal zone has a much smaller population, about 24 000 people distributed between eight municipalities, which is less than 9 % of the total population of the county. On 1 January 2007, Nord-Trøndelag had a total population of around 129 000 people. Most of them do not live in the coastal zone but in the lowland districts east of the Trondheimsfjorden. The coastal zone has a population of about 11 500 distributed between five municipalities, which is only 9 % of the population of the county.

In Sør-Trøndelag and Nord-Trøndelag the coastal zone is less important in terms of value creation than in Møre og Romsdal. Almost all the growth in population, value creation and employment in Sør-Trøndelag is concentrated in the Trondheim area. Fishing accounts for only a small part of the value creation in the county and there is little petroleum activity. Fish farming is a much more important sector than fishing. Land-based activities related to the petroleum industry are

Box 4.4 The Vega Archipelago – UNESCO World Heritage site

The Vega Archipelago on the coast of Helgeland, Nordland, was inscribed on the World Heritage List (established under the Convention concerning the Protection of the World Cultural and Natural Heritage) in 2004.

In the justification for the inscription, it was emphasised that the Vega islands are a living cultural landscape that «reflects the way generations of fishermen/farmers have maintained a sustainable living» based on fishing and harvesting eider down. The islands have a particularly rich natural environment. Twenty-two per cent of the Archipelago is protected under the Nature Conservation Act (one protected landscape, four nature reserves and four bird reserves). The Planning and Building Act is the most important instrument for maintaining the environmental value of the rest of the archipelago. Two cultural monuments are protected by individual protection orders under the Cultural Heritage Act.

The Vega Archipelago covers 1037 km^2, about 970 km^2 of which is seascape. The rest consists of islands, islets and skerries. Fishing, farming and hunting have been practised there for the last 10 000 years, and since the Middle Ages the harvesting of eggs and down from wild eider ducks have become an important supplement to these activities. This sustainable livelihood, based on «the now unique practice of eider down harvesting», was emphasised in the justification for the inscription on the World Heritage List.

The World Heritage Convention does not specify any clear commitments with regard to protection of cultural properties. However, according to Articles 3 and 5, parties to the Convention are obliged to identify and protect their cultural and natural heritage, although the convention says little about legal protection under national law. The Operational Guidelines for the

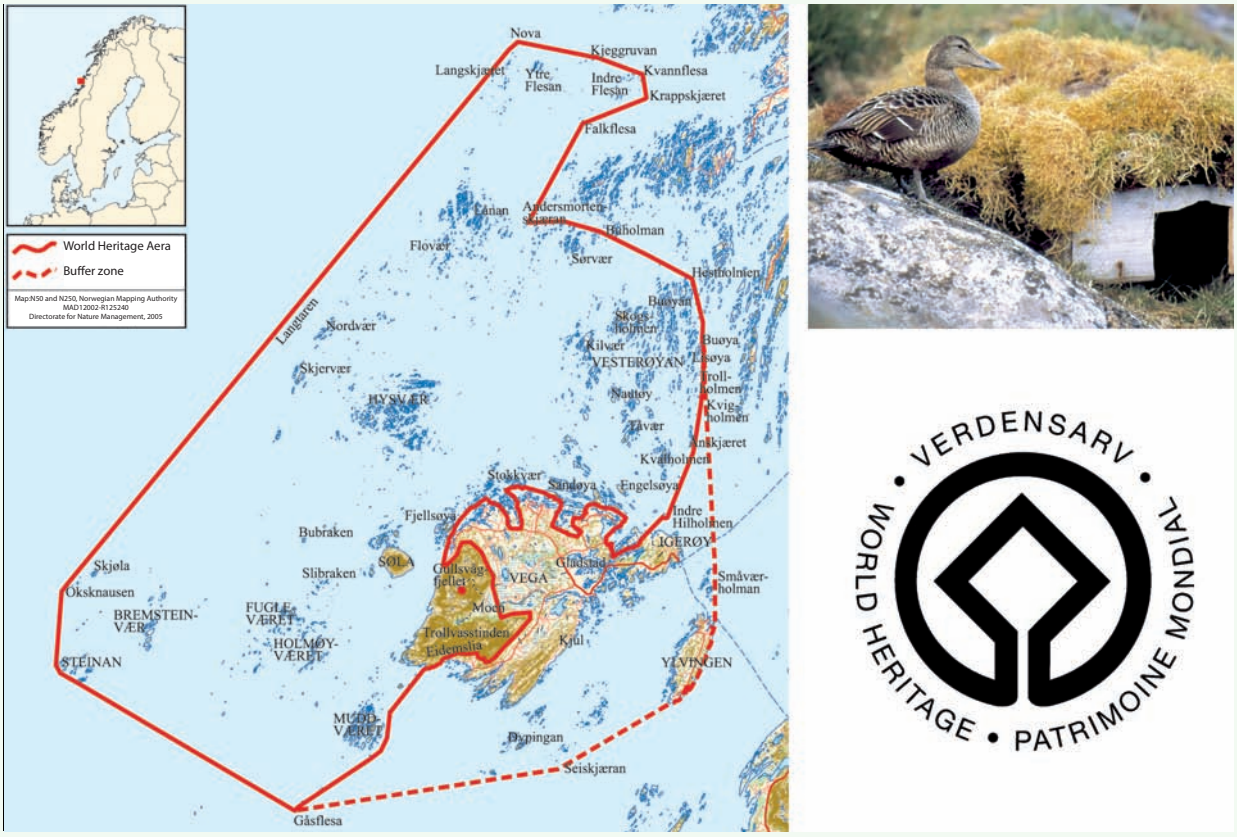

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Figure 4.8 Vegaøyan – the Vega Archipelago – is a UNESCO World Heritage site.

Source: Ministry of the Environment

Box 4.4 cont.

Implementation of the World Heritage Convention list the requirements that must be met when a property is nominated for inscription on the World Heritage List. These include «adequate long-term legislative, regulatory, contractual, planning, institutional and/ or traditional measures» to protect the property. There must also be a sound management plan or other management regime that safeguards the outstanding universal value of the property and ensures that it is not subject to development or changes that would have a negative impact.

The Norwegian World Heritage sites will be developed as leading examples of best practice in cultural heritage management. This will require a strict management regime, and a management plan for the Vega Archipelago has been developed for the period 2005–2010. Large areas of the seascape are shallow, with high species diversity and substantial biological and commercial resources. In the decision to inscribe the property on the World Heritage List, it was recommended that Norway should consider expanding the property to include a buffer zone consisting of islands and sea areas to the north and north-west.

localised in Stjørdal. A great deal of maritime research is conducted in both Nord-Trøndelag and Sør-Trøndelag, at the University of Science and Technology and MARINTEK.

On 1 January 2007 Nordland county had a population of around 235 000. The numbers have been decreasing for the last 20 years, and in the last 10 years the county has experienced a population decline of almost 5000 a year. The decline is most marked on the islands and in small coastal municipalities that have no large urban centres. The only areas to experience population growth during this period are Salten and Bodø municipalities, and Bodø is by far the largest area of growth in the county. Today around 60 % of the population lives and works in the coastal zone. Of all the counties in the country, Nordland is the county with the largest number of fish farms and where the second largest quantity of fish is landed. This has substantial spin-off effects in other industries, especially the fish processing industry and service industries for the fishing fleet, but also for salmon-slaughtering plants, fish feed manufacturing plants and suppliers of equipment for fish processing. Currently there is little petroleum-related activity in Nordland but there are some supply/helicopter services from Sandnessjøen/Brønnøysund to the Norwegian Sea.

4.2.2 Employment

As regards petroleum-related employment on the continental shelf, the table only shows the number of people in the four counties employed in the extraction of crude petroleum and natural gas.

Of the four counties bordering on the Norwegian Sea, Sør-Trøndelag had the largest number of people employed in the fourth quarter of 2007, followed by Møre og Romsdal, Nordland and Nord-Trøndelag, in that order. Most of the employed are in the service industries, which corresponds to the figures for the country as a whole. According to Statistics Norway, employment in the secondary and tertiary industries rose by about 3 % in all four countries from 2006 to 2007. In Møre og Romsdal and Nordland the number of people employed in the primary industries declined. In Nord-Trøndelag employment in the primary industries remained unchanged, whereas in Sør-Trøndelag it rose by about 1.5 %.

Table 4.3 shows that in 2007, 130 681 persons were employed in Møre og Romsdal. Employment in the manufacturing and mining and quarrying industries was high in this county, at 18 %, as compared with approximately 10 % for the country as a whole. Roughly the same number of people worked in the health and social work sector as in the manufacturing and mining and quarrying industries. Wholesale and retail and hotels and restaurants accounted for 17 % of employment in the county. Employment was higher in fishing, fish farming and related services than the national average. From 2006 to 2007 employment declined by 3 % in the primary industries and rose by 4 % in the secondary and tertiary industries.

In 2007, 150 041 persons were employed in Sør-Trøndelag. Of these, 19 % were employed in the health and social work sector and 17 % in wholesale and retail, hotels and restaurants. Sør-Trøndelag had relatively more people employed in business

Table 4.3 Number of employed persons in the fourth quarter of 2007 by county and industry

	Møre og Romsdal	Sør-Trøndelag	Nord-Trøndelag	Nordland
Total	*13 0681*	*15 0041*	*66 166*	*11 8384*
Agriculture and forestry	3 804	4 806	5 257	3 669
Fishing, fish farming and related services	2 986	901	523	3 503
Extraction of crude petroleum and natural gas	1 465	1 656	442	626
Manufacturing and mining and quarrying	23 885	14 335	8 382	11 826
Electricity, gas and water supply	1 091	1 101	672	1 261
Construction	9 047	11 743	5 485	9 048
Wholesale and retail, hotels and restaurants	22 076	25 976	10 583	19 328
Transport and communications	10 363	8 546	3 975	9 296
Financial services	1 928	3 054	644	1 361
Business activities, real estate	9 201	18 812	4 479	7 745
Public admin., defence, compulsory social security	6 315	8 887	4 240	9 809
Education	9 344	14 721	5 641	10 540
Health and social work	24 692	29 176	13 533	25 803
Other community, social and personal services	3 973	5 845	2 073	4 178
Unspecified	511	482	237	391

Source: StatBank, Statistics Norway

activities (13 %) than the other three counties. Manufacturing and education accounted for about 10 % of employment in the county. According to Statistics Norway, from the fourth quarter of 2006 to the fourth quarter of 2007 employment in the primary industries rose by 1.5 % and in the secondary and tertiary industries by 4 %.

In 2007, 66 166 persons were employed in Nord-Trøndelag. Here too, many people were employed in health and social work (20 %) and wholesale and retail, hotels and restaurants (16 %). Manufacturing and mining and quarrying accounted for 13 %. The proportion of employed in agriculture, forestry and fishing (9 %) was about three times as high as the national average (3 %). Employment in the secondary and tertiary industries rose by 5 % from 2006 to 2007.

In 2007, 118 384 persons were employed in Nordland. The largest proportion was employed in health and social work (22 %) and wholesale and retail, hotels and restaurants (16 %); 10 % were employed in manufacturing and 3 % in fishing, fish farming and related services. A high percentage of the employed in Nordland worked in the public administration, defence and compulsory social security sectors (8 %) as compared with the national average (4 %). Nordland also had relatively high employment in fishing, fish farming and related services (3 %) compared with the national average (0.6 %). From 2006 to 2007, employment in the primary industries declined by 3 % and that in the secondary and tertiary industries rose by 6 % and 3 % respectively.

4.2.3 Value creation

Value added is often used as a measure of wealth creation. Value added is defined as the difference between the value of produced goods and services (production value) and the goods and services required to produce them (material input).

This overview does not include value creation on the continental shelf because the petroleum revenues are channelled directly to the state. The figures for value creation in the extraction of crude petroleum and natural gas industries in the four counties are based on tax revenues from company headquarters/onshore activities.

Table 4.4 shows that in 2005 value added for Møre og Romsdal was NOK 58 936 million, and GDP per employed person was NOK 589 788, as compared with the national average of NOK 618 674. Manufacturing is a major industry in Møre og Romsdal, and the value added from this industry is divided between manufacturing of machinery and other equipment (about 22 %), manufacture of food products, beverages and tobacco (16 %), shipbuilding etc. (14 %) and furni-

Table 4.4 Value added by county and industry in 2005, base value. NOK million

	Møre og Romsdal	Sør-Trøndelag	Nord-Trøndelag	Nordland
Total	*58 936*	*70 812*	*24 888*	*51 993*
Agriculture and forestry	671	717	969	544
Fishing, fish farming and related services	3 035	445	305	2 483
Extraction of crude petroleum and natural gas, including services	103	470	254	0
Manufacturing and mining and quarrying	14 677	7 904	3 695	6 735
Electricity, gas and water supply	2 785	2 110	748	4 251
Construction	3 426	5 008	1 673	3 455
Wholesale and retail, hotels and restaurants	5 738	9 605	2 541	4 772
Ocean transport	310	51	11	15
Transport and communications	2 564	3 863	2 341	3 025
Financial services	1 964	4 195	567	1 498
Business activities, real estate	8 178	14 239	3 258	7 163
Public administration and defence	2 632	4 147	1 719	4 577
Education	3 606	6 333	2 119	3 946
Health and social work	7 571	8 947	3 853	7 781
Other community, social and personal services	1 676	2 777	837	1 747

Source: StatBank, Statistics Norway

ture and other manufacturing (14 %). The manufacture of basic metal and chemical raw materials accounted for about 10 % and 12 % respectively. Fishing, fish farming and related services includes fishing in ocean and coastal waters, processing on board fishing vessels and fish farming. Although this sector accounts for a relatively small proportion of value creation in the county (5 %), it represents about 24 % of total value creation in the sector at the national level.

Value added for Sør-Trøndelag in 2005 was NOK 70 812 million, and GDP per employed person was NOK 586 549. The industries that contributed most to value creation in Sør-Trøndelag were business activities and real estate (20 %), health and social work (13 %), wholesale and retail, hotels and restaurants (14 %), manufacturing and mining and quarrying (11 %) and education (9 %). The proportions of value added contributed by the different industries are very similar to those at national level.

Total value added for Nord-Trøndelag in 2005 was NOK 24 888 million, and GDP per employed person was NOK 499 046, which is considerably lower than the national average. The five industries that accounted for most of the value creation in this county were health and social work (15 %), manufacturing and mining and quarrying (15 %), business activities and real estate (13 %), wholesale and retail, hotel and restaurants (10 %) and education (9 %).

Value added for Nordland in 2005 was NOK 51 993 million, and GDP per employed person was NOK 542 083. The industries that accounted for most of the value creation in this county in 2005 were health and social work (15 %), manufacturing and mining and quarrying (13 %), business activities and real estate (14 %) and wholesale and retail, hotels and restaurants (9 %). Fishing, fish farming and related services in Nordland accounted for 20 % of the national value creation in this sector.

5 Pressures and impacts on the environment

This chapter presents an assessment of the cumulative environmental effects on specific components of the Norwegian Sea ecosystem and on the particularly valuable areas, based on current knowledge. Cumulative effects assessment is a methodologically complex undertaking, and cannot yet be used to replace assessments of individual problems and species. In this case, pressures and their impacts on a selection of species and habitats were evaluated and used as a basis for an assessment of cumulative environmental effects. Assessments were made both for the current level of activity in different sectors and for scenarios constructed for future levels of activity. If activity patterns, and especially the location of activities, turn out to be different from those estimated in the assessments, the impacts during normal operations may also differ, and so may the probability and potential impacts of major or minor accidents. This was taken into account when the scientific basis was used during the preparation of the white paper. Fishing pressure on fish stocks is also included when the cumulative effects on individual species or species groups are assessed.

The expert group used a five-point scale (insignificant, minor, moderate, major, catastrophic) to indicate the level of impact in its discussion of cumulative environmental effects in the Norwegian Sea (see the description in Chapter 2.4). It is important to note that the scale is largely based on possible effects on the Norwegian Sea ecosystem as a whole. In most cases, the cumulative effects have been assessed at population level or for larger areas, rather than at individual level or more locally. This means that in cases where the category *insignificant* is used here, smaller-scale assessments (for example in connection with the regulation of specific activities) may indicate more serious impacts on individuals or on smaller areas. The expert group has attempted to assess cumulative effects up to 2025, based on the scenarios of future activity levels.

Greenhouse gases that have already been released to the atmosphere will result in climate change and ocean acidification. Because of the oceanographic and biological features of the Norwegian Sea, the impacts of ocean acidification are expected to become apparent particularly quickly here, and damage to ecosystems is expected as early as 2025.

There is considerable uncertainty as to how and how quickly the impacts of climate change will become apparent in the Norwegian Sea. However, warming of the Norwegian Sea is expected to lead to a northward and westward shift of the front zone between Atlantic and Arctic water. New species may expand their distribution northwards towards Norwegian waters. Southerly species along the Norwegian coast are expected to shift northwards along the coast towards Svalbard and the eastern part of the Barents Sea. Climate change and ocean acidification may reduce the resilience of ecosystems to other pressures. In future, the management regime must therefore be adapted to changes in ecosystems. This is discussed in more depth in Chapter 6.

5.1 Cumulative environmental effects

5.1.1 Cumulative environmental effects of normal activities

The Norwegian Sea is a large area, and large parts of the water masses and the deep seabed beyond the continental shelf are relatively unaffected by direct pressures from human activity. Like all marine areas, the Norwegian Sea is affected by long-range transboundary pollution, but no direct impacts on ecosystems have been demonstrated, although pollutants have been found in organisms at the highest trophic levels of food chains. Direct pressures from human activity are mainly concentrated in the continental shelf areas near the Norwegian coast. At present, the Norwegian Sea is one of the cleanest sea areas in the world, and the state of the environment here is generally good (see Chapter 3). However, several species and parts of the area show clear evidence of impacts, mainly from environmental pressures on the continental shelf.

The greatest cumulative effects in the Norwegian Sea today are on certain fish species, seabird species and seabed habitats. For various reasons such as natural fluctuations, climate change and

high level of fishing pressure, certain fish stocks are not in a very healthy condition, and are therefore particularly vulnerable to even a small increase in human pressures. These include redfish (*Sebastes marinus* and *S. mentella*) and coastal cod. Other species such as blue whiting and Greenland halibut are also considered to be vulnerable. The cumulative pressures on such stocks have been ranked as *major* on the five-point scale. However, management measures have been introduced at national and international level to improve the situation. The cumulative effects on certain seabed habitats such as corals, sponges and other vulnerable benthic fauna groups are also ranked as *major* in areas where bottom trawls are used. Seabirds are exposed to many complex environmental pressures, and the impacts may be direct (higher mortality, reduced fitness) or indirect (through food supplies or access to important habitats). Many of the seabird populations in the Norwegian Sea are declining and are therefore particularly vulnerable to an increase in cumulative effects. We know too little about the reasons for this decline, but poor food supplies are believed to be a critical factor. The cumulative effects on common guillemot, puffin, common eider, kittiwake and shag are ranked as *moderate*.

The human activity that currently puts most pressure on the Norwegian Sea during normal activities is the fisheries. Any fishery necessarily has some influence on the ecosystem where it takes place. The level of pressure depends on how much of a stock is harvested, how it is harvested, and the trophic level to which the stock belongs. If harvesting is not to have adverse impacts on ecosystems, it must be sustainable. Ideally, this means that only the surplus biological production is removed from the ecosystem each year. Permitted operational discharges from maritime transport make a relatively small contribution to the cumulative effects on the Norwegian Sea ecosystem, except for discharges of waste, which may have *insignificant* effects on marine mammals and the shoreline and up to *moderate* effects on seabirds, and discharges of oil, which are estimated to have *insignificant* effects on seabirds. Operational discharges from petroleum activities are generally so strictly regulated that they are only considered to have more local effects, which are ranked as *insignificant* for the Norwegian Sea ecosystem as a whole. However, there is still some uncertainty as regards the possible long-term effects of discharges of produced water from petroleum activities.

In addition to the above-mentioned pressures, which apply to the current situation, it is expected that by 2025, the impacts of gradual ocean acidification will begin to be apparent for corals and other benthic animals with calcareous skeletons. Ocean acidification may also result in changes in the species composition of phytoplankton, and thus have an impact on the food chains that include zooplankton, the benthic fauna, fish, seabirds and marine mammals, and on which all these species depend. Both the gradual process of climate change that is being observed and long-range transport of pollutants increase the level of uncertainty as regards the impacts that can be expected in 2025.

Particularly valuable areas

The coastal zone (including the Vestfjorden) and the Møre, Halten and Sklinna banks are the particularly valuable areas of the Norwegian Sea where cumulative environmental effects are currently considered to be greatest during normal activities. In the Jan Mayen/West Ice area and the arctic front zone, on the other hand, there is currently little activity (little maritime transport and fisheries activity, no petroleum activities), and little direct environmental pressure. These assessments are based on a situation with no petroleum activities in any of the valuable areas near the coast, but some activity along the edge of the continental shelf. The impacts of the current level of petroleum activity on the particularly valuable areas in the Norwegian Sea are assessed as *insignificant*. The impacts of operational discharges from maritime transport are also assessed as *insignificant* in the particularly valuable areas, except that discharges of waste have greater impacts, especially off the coast of Møre og Romsdal. Under normal circumstances, the fisheries and activities in the coastal zone put most pressure on the environment. There is considerable fisheries activity in several of the valuable areas, and species such as saithe, herring and cod are harvested. Bottom trawling operations may have an impact on the seabed. Seabirds may be taken as bycatches. There are many other pressures on the coastal zone that may affect particularly valuable areas (for example wind power production, aquaculture, runoff of pollutants and tourism), but their impacts have not been specifically assessed for each area.

If trends in climate change and ocean acidification continue as projected in the scenarios for 2025 and 2080, there will be *major* effects on all the particularly vulnerable areas and on the Norwegian Sea as a whole.

5.1.2 Impacts of acute pollution

There is a risk of accidents involving releases of oil, chemicals or radioactive substances in the Norwegian Sea. The consequences of accidents are additional to the impacts of normal activities. Because transport of chemicals is strictly regulated, the environmental risk associated with spills during this type of transport is expected to be generally low. Accidents involving radioactive contamination could result in considerable inputs of radioactive substances to the environment, and elevated concentrations in seawater, sediments and species at all trophic levels for several years after a spill. Modelling indicates that levels of radioactivity to which marine organisms are exposed are likely to be below the threshold values at which damage is expected. However, we know too little about the effects of radioactive contamination on the natural environment.

Petroleum activities and maritime transport in the Norwegian Sea represent a risk of accidents that could result in oil spills. Regular updating of the legislation for both industries means that operators must meet higher and higher standards. This reduces the probability of accidents (see Chapter 7.5). In general, the probability of a small spill is higher than that of a large spill. The potential consequences of different types of accidental events are closely linked with where they happen and their scale, the type of oil, the weather conditions, the time of year and how likely the spill is to affect vulnerable species and habitats. In addition, species and habitats that are known to be vulnerable to oil are generally found in larger numbers or at higher densities in coastal areas, and the distance to the shore is therefore another factor of importance in evaluating the potential consequences of a spill.

The environmental impacts of the current level of activity have been assessed by modelling major spills from blow-outs and shipwrecks in the Norwegian Sea. The results show the most serious potential consequences for seabirds and the shoreline, while potential consequences for earlier stages of fish life cycles and for the coastal seal species are assessed as less serious. It is less likely that a large proportion of a plankton population or of a benthic community will be affected by a spill, and the potential consequences are therefore not considered to be very important. The impacts of a major blow-out or a large oil spill from a ship may vary from *insignificant* to *major*, depending on whether vulnerable species and habitats are present and become contaminated. Generally speaking, the probability of major spills from petroleum operations is low.

In general, the probability that the shoreline or species and habitats near the coast will be affected is lower in the event of a blow-out from the oil and gas fields considered in this assessment than in the event of an oil spill from a ship near the coast, unless a blow-out affects large concentrations of seabirds foraging at sea. Thus, the probability of the most serious impacts on plankton (fish eggs and larvae), seabirds, marine mammals and the shoreline has been assessed as lower for the blow-outs modelled than for the spills from ships closer to the coast. If there is a major spill from a ship further from the coast in the Norwegian Sea, both the potential consequences and the probability of the most serious consequences are expected to be lower. However, a major spill from a ship or a petroleum installation in the open sea could spread more widely and affect a larger area. On the whole, the potential environmental consequences of a major oil spill from a ship or a blow-out in the 2025 scenario are assessed as similar to those at the current level of activity. The 2025 scenario assumes that several of the fields currently on stream have shut down, while several new gas fields and one new oil field are on stream. The scenario also includes exploration drilling in new areas. The closure of oil fields removes their contribution to the overall risk level. The development of oil fields and exploration drilling in new areas means that the environmental risk shifts to new areas. However, new gas fields do not involve the same risk of spills of oil as oil fields. A general increase in the volume of maritime transport in the Norwegian Sea is expected in the period up to 2025, mainly in the form of tanker traffic to and from Russia. As a result, there will be an increase in the probability of maritime transport accidents up to 2025 throughout the management plan area, and spills of crude oil, bunker fuel and petroleum products are expected to increase. The assessment did not include the effects of introducing stricter legislation or response measures. The growth in the volume of traffic is not necessarily expected to result in changes in the potential consequences of different types of accidents, but it is expected to result in an increase in the overall environmental risk associated with oil spills from maritime transport.

Particularly valuable areas

In today's situation, a blow-out from petroleum operations in the Norwegian Sea could in the worst case have *major* impacts on the Vestfjorden and the

coastal zone, which have been identified as particularly valuable and vulnerable areas. However, the probability of a blow-out is low. Modelling showed that oil from a blow-out on the Norne og Draugen fields would be most likely to reach the coast (probability of shoreline impact 10 and 16 % respectively). For other fields, the probability of oil reaching the shore is less than 5 %. On the basis of these figures, the probability of the most serious consequences is considered to be relatively low. In the event of similar spills from activities within or near particularly valuable and vulnerable areas, both the probability that such areas will be affected and the probability of more serious consequences are expected to be higher. The legislation governing the petroleum industry is risk-based and follows the principle that a higher risk requires greater efforts to reduce the probability of a spill occurring, which covers situations where there is a higher probability of more serious consequences. Reducing the consequences of spills by improving the oil spill response system can also reduce the level of environmental risk. Such measures are not included in the assessments described above. In the worst case, oil spills from ships, like the blow-outs that have been modelled, may have *major* impacts on the particularly valuable and vulnerable Vestfjorden and coastal zone. However, the probability of more serious consequences may be higher for near-shore spills of oil from ships than for blow-outs from the existing petroleum installations. The area around the Møre banks is most vulnerable to acute pollution from maritime transport in the Norwegian Sea, because of the large volume of traffic concentrated in this area. The risk of spills in or near the other particularly valuable and vulnerable areas is lower.

In the 2025 scenario, the Norne field has been closed down, and the potential consequences for the Vestfjorden are therefore less serious. The potential consequences for the other particularly valuable and vulnerable areas will depend on where new petroleum activities are started and whether new fields contain oil or gas. Gas fields do not present the risk of oil spills that oil fields do. For maritime transport, the potential consequences for the different areas are expected to about the same as in 2006, but the probability of oil spills is expected to rise with the projected rise in the volume of traffic, and this will result in a rise in the environmental risk associated with such incidents.

5.1.3 Cumulative environmental effects on primary and secondary production (plankton)

None of the activities assessed has much impact on primary and secondary production in the Norwegian Sea, and the cumulative effects of the current level of activity are ranked as *insignificant*. Nor are the impacts of acute pollution expected to exceed this level. However, by 2025, more widespread damage at the level of primary and secondary production may occur as a result of ocean acidification, and this may have impacts at ecosystem level. The impacts of ocean acidification on primary and secondary production are assessed as *moderate* up to 2025 and *major* in the longer term.

5.1.4 Cumulative environmental effects on seabed habitats

Bottom trawling has *major* impacts on the benthic species and communities that are directly affected. The impacts at population level (in this case best considered as the Norwegian Sea as a whole) are more uncertain, and should be investigated further. The pressure on such areas varies, depending on how intensively they are trawled. Other physical disturbance of the seabed and discharges of drill cuttings from exploration and production drilling are considered to have more local impacts and only *insignificant* impacts on the Norwegian Sea as a whole. Operators are required to ensure that petroleum activities do not damage corals or other valuable benthic communities. Oil spills are not generally expected to have very serious impacts on benthic communities, but the potential consequences are likely to be higher in the event of a spill near the coast in shallow water, or if there is a possibility of direct contamination of the seabed (for example if a ship is grounded). Such consequences are expected to be local and will be less serious for the area as a whole. Accidents involving releases of radioactive material could have long-lasting impacts on benthic communities.

The expert group concluded that up to 2025, there could be *major* cumulative effects on some benthic species and habitats unless new measures are introduced to reduce the damage caused by bottom trawling, and the effects may be aggravated as ocean acidification increases. This applies particularly to corals and other organisms that have calcareous skeletons or are otherwise dependent on calcium. At present other physical disturbance of the seabed and discharges of drill cuttings from exploration and production drilling

have more local effects, and this situation is expected to continue, provided that strict regulation to avoid damage is maintained.

Particularly vulnerable habitat types such as coral reefs, gorgonian forests and sponge communities

Corals form habitats such as coral reefs, coral rubble and gorgonian forests. Other animal groups such as sponges can also form dense stands and form habitats with similar ecological functions to coral habitats. Corals are fragile and extremely vulnerable to physical damage and sediment deposition. The oldest parts of known Norwegian coral reefs are more than 8 000 years old. Corals grow very slowly, and corals in the Norwegian Sea may stop growing altogether in the course of the present century as a result of ocean acidification. Because of their slow rate of growth, there is reason to believe that damage to these habitat types in the years ahead may in practice be irreversible. It has previously been estimated that about 30–50 % of Norwegian coral reefs have been damaged or destroyed by bottom trawling. This estimate should be updated now that new coral reefs, both intact and damaged, have been discovered. Even less is known about the status of gorgonian forests and sponge communities in Norwegian waters.

Sponges are also vulnerable to physical damage, bycatch and sediment deposition. Coral reefs, gorgonian forests and sponge communities are important for biological diversity and marine living resources. However, little is known about the exact role of these habitat types and species in ecosystems, and their distribution in the Norwegian Sea has not been properly mapped.

These habitat types are particularly vulnerable to fishing gear that may touch the seabed, such as bottom trawls and other towed gear, including Danish seines. Equipment such as sea anchors, sampling equipment including grabs, and equipment used to retrieve lost gill nets will also cause damage on contact with corals. Passive fishing gear such as gill nets and longlines can also cause damage if it is set above corals reefs or gorgonian forests. Nets and hooks easily become entangled in corals, and fishermen have indicated that they sometimes take considerable bycatches of corals. Retrieving lost gear can do more harm than good, so the solution may be to abandon the gear, which will then continue to catch fish («ghost fishing»).

Other activities can also damage or threaten these vulnerable habitat types, for example pipeline- and cable-laying using a vessel without a dynamic positioning system. Such processes and other activities involving physical disturbance of the seabed can also result in resuspension of sediments and sediment deposition on corals, sponges and other benthic animals.

Other examples of local activities that may damage vulnerable habitat types such as coral reefs are extraction of coral rubble, deposition of

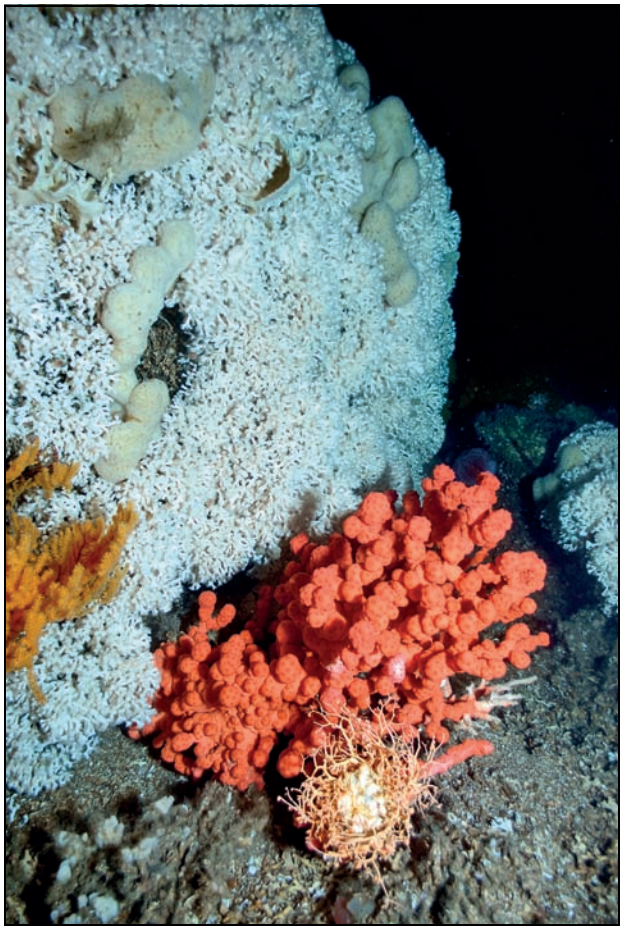

Figure 5.1 Corals

Photo: Erling Svensen

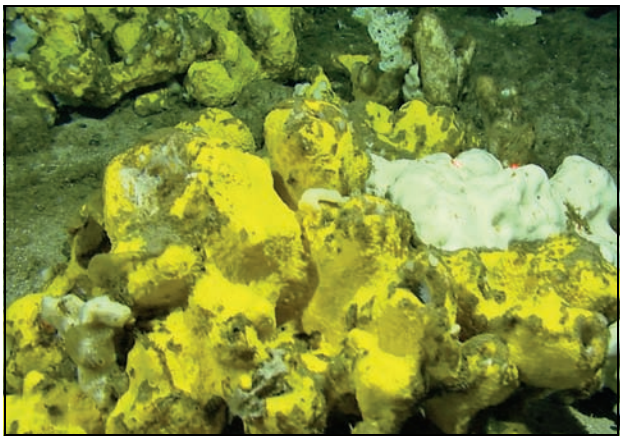

Figure 5.2 Sponges

Photo: Institute of Marine Research/MAREANO programme

Figure 5.3 Branching corals are very vulnerable to fishing with gill nets. They can easily become entangled in the meshes, like the gorgonian coral shown here. The fish shown is a tusk.

Photo: Institute of Marine Research

sediments and drill cuttings, collection of corals or other animals for bioprospecting, and detonations near the seabed in connection with military exercises. In addition, there are external pressures such as long-range transboundary pollution, climate change and ocean acidification (see Chapter 6). Because of the importance of coral reefs and gorgonian forests in the ecosystem and their vulnerability and current status, it is particularly important to take a precautionary approach to their management.

It is uncertain whether there are cold seeps and black smokers (including pockmarks) in the parts of the Norwegian Sea where trawling is permitted. The pockmarks in the Nyegga area, which are at a depth of 700–800 metres, may be at risk from trawling.

Kelp forests

The impact of kelp trawling on kelp forests is assessed as *minor*. The annual harvest is 150 000 tonnes, which is less than one per cent of the total biomass of *Laminaria hyperborea* along the Norwegian coast. Nevertheless, this harvest of a renewable resource may have local impacts, depending on the quantity harvested, the proportion of a stand harvested and the capacity of the kelp forests for recovery. Kelp trawling and storm damage generally leave considerable numbers of recruits in the undergrowth, so that the kelp forest recovers without problems. The kelp forests in the southern coastal parts of the Norwegian Sea are dense and productive, whereas those further north have been severely depleted by sea urchin grazing. For Norway as a whole, it is estimated that sea urchin grazing corresponds to an annual production of 20 million tonnes of kelp, which is about 130 times the harvest taken by trawling.

Kelp forests are important for biological diversity, for example as nursery areas for fish larvae and feeding areas for several species of seabirds. For certain seabirds, particularly shag and black guillemot, productive kelp forests near their breeding sites can be a key factor in breeding success. Climate change and a higher concentration of CO_2 in sea water may stimulate growth of *Laminaria*

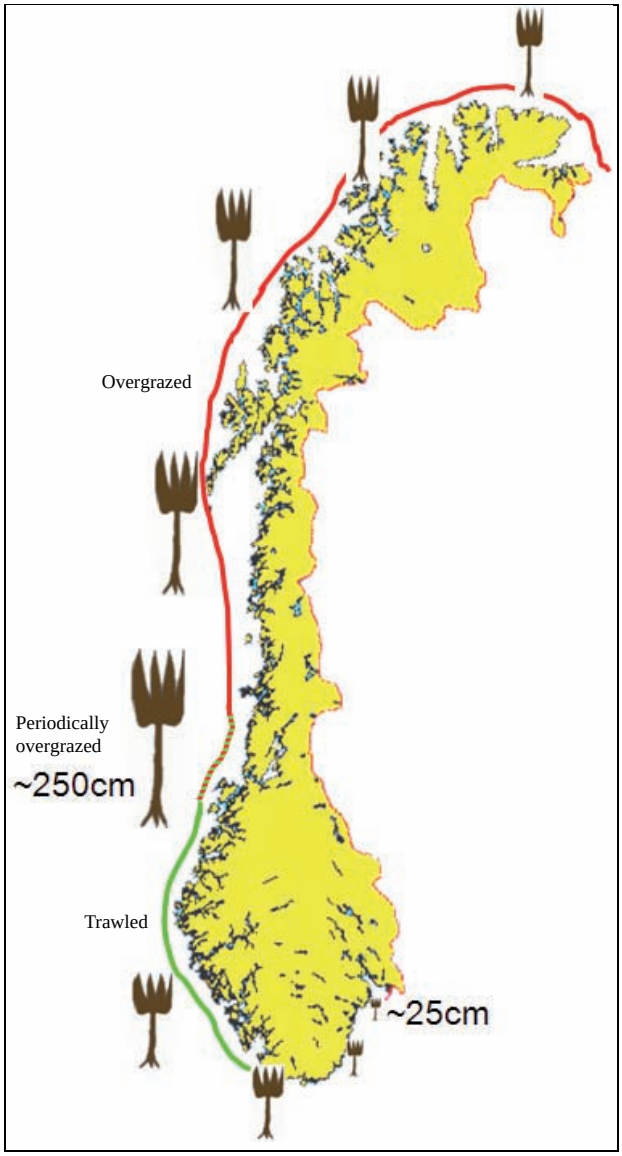

Figure 5.4 Distribution of Laminaria hyperborea along the Norwegian coast and geographical variation in average size

Source: Institute of Marine Research

hyperborea and possibly in the long term boost the recovery of kelp forests that have been overgrazed by sea urchins. It is important to ensure that kelp resources, like other living marine resources, are managed sustainably, taking into consideration biological and habitat diversity and food supplies for fish stocks and seabirds.

5.1.5 Cumulative environmental effects on fish stocks, including commercially harvested stocks

Harvesting a fish stock puts pressure on it, and under normal circumstances this will be the most important anthropogenic pressure. For example, the recommended TAC for Norwegian spring-spawning herring in 2009 is more than 1.6 million tonnes from an estimated spawning stock in excess of 12 million tonnes. The largest and most important fish stocks in the Norwegian Sea, such as Norwegian spring-spawning herring and saithe, are being harvested sustainably at present. Another large stock, that of blue whiting, is above the precautionary level, but has been heavily fished because there has been no international agreement on its management. An agreement is now in place, and the parties have agreed on steps to rebuild the blue whiting stock so that it can be harvested sustainably. Stocks of certain species, such as Greenland halibut, redfish (*Sebastes marinus* and *S. mentella*), tusk and coastal cod, are in poorer condition, and the fisheries are considered to have *major* impacts on these species.

The main impacts of any major oil spills from the petroleum industry or ships are expected to be largely the result of damage to fish eggs and larvae. The scale of such impacts will depend on when and where a spill happens, fluctuations in fish stocks, and the properties of the oil. Damage to eggs and larvae can result in poorer recruitment from the year class affected. The most serious consequences are expected to be greatest in areas and at times of year when high concentrations of eggs and larvae are present. For a further discussion of the risks associated with acute pollution, see Chapter 5.6.

In the period up to 2025, the situation for fish stocks will probably change to some extent as a result of climate change and ocean acidification. There is some uncertainty about the possible long-term effects of discharges of produced water. In addition, the management regime will be important for the development of a number of fish stocks.

5.1.6 Cumulative environmental effects on seabirds

Although in most cases individual environmental pressures have *insignificant* or *minor* impacts on seabirds in the Norwegian Sea, the cumulative effects for the current situation (activity levels and external pressures) are classed as *moderate*. In the management plan area, pressures such as climate change and long-range transport of hazardous substances act together with regional and local pressures, including releases of pollutants from land, bycatches, poor food supplies and oil pollution (probably from illegal discharges from ships). Food supplies are the most important single factor, but it is uncertain to what extent poor food supplies are a result of large-scale changes (for example climate change) or the harvest taken by the fisheries. Many seabird populations in the Norwegian Sea are already declining, and are therefore particularly vulnerable to an increase in anthropogenic pressures. A combination of different pressures may have synergistic effects, so that the cumulative effect is greater than the sum of the separate impacts. Over time, this may result in a considerable reductions in numbers in many species, which under certain conditions may have negative impacts at colony or population level. The cumulative environmental effects on common guillemot, puffin, common eider, kittiwake and shag are assessed as *moderate*.

Any impacts of oil spills will be additional to the cumulative environmental effects considered here. In most cases, accidents are most likely to have *minor* or *moderate* impacts, but in the worst cases they may have *major* impacts on certain species.

It is generally assumed that the potential for serious environmental consequences is lower for small oil spills than for major spills. However, studies have shown that even small quantities of oil on the sea (from small illegal discharges and leaks from unspecified sources) can cause serious damage to seabirds, particularly if this results in repeated exposure. It has been suggested that more frequent exposure to small oil spills can have more serious effects on the long-term population stability of seabirds than infrequent major spills. A small oil spill that coincides in time and space with large numbers of seabirds can kill more birds than a major spill that does not. On the basis of current knowledge it is only possible to conclude that small oil spills may be an important pressure on seabirds, but it is not possible to quantify this at present.

The situation for individual seabird populations in 2025 is very uncertain, as are the possible effects of climate change, ocean acidification and changes in food supplies. It is therefore difficult to assess the cumulative environmental effects on seabirds in the 2025 scenario.

5.1.7 Cumulative environmental effects on marine mammals

At the current level of activity, the impacts of human activities and external pressures are assessed as *moderate* for minke whale and hooded seal, and *minor* for pelagic whale communities. However, the cumulative effects are assessed as *major* for porpoises in the Vestfjorden and for common seal generally. The impacts on minke whale, hooded seal and common seal are largely a result of deliberate harvesting, whereas porpoises are taken largely as a bycatch. The accident scenarios that have been assessed show that accidents involving oil spills may have from *insignificant* to *moderate* impacts on coastal seals, depending on whether or not a slick contaminates large numbers of animals.

In the period up to 2025 the situation for seals may deteriorate as a result of climate change, and as an indirect result of ocean acidification.

5.2 Pressures and impacts associated with the fisheries

The Norwegian fisheries, like any harvest from a renewable resource, are bound to have an effect on the stocks that are harvested. Fishing pressure is therefore not comparable with pressures such as pollution and the introduction of alien species. The challenge in fisheries management is to ensure that harvesting is carried out in a way that maintains fish stocks for the future and that minimises impacts on the seabed and on other species.

5.2.1 The fisheries in the Norwegian Sea

There are large stocks of Norwegian spring-spawning herring, blue whiting, mackerel and saithe in the Norwegian Sea, which provide the basis for the most important fisheries in this sea area. In addition, small quantities of the redfish *Sebastes mentella* are harvested while feeding in the Norwegian Sea, and there are fisheries for tusk, ling, Greenland halibut, redfish and greater argentine along the continental slope. The Møre banks are intensively used as a fishing ground throughout the year. From January, fishing vessels follow the herring on their spawning migration towards spawning grounds on the Møre banks. Otherwise, herring, blue whiting and mackerel are fished in large parts of the Norwegian Sea, there is a year-round fishery for saithe all along the coast, greater argentine is trawled in certain areas, and there are other sporadic fisheries. The areas that are most intensively fished during the year are illustrated in Figure 5.5. With the exception of Northeast Arctic saithe, Norway shares all the commercially important fish stocks with other coastal states. Chapter 7.3 describes the fisheries management regime. Norway also harvests the minke whale stock, and much of the catch is taken within the management plan area.

Within the time frame of the management plan, fisheries are the human activity that will probably have the greatest impact on the ecosystem. The harvest must be adjusted to ensure that the natural interplay between different components in the ecosystem is maintained. The pressure on the Norwegian Sea ecosystems depends on how much of a stock is harvested, how it is harvested, and the trophic level to which the stock belongs.

The effects of external factors such as variations in temperature and current patterns must also be taken into account in evaluating the pressure exerted by the fisheries. In some cases, external factors and natural fluctuations in fish stocks due to competition between species and variations in food supplies may be more important than anthropogenic pressures on the same stocks. Our knowledge of the impacts of fisheries varies from one species and area to another, and it is difficult to distinguish between human and other pressures. The fish stocks that are most important in commercial terms have been harvested and managed for many years, and a considerable body of knowledge has been obtained by research and in other ways, so that we know most about the impacts on these stocks. On the other hand, relatively little is known about the impacts of the fisheries on species that are not harvested commercially and on other parts of the ecosystem, see Chapter 9.

5.2.2 Impacts on commercially exploited stocks

The main pressure exerted by the fisheries is the deliberate harvesting of commercial stocks, which results in changes in stock sizes and in the size and age structure of stocks. Very selective fishing of specific year classes can also result in changes in

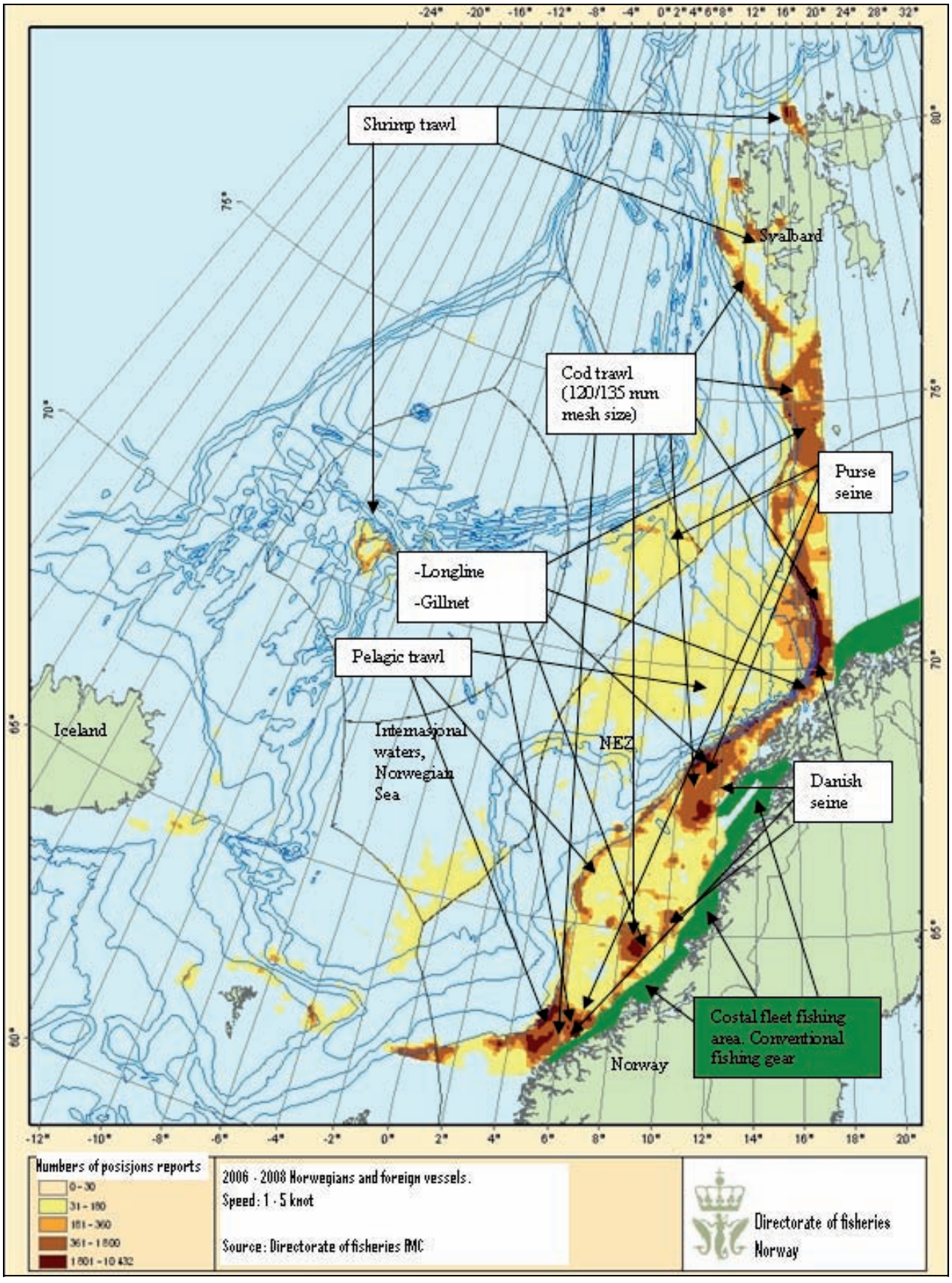

Figure 5.5 Map of the most important fisheries in the Norwegian Sea during the year

Source: Directorate of Fisheries

genetic make-up. Evolutionary impacts are further described below.

The stocks of Norwegian spring-spawning herring, Northeast Arctic saithe, Northeast Arctic cod and Northeast Arctic haddock are being harvested sustainably and are in good condition. The impacts of the fisheries are considered to be *moderate* for these species. The blue whiting and mackerel stocks are both above the precautionary level, but have been heavily fished, and the expert group has assessed the impacts of harvesting as *major* for these species. Stocks of other species such as Greenland halibut, the redfish *Sebastes marinus* and *S. mentella*, tusk and coastal cod are not in good condition (see the descriptions of each stock in Chapter 3.2), and the expert group has ranked the impacts of the fisheries as *major* for these species.

The *Norwegian spring-spawning herring* stock was severely depleted at the end of the 1960s, resulting in total collapse. After a long recovery period, the spawning stock had rebuilt to more than 12 million tonnes in 2009, about the same level as in the 1950s. The collapse of the stock also resulted in major changes in its feeding and wintering patterns. Today, the herring follow very similar patterns to those in the period preceding the collapse. The more recent management regime has been greatly influenced by the earlier collapse of the stock. An important element of the international regime for management of Norwegian spring-spawning herring is the complete protection of juvenile herring in the Barents Sea.

Saithe north of 62°N: Low fishing pressure over the last 10 years has had a positive effect on recruitment and stock development.

Blue whiting: A coastal state agreement between Norway, the EU, Iceland and the Faeroe Islands has only been in place for this stock since 2007. Over the past 10 years, catches have therefore been above the level recommended by the International Council for the Exploration of the Sea (ICES), and the expert group therefore assessed the impacts of the fisheries on the blue whiting stock as *major*. The stock is now mainly jointly managed by the coastal states listed above, while the North East Atlantic Fisheries Commission (NEAFC) manages a more limited area of its distribution. Recruitment has been poorer since 2005, and a reduction in the spawning stock is expected. The coastal states have therefore decided on a two-year phased reduction in fishing mortality (for 2009 and 2010) to ensure that that the stock is managed within safe biological limits.

Mackerel: The Northeast Atlantic mackerel stock has been highly selectively fished for more than 30 years. As a result, the age and size structure of the stock has changed dramatically from the 1970s to the present. In broad outline, there has been a change from a stock in which all age groups from one to 12 years are present and there is a substantial proportion of large, older fish, to one with only three to four age groups, strongly dominated by younger year classes (2–5 years). Estimates of the spawning stock are uncertain because far more mackerel is caught than is reported to ICES. Illegal landings, discards and slippage of whole catches or parts of catches add to the uncertainty. Statistical calculations by ICES indicate that unaccounted catches account for at least another 60 % over and above reported catches. It is important to obtain better information on the problem of slippage of mackerel catches, and on the basis of research to implement practical measures and legislation to minimise unintended mortality from fishing with pelagic trawls and purse seines.

Ling, tusk and blue ling: These species are fished across large areas of the North Atlantic. No estimates of stock sizes are available. Calculations based on catch per unit effort suggest that their stocks have declined in the past 40 years, but figures for the fishing grounds in the Norwegian Sea are so uncertain that it is impossible to determine how great the decline has been. ICES has recommended that catches of tusk and ling should be limited to 5 000 tonnes and 6 000 tonnes respectively in the Norwegian Sea and Barents Sea. In 2007, catches of both species were over 10 000 tonnes. ICES recommends that there should be no directed fishery for blue ling, and that spawning areas should be closed and technical measures introduced to reduce bycatches in mixed fisheries.

Greenland halibut: there is a limited coastal fishery and the species is also taken as a bycatch in trawl fisheries. In 2002 and 2003, catches were reduced to the level recommended by ICES, but in the period 2004–2007 they rose again to far more than the recommended level. The state of the stock is uncertain, and the expert group assessed the impacts on Greenland halibut as *major*. ICES stresses that further measures should be taken to reduce catches.

Redfish (Sebastes marinus): Results of research cruises and catches in trawl fisheries show a substantial reduction in abundance, and suggest that the stock is at a record-low level. Weak year classes are expected to persist for many years. Because the spawning stock and recruitment are continu-

ing to decline, ICES recommends stricter restrictions. The measures currently in force are inadequate. ICES has reiterated its advice that there should be no directed fishery, that area closures should be maintained and that there should be stricter bycatch limits for trawl fisheries. Strict protection of juvenile fish is important to ensure recruitment and to rebuild the stock.

Redfish (Sebastes mentella): Before 2005, recruitment failure had been a problem for this stock for 15 years . Recruitment improved in the period 2005–2007, which was partly ascribed to protection of juvenile age groups in the shrimp fisheries. To safeguard the stock in the years ahead, it is essential to protect the mature component of the stock, so that stable recruitment is ensured for many years ahead. Important measures to rebuild the stock are to control the fishery in the Norwegian Sea and limit bycatches of redfish in the shrimp fishery. ICES recommends that there should be no directed trawl fishery for *Sebastes mentella* in the Barents and Norwegian Seas. Area closures should be maintained and bycatch limits should be as low as possible until a significant increase in the spawning-stock biomass and number of juveniles has been verified.

Greater argentine: This species is found across much of the Northeast Atlantic, and with the exception of greater argentine around Iceland, is considered to belong to a single stock. However, the stock structure is unclear, and ICES recommends genetic studies so that this can be evaluated further. There is very little information on stock development and age and length distribution, and it has not been possible to make reliable estimates of stock size in recent years. Given the lack of stock estimates and analyses, the Institute of Marine Research has recommended that the quota should be set at the level that appears to have been sustainable over the last 20 years, i.e. 10 000 tonnes. However, more information is needed to improve assessments of fishing pressure on the stock.

Fisheries also have impacts on other fish stocks that are taken as bycatches. However, in many cases bycatches have to be permitted so that quotas can be utilised. To ensure that such bycatches are included in figures for the total harvest from a particular stock, a certain proportion is set aside to allow for bycatches when the TAC is shared between different vessel groups. The authorities are also making considerable efforts to reduce bycatches through requirements to use selective gear or sorting grids and by opening and closing fishing grounds as appropriate.

Evolutionary impacts

Heavy fishing pressure can result in sexual maturation at an earlier age and smaller size. This in turn may have an impact on egg production (number and quality) by a particular spawning stock. The possibility of such evolutionary changes in fish stocks indicates that it is preferable, in accordance with the precautionary principle, to keep mortality of juvenile fish low and delay harvesting until fish reached sexual maturity.

The herring and mackerel fisheries in the Norwegian Sea largely take sexually mature fish. It is therefore not expected that fishing exerts much selective pressure towards earlier sexual maturation in these species. In the case of blue whiting, immature fish have been somewhat more heavily exploited because of the lack of an international agreement, so that a certain selective pressure towards earlier sexual maturation could theoretically be expected in this species. Immature fish of demersal species such as cod, Greenland halibut and redfish have been relatively heavily exploited over the past 30–40 years. Selective pressure towards earlier sexual maturation and subsequent evolutionary impacts of fishing are therefore most likely to be found in this species group.

Loss of fishing gear

Every year, fishing gear is lost and sinks to the seabed or is washed ashore. Since 1980, the Norwegian Directorate of Fisheries has run an annual programme to retrieve gear that has been reported as lost and other lost gear that for various reasons has not been reported. Norway is leading the way in this area, and the Directorate has shared its expertise with other fishing nations that wish to address the problem of retrieving lost and abandoned gear.

Fishing gear can continue to catch fish long after it has been lost or abandoned (this is known as «ghost fishing»). This is a problem because it results in unregistered harvesting of fish stocks. Whales, seals and seabirds can also be killed if they become entangled in such gear. The scale of this problem has not been specifically investigated in the Norwegian Sea. Norwegian regulations now include a requirement to report the loss of gill nets.

Illegal, unreported and unregulated fishing (IUU fishing)

It is important that all fisheries in international waters (for example the fisheries for herring,

mackerel, blue whiting and *Sebastes* mentella in the «Banana Hole») are managed, controlled and inspected in accordance with international agreements to avoid illegal, unreported and unregulated fishing. The fisheries in international waters in the Northeast Atlantic are regulated by the NEAFC, where Norway is an important member. To reduce the uncertainty of catch estimates, it is essential that all catches are registered. In the Norwegian Sea, there are particular problems related to illegal and unreported fishing for mackerel. This is further discussed in the section on the impacts of the fisheries on the mackerel stock.

5.2.3 Impacts on other components of the ecosystem

Plankton

Since there is very little directed fishing for plankton in the Norwegian Sea, the fisheries will only have indirect impacts on plankton. Zooplankton is an important part of the diet of herring, mackerel and blue whiting, which are the major pelagic fish stocks in the Norwegian Sea. If harvesting reduces the size of these stocks, it will also reduce the amount of plankton they eat. This in turn will make a larger proportion of the total zooplankton production available to other plankton-eating species, such as mesopelagic fish (small plankton-eating species that live at depths of 200–1000 metres), cephalopods, seabird, whales and other zooplankton species.

If a directed fishery for plankton is started up in the period up to 2025, various problems could arise. For example, fish eggs and larvae could be taken as a bycatch. This problem would have to be solved before a large-scale plankton fishery could be developed. Since there is no large-scale harvesting of plankton in the Norwegian Sea today, we know little about the possible consequences of a directed fishery on plankton production.

Seabirds

The impacts of fisheries on seabirds may be both direct and indirect, since they may change the food supplies available. It is difficult to document and quantify these impacts. Breeding failure, changes in feeding habits, higher adult mortality and mass mortality events are all indications that seabird populations are facing problems. The expert group assessed the impacts of harvesting of fish stocks on seabirds stocks to be *moderate* for common guillemot, puffin, common eider, shag and kittiwake. The best documented examples of negative interactions between fisheries and seabirds in Norwegian waters are related to the collapse of the Norwegian spring-spawning herring stock at the end of the 1960s and the Barents Sea capelin in the mid-1908s. When the herring stock collapsed, the drift of herring larvae northwards along the Norwegian coast in summer more or less ceased. The breeding success of puffins on the Røst archipelago is closely linked with year-class strength and the timing of larval drift in herring. The collapse in the herring stock resulted in prolonged breeding failure for the Røst puffin population, which dropped by more than half in less than 10 years. In the first 20 years after the herring stock collapsed, the puffins had only three successful breeding seasons. However, the puffin population on Røst has shown a positive trend in the last five years.

There is little documentation of unintentional bycatches of seabirds in fishing gear in the management plan area. It is therefore difficult to predict the impacts of bycatches on seabird populations. Gill netting mainly affects coastal and pelagic diving species, while surface-feeding species are mainly affected by longlining. Even relatively small bycatches can be a threat to red-listed species such as common guillemot, lesser black-backed gull (subspecies *Larus fuscus fuscus*), Slavonian grebe, yellow-billed diver, Steller's eider and velvet scoter. The Norwegian Institute for Nature Research has recently completed an overview of current knowledge, and concluded that there is only fragmentary information about the scale and impacts of bycatches of seabirds in Norwegian waters. A seminar on bycatches held by the Directorate for Nature Management spring 2008 concluded that data on the scale of bycatches of seabirds in the Norwegian fisheries must be collected and used to estimate the impacts on seabird populations. This work is being started up in 2009. Fishing effort, catches and all bycatches, including seabirds, are therefore being registered on a daily basis by a reference fleet of gill net vessels that cover the entire coastline and a second reference fleet of seagoing fishing vessels, and reported to the Institute of Marine Research. The data collected will be scaled up to provide an estimate of total bycatches during fishing operations.

Lost gill nets, longlines and other gear can also be a threat to seabirds, but there have been few studies of such «secondary» bycatches. Several species, particularly cormorants, shags and gannets, which use remains of fishing gear as nesting material, risk becoming entangled and dying. Collection of dead seabirds from the shoreline often reveals auks, gannets and cormorants that are

entangled in remains of fishing nets. These birds may well have been taken as a bycatch during fishing and then discarded.

Marine mammals

The fisheries may also have indirect impacts on marine mammals, since these animals prey on fish and therefore compete with people for the same resources. However, we have only limited information on the which fish species the various marine mammals eat, and how much. Bycatches of marine mammals can be a problem. A particularly large bycatch of porpoises is taken in gill nets in the Vestfjorden. Data from 2006 indicate that the local bycatch is so large that the porpoise population in the Vestfjorden is only maintained by immigration from neighbouring areas. The expert group assessed the impact of this bycatch as *major* for the porpoise population in the Vestfjorden. The impacts effects on minke whale, hooded seal and harp seal stocks are largely related to harvesting, and are ranked as *moderate*. There is nothing to suggest that the current harvest of minke whales is a threat to the North Atlantic minke whale stocks. There is little data on hooded seals, but a decline in pup production has been observed in the Norwegian Sea. ICES has concluded that if the harvest is continued, there is a risk that the stock will not be able to recover, and that it may in the worst case decline further, even if the decline was not caused by hunting. ICES has therefore recommended that no harvest of hooded seal should be permitted in the West Ice from 2007 onwards. For common seal, the impacts of hunting and bycatches are assessed as *major*.

5.3 Pressures and impacts associated with the oil and gas industry and other energy production

5.3.1 Petroleum activities in the Norwegian Sea

Since the first areas in the Norwegian Sea were opened for petroleum activities in 1979, about 160 exploration wells have been drilled, and currently 12 fields are on stream. As of September 2009, a further two fields are under development: Skarv and Morvin. At present, petroleum activities are largely concentrated in the area between 62° N and 68° N and east of 2° E, mainly on the Halten bank. A scenario for 2025 has been analysed, featuring three new field centres for gas production, a new oil field off the coast of Møre og Romsdal, including transport ashore, and a new pipeline to Kollsnes for gas export. The scenario also includes exploration drilling in the area between Jan Mayen and Iceland. Iceland has already announced its first oil and gas licensing round for areas bordering on the Norwegian continental shelf around Jan Mayen, and the country is planning to award exploration licences in autumn 2009. The scenario for 2025 also assumes that four oil fields that are currently on stream will have closed down. There will be a decline in oil production in the management plan area up to 2025, while gas production will increase markedly up to 2020, and then decline somewhat. Total production in 2025 is expected to be about the same as today, but with a shift towards a larger proportion of gas. The basis for value creation in the petroleum industry is described in more detail in Chapter 4.1.

In general, the petroleum industry can have negative impacts on the environment through operational discharges of chemicals, oil and other naturally occurring substances, including radioactive substances released to the sea, emissions to air of nitrogen oxides, volatile organic compounds and carbon dioxide (NO_x, VOCs and CO_2), and also in other ways, such as physical disturbance of the seabed and effects of seismic surveys on fish and marine mammals. The Norwegian petroleum industry is therefore strictly regulated in order to avoid or minimise damage. The impacts of acute discharges to sea are discussed in section 5.6 below. It is not possible to identify direct impacts on the Norwegian Sea specifically from emissions to air from petroleum activities, and this issue is therefore not discussed further. Chapter 6 deals with the impacts of total emissions of greenhouse gases on climate change and ocean acidification.

Oil and gas fields differ, and often different technical solutions are required to reduce discharges on different fields. Technology and operating conditions are continually being developed and improved, but existing and new installations often require different technical solutions. For example, lack of space or other features may make it impossible to install new and improved technology on an existing installation. Thus, solutions must be evaluated on a case-to-case basis.

5.3.2 Impacts of operational discharges to sea

Today, allowed operational discharges to sea consist mainly of produced water, drill cuttings and

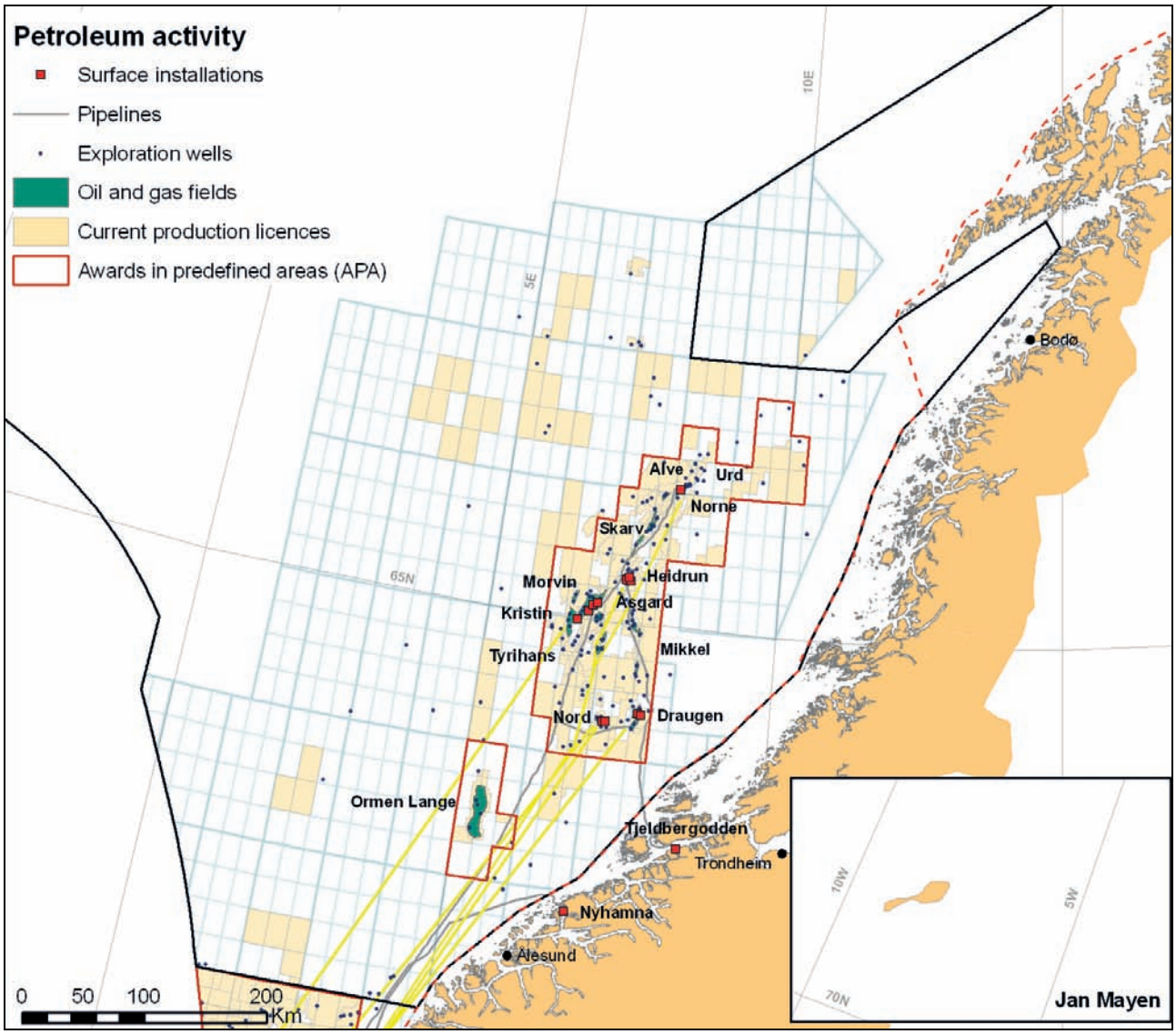

Figure 5.6 Overview of petroleum activities in the Norwegian Sea

Source: Norwegian Petroleum Directorate

small quantities of chemical additives and cement from drilling operations.

Zero-discharge targets for releases of environmentally hazardous substances to the sea from petroleum activities were first set out in a white paper on an environmental policy for sustainable development (Report No. 58 (1996–1997) to the Storting). Since then, the authorities and the industry have been cooperating on refining the targets and developing measures to meet them. The petroleum industry has invested heavily in technology for reducing discharges to sea, and the measures implemented so far have resulted in substantial reductions. Stricter requirements for discharges, that include the requirement of zero discharges of produced water, have been introduced in the Barents Sea.

The Norwegian Pollution Control Authority, the Norwegian Petroleum Directorate and the Norwegian Radiation Protection Authority published a report in December 2008 evaluating the environmental and social costs and benefits of zero discharges. They concluded that a socioeconomic cost-benefit analysis should be conducted for each new development that will include overall environmental assessments of measures to prevent discharges of produced water and/or drill cuttings and drilling mud.

The quantities of environmentally hazardous chemical additives used and discharged on the Norwegian continental shelf are declining, in accordance with the zero-discharge target for such substances. In 2007, 90 % of the discharges of chemical additives on the Norwegian shelf were

Box 5.1 What is produced water?

Produced water is water extracted from oil wells together with the oil. This water occurs naturally in oil reservoirs and contains other substances occurring naturally in the reservoirs as well as chemicals introduced as part of the production process. Produced water may contain particles (such as scale and naphthenate), dispersed oil (drops of oil), dissolved oil components/organic compounds (such as PAHs and alkyl phenols), inorganic compounds (heavy metals, radioactive substances) and chemical additives (chemicals necessary for production).

Produced water is injected or discharged to the sea. Before being discharged to the sea the water is treated. This removes naturally occurring substances to a varying degree, but not heavy metals or radioactive substances. Currently the maximum permitted concentration of oil is 30 mg/l after treatment. In 2007, the average concentration of oil in produced water discharged on the Norwegian shelf was 9.5 mg/l (using the standard ISO method). Currently most oil in operational discharges from petroleum activities is in produced water (91 %). As the volume of oil in a reservoir declines, an increasing volume of water is produced. Thus a number of older fields produce considerably more water than oil. In some fields this water is pumped back into the rock (reinjection into the formation from which it is produced or injection into some other formation), but in most fields the water is separated from the oil and discharged after being treated.

Environmentally hazardous substances discharged during the operational phase are mainly discharged together with produced water. The produced water contains a large number of other substances that occur naturally in the reservoirs, including radioactive substances. Unidentified compounds in produced water, such as the unresolved complex material (UCM) fraction, may also contain environmentally hazardous substances. Today a large number of chemical additives are used in the various phases of petroleum activities, but approximately 98 % of those discharged are not considered to be environmentally hazardous.

Produced water is normally discharged relatively high up in the water column and is rapidly diluted with seawater. Possible long-term impacts include endocrine disruption and genetic and developmental damage. Our knowledge of degradation products and the large fraction of UCM in oil is very limited. Studies have shown that the UCM fraction may have long-term impacts on fish and mussels; for example, alkyl phenols have endocrine-disrupting effects in fish.

green-category substances (substances that have no significant environmental impacts) according to the system used by the Norwegian Pollution Control Authority. Discharges of red-category or black-category substances were reduced from 4 160 tonnes in 1997 to approximately 24 tonnes in 2007, a reduction of over 99 %. Today the petroleum industry is only responsible for less than 3 % of total discharges to the sea of environmentally hazardous substances on the authorities' priority list. The efforts to meet the zero-discharge targets are described in more detail in the white paper on the Government's environmental policy and the state of the environment in Norway (Report No. 26 (2006–2007) to the Storting).

The total volume of produced water discharged on the Norwegian continental shelf in 2007 was approximately 162 million m³, 13.6 million m³ of which was discharged to the Norwegian Sea. As fields age, the total volume of produced water discharged to the Norwegian Sea will increase to approximately 28.5 million m³ up to 2014. Later, as oil fields are shut down, the total volume of produced water discharged will be substantially reduced, and is expected to be 7 million m³ in 2025. Discharges are strictly regulated and the produced water must be thoroughly treated before discharge. Produced water is usually discharged relatively high up in the water column and the most toxic water-soluble fractions are rapidly diluted by seawater. The acute impacts of operational dis-

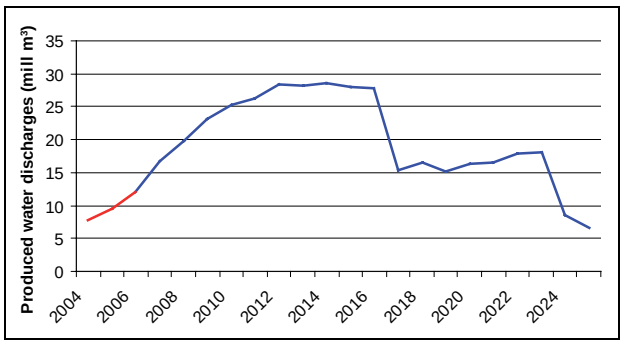

Figure 5.7 Projected discharges of produced water

Source: Norwegian Petroleum Directorate

charges of produced water and drill cuttings are assessed as *insignificant* since they will generally be local and short-term and will not have effects at population level. There is more uncertainty about the long-term effects. No impacts at population level have so far been demonstrated by research and monitoring, but further studies are being conducted.

Produced water contains naturally occurring, low-level radioactivity from rock formations. The quantities depend on the type of formation and vary from field to field. It is difficult to assess the direct impacts on the environment of discharges of such substances with water. Background levels only appear to be exceeded in the vicinity of discharges. However, there is a need for more knowledge about the concentrations of these radionuclides in the Norwegian Sea (in seawater, sediments and living organisms) and of the effect level for the marine environment.

Drilling of exploration and production wells produces waste in the form of drill cuttings and drilling mud. Discharges of drill cuttings may result in sediment deposition on the seabed close to the point of discharge. In general, discharges of drill cuttings are permitted if water-based drilling mud has been used, but if oil-based muds are used, drill cuttings and drilling mud must be reinjected or taken ashore for treatment. The impacts of discharges of drill cuttings from drilling with water-based mud are mainly local. Vulnerable organisms such as corals and sponges can be smothered by sediment. Studies of sponges have concluded that the impacts of discharges of drill cuttings and other petroleum activities are greatest within a radius of 50–100 m from the drilling site, and that certain chemicals may have impacts on larvae and recolonisation in certain species within a radius of 300–500 m. Discharges are not permitted in areas where surveys have revealed the presence of particularly valuable and vulnerable benthic communities or habitats, such as corals.

5.3.3 Impacts of other activities

Other pressures on the environment include physical disturbance of the seabed, seismic surveys, introduction of alien species attached to hulls (rigs and production ships), decommissioning of facilities and discharges of waste or litter. However, our knowledge of their impacts varies.

Physical disturbance of the seabed: this is largely due to mechanical work such as pipelaying (including burying and armouring), construction of installations and use of anchors. Benthic communities and corals are affected by physical disturbance, but the impacts are limited and local. Conducting adequate surveys and adapting petroleum operations to take this into account should ensure that corals and other valuable benthic communities are not damaged by petroleum activities.

Seismic surveys: these are conducted to assess the potential for petroleum deposits, and are an important aid to good decision-making in both the exploration and the production phases. Geological surveys of the seabed involve the use of sound pulses. These are discharged by air cannons, creating air pressure. It is the noise generated by this activity in the form of sound waves or disturbance of particles in the water that can have a negative impact on the marine environment. The impacts of seismic surveys on fish eggs and larvae are confined to the area in the vicinity of the air cannon. The impacts at population level are considered to be *insignificant*, and the level of uncertainty is low. For adult fish, the impacts of seismic activities are considered to be limited to within a few metres of the air cannon.

Alien species: in the impact assessment for the oil and gas industry and other energy production, only the hulls of installations and rigs were considered as routes of introduction for alien species. The risk of alien species being introduced through these vectors is considered to be very low (introduction by ballast water was considered in the impact assessment for maritime transport), and the impacts of the introduction of alien species are not discussed further here.

Waste/litter: the petroleum industry has sound procedures for waste management and for the environmentally acceptable disposal of waste. The risk of litter in the sea and resulting impacts on marine life is therefore considered to be very low.

5.3.4 Impacts of offshore wind power

There is currently no offshore wind power production on the Norwegian continental shelf. At the international level the only experience available is from production in shallow waters in coastal areas. This means that there is considerable uncertainty about the possible impacts if offshore wind production is established. 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 be during construction work and maintenance operations. Environmental pressures will in general be associated with infrastructure (cables, anchors, etc.), the possibility of collisions and barrier effects for seabirds, the aesthetic (visual) impact and noise. During the construction phase, vessel operations, use of explosives and physical disturbance will produce noise, while during the operational phase wind turbines will be a permanent source of noise.

Any environmental impacts of the establishment and operation of offshore wind farms are expected to be restricted to species and habitats in the vicinity of the installations, and any damage is expected to be at the individual level. However, there is some uncertainty about the impacts of offshore wind farms on seabirds. We do not know enough about the risk of collisions for local and migrating birds or about barrier effects. We also have limited knowledge about the impact of noise from wind turbines on the behaviour of fish and marine mammals.

5.4 Pressures and impacts associated with maritime transport

5.4.1 Maritime transport in the Norwegian Sea

Ship traffic in the Norwegian Sea consists mainly of fishing vessels, followed by cargo vessels, bulk carriers, tankers and gas tankers, and offshore supply vessels. In internal waters and in the Vestfjorden the main form of traffic is passenger transport (conventional and high-speed ferries and the Hurtigruten fleet), followed by cargo vessels and fishing vessels larger than 24 metres. Transport of iron ore from Narvik also accounts for a considerable proportion of ship traffic in the Vestfjorden. The different traffic routes are described in more detail in Chapter 4.1. Traffic density is highest along the Norwegian coast from Røst at the southern end of the Lofoten Islands to Stad at 62° N, and much lower in the rest of the Norwegian Sea. Maritime transport of oil and gas, particularly gas, is likely to increase considerably up to 2025. However, this will depend on future developments in the petroleum industry in northwestern Russia and on the Russian and Norwegian sides of the border in the Barents Sea, as well as on the choice of transport. Apart from this, only small changes in traffic density seem likely to occur during the period up to 2025. The Government is seeking to ensure that a larger volume of goods transport is switched from road to sea, and this would increase the volume of traffic, but on the other hand maritime transport is a more secure and environmentally friendly alternative for shipping goods than road transport.

Maritime transport can put pressure on the environment through operational discharges to water and air, illegal discharges, the introduction of alien species via ballast water or attached to hulls, and noise. According to the impact assessment for the maritime transport sector operational discharges to the Norwegian Sea are small. No significant impacts from operational discharges of oil, sewage or organotin compounds have been found, and operational discharges to air from maritime transport or fisheries activities have not in themselves been found to have direct impacts. However, maritime transport involves a risk of collisions, which can result in acute oil or chemical pollution (see section 5.6). Norway is playing an active role in the efforts, particularly in the IMO, to make maritime transport a safer, more environmentally friendly form of transport (see Chapter 7.5).

5.4.2 Impacts of discharges to the sea

Shipping puts pressure on the environment on a day-to-day basis through ordinary operational discharges. However, operational discharges of oil and oil residue from ships in the management plan area are considered to be small. Discharges of oil, sewage and organotin compounds from anti-fouling systems have not been found to result in impacts of any magnitude in the management plan area, and the impacts are assessed as *insignificant* for the area as a whole. Much of the extensive littering of the coastal and sea areas comes from ships and fishing vessels, and the impacts are assessed as *moderate* for the most seriously affected species, such as the kittiwake.

Discharges of sludge and oily bilge water from machinery spaces, discharges of oil and oily mixtures from the cargo area (slops) and oil residue (sludge) are regulated internationally by MARPOL (International Convention for the Prevention of

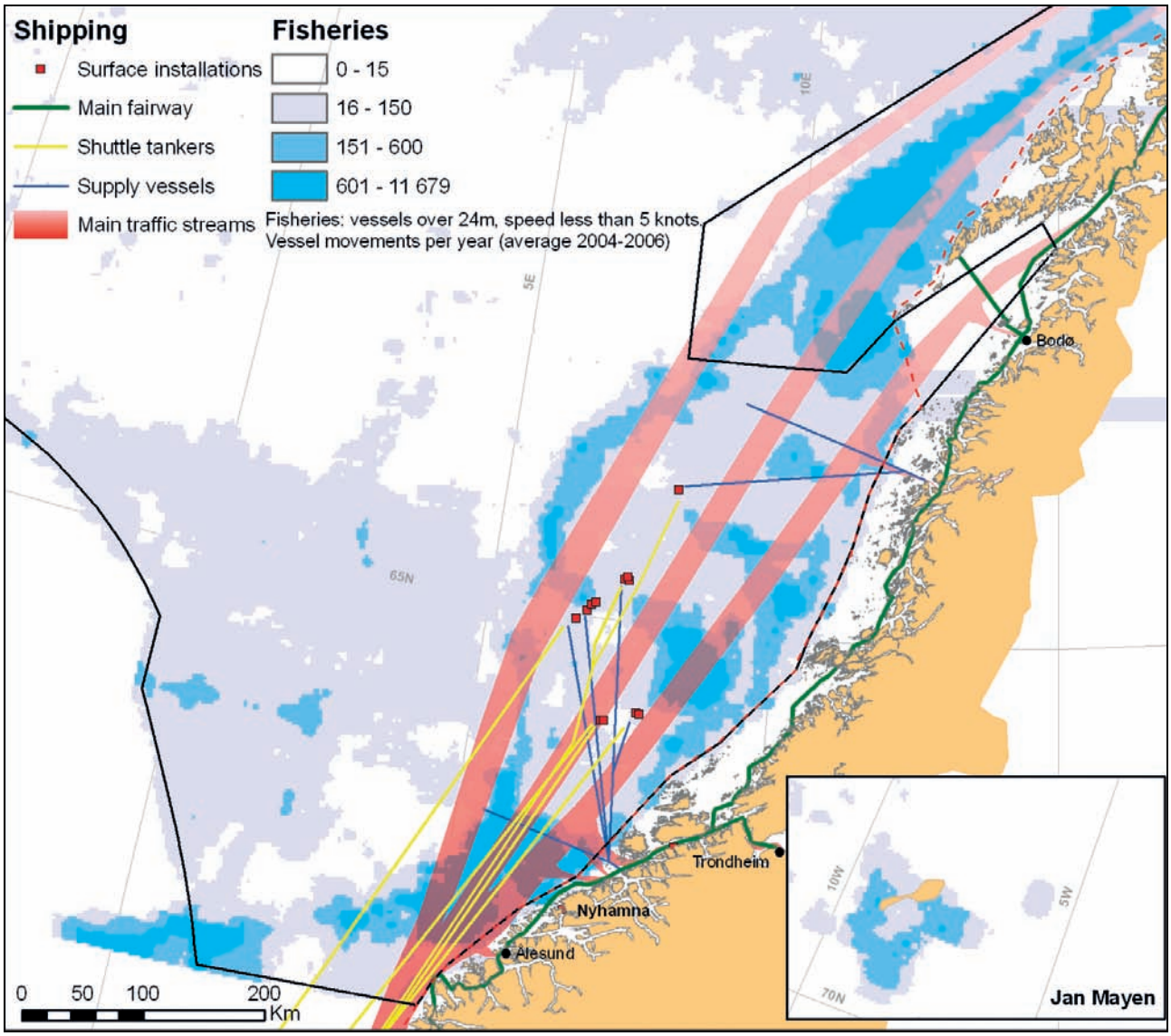

Figure 5.8 Main traffic streams and fisheries activities in the management plan area

Source: Norwegian Coastal Administration and Directorate of Fisheries

Pollution from Ships). The convention permits a certain level of discharges of oily bilge water and oily mixtures from tank washings. Tank washings are the largest legal source of oil discharges today (oily mixtures from washings 840 tonnes/year, oily bilge water 0.470 tonnes/year). However, all ships are required to have segregated ballast tanks by 2010, and this will reduce discharges of oily ballast water. Oil slicks on the sea are reported every year, and most of these are believed to be from illegal discharges from ships. Experience has shown that accidental spills and illegal discharges have the greatest environmental impacts, and most are probably unreported. Seabirds are particularly vulnerable, but it is difficult to estimate the magnitude of the impacts.

Tributyl tin (TBT) and other organotin compounds from ships' anti-fouling systems are hazardous substances that can be absorbed by living organisms. However, under an IMO convention, a ban was adopted on the application of anti-fouling systems containing TBT from 2003, together with a requirement to remove older anti-fouling systems containing TBT by 2008. These measures are expected to reduce inputs of TBT to the environment.

We do not have sufficient information on how different types of vessels deal with waste on board, and it is difficult to estimate how much waste is delivered to port reception facilities, incinerated on board or discharged to the sea. However, much of the floating waste is assumed to be discharged from ships at a legal distance from shore. Plastic

waste from fishing vessels and other ships has been shown to have negative impacts on many species of seabirds and marine mammals, which either become entangled in the waste and die as a result, or eat the waste, which then accumulates in the digestive organs, blocking or injuring them. A global ban on discharges of plastics was adopted by IMO (MARPOL) in 1998, but in spite of this, large volumes of plastic waste are still being found in the marine environment. The expert group) concluded that waste drifting on the surface of the sea may have up to *moderate* impacts on surface-feeding seabirds such as kittiwakes. The IMO rules in this area are under revision.

5.4.3 Impacts of emissions to air

Emissions to air from maritime transport include greenhouse gases and acidifying substances from engines in addition to fugitive emissions of volatile substances from cargoes (petroleum and petroleum products). In the management plan area the total annual emissions of CO_2 from maritime transport and fishing vessels are estimated at approximately 755 000 tonnes. Norway's total CO_2 emissions (2007) are estimated at approximately 45 million tonnes. It is not possible to identify direct impacts specifically from emissions from ships. Emissions of greenhouse gases from maritime transport act in combination with other emissions from national and international sources. The most serious impacts of greenhouse gases in the Norwegian Sea are expected to be ocean acidification and climate change. These topics are dealt with in Chapter 6.

In spite of a moderate increase in overall volume of maritime transport in the management plan area, and a considerable increase in tanker traffic, emissions to air are expected to be reduced, due to the rapid development and adoption of new technology. The improvements are being made in response to the stricter international rules governing operational discharges from ships. In 2008 the IMO adopted new and stricter rules on reductions in emissions of NO_x and SO_2 in order to further reduce air pollution from ships. The tax on NO_x emissions in Norwegian waters will also result in the installation of NO_x-reducing technology on ships sailing between Norwegian ports, which will also reduce emissions. The new agreement between the Government and 14 trade organisations on measures to reduce NO_x emissions by 30 000 tonnes by 2010 will be a valuable tool for reducing emissions to air from a number of industries, including maritime transport and fisheries. A NO_x fund has been established and a large number of companies have joined it.

5.4.4 Introduction of alien organisms via maritime transport

Today the introduction of alien organisms is considered to be one of the most serious threats to biodiversity in marine ecosystems. Alien organisms can be a threat to species and habitats in several ways, but mainly by competing for food with native species or through overgrazing or overforaging of resources. However, knowledge about the effects of alien species is limited (see Chapter 9.3), and it is difficult to assess how serious their impacts could be.

The most important pathways of introduction (vectors) of alien species with maritime transport are ballast water and fouling of ships' hulls. In 2004, IMO adopted the International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Convention). Norway has ratified the convention and is in the process of developing national legislation in accordance with it. Under the provisions of the convention, ballast water exchange must be conducted in open waters (at least 200 nautical miles, or if this is not possible, at least 50 nautical miles, from the nearest land and in water at least 200 m deep) during a transitional period. If these requirements cannot be met, ballast water exchange must be conducted in specific areas along the coast. The choice of such areas will take into account the risk that alien species will become established in the area. Closeness to existing shipping lanes will also be taken into consideration.

The proposed ballast water exchange areas will be provisional, since the above requirements will be replaced over a period of time by requirements for the treatment of ballast water. The latter requirements will only be introduced when the convention enters into force, which will be 12 months after at least 30 states representing 35 % of world merchant shipping tonnage have ratified it. It may well take several more years before the convention enters into force. However, draft Norwegian ballast water regulations provide for ships to install equipment to treat ballast water on a voluntary basis in order to test new technology. As such equipment is installed, the risk of negative impacts will be reduced. Studies indicate that about half of all identified alien species come from ships' hulls. This is very difficult to prevent, and this route of introduction will therefore continue to be a problem in the time to come.

5.5 Impacts of long-range transboundary pollution, alien species and activities outside the management plan area

The state of the environment in the Norwegian Sea is also affected by activities outside the management plan area. Environmentally hazardous substances are transported over long distances by winds and ocean currents. The ocean climate is changing as a result of greenhouse gas emissions worldwide, ocean acidification is increasing and alien species can be introduced from other sea areas. Today the most important external pressures are climate change and long-range transboundary pollution. Over the long term ocean acidification is expected to have *major* impacts on the management plan area.

5.5.1 Long-range transboundary pollution

Long-range transboundary pollution is pollution that enters the Norwegian Sea from sources outside the area. Wind and ocean currents are the most important transport routes, but transport with ice and inputs via rivers may have local impacts.

Persistent organic pollutants (POPs) such as PCBs, DDT, toxaphene and brominated flame retardants are often the most important environmentally hazardous substances. In the management plan area, levels in water and sediment are generally low, as they are in fish from the Norwegian Sea. However, high levels of POPs, especially PCBs, have been found in birds in several locations in the management plan area, and particularly in seabirds high in the food chain, such as glaucous gulls and great black-backed gulls. POPs levels in certain glaucous gull colonies are probably so high that they could threaten the survival of these populations. Marine mammals high in the food chain such as killer whales and polar bears have elevated concentrations of hazardous substances in fatty tissue. Polar bears live mainly on seal blubber, and with time build up high concentrations of POPs in their bodies. Females transfer considerable amounts of these substances to cubs in milk, and may therefore have considerably lower levels than males, and it is not uncommon for cubs to have higher levels of such substances than their mothers. The immune system in polar bears on Svalbard has been shown to be weakened. Some killer whales have been found to contain such high levels of POPs that the same probably applies to this species. POPs are the most serious environmental problem in the northern parts of the management plan area.

Studies of organochlorine compounds in fish have shown that in the management plan area the levels are considerably lower than the EU limit values for hazardous substances in seafood. However, dioxins, PCBs and mercury have been found in certain large, long-lived species of fish that are high in the food chain, such as large halibut and Greenland halibut.

In spite of international efforts to reduce the use and releases of POPs, such substances are still entering the high-latitude areas, and are expected

Box 5.2 Environmentally hazardous substances of very high concern, and radioactive substances

The most environmentally hazardous substances are persistent and bioaccumulative as well as toxic (PBT substances). Because such substances persist in the environment after they are released, they can cause irreversible long-term damage to health and the environment. They can be transported over long distances to other parts of the world, and thus end up in vulnerable areas such as the Norwegian Sea and the Arctic. Many of the most dangerous of these substances condense out of the atmosphere in the cold climate at high latitudes and then enter food chains.

A number of *heavy metals* and *organic pollutants* can bioaccumulate and are toxic, and therefore pose serious risks to the environment and threaten food security. *Endocrine disrupters* can affect the hormone balance in humans and animals, and for example reduce their reproductive capacity.

Radioactive substances are unstable elements that emit ionising radiation. Some occur naturally, whereas others are man-made. Radiological toxicity varies considerably, depending on how readily a substance is absorbed by living organisms, the type of radiation emitted and its intensity. Radioactive substances are unstable and decay over time. Half-life is used as a measure of how long-lived a radioactive substance is, and can vary from only a few seconds to several hundred thousand years. Like PBT substances, substances with long half-lives can be transported over long distances and bioaccumulate and harm living organisms.

to be traceable in many animals for decades. Inputs of new substances with the characteristics of POPs, such as brominated flame retardants, are expected to rise. For example, rising levels of the extremely persistent compound perfluorooctyl sulphonate (PFOS) have been registered in Arctic animals.

Inputs of heavy metals to Norwegian areas have declined steeply since the 1970s, since restrictions on their use have been introduced in Europe. Inputs of cadmium and lead are declining but the decline in mercury inputs has stopped. There is therefore still cause for concern about possible adverse impacts of mercury in parts of the management plan area. However mercury levels are expected to decline gradually since its use in products is no longer permitted.

There are three main sources of radioactive pollution in Norwegian sea areas: fallout from atmospheric nuclear testing almost 50 years ago, releases from European reprocessing plants for spent nuclear fuel and fallout from the Chernobyl accident in 1986. However, according to current knowledge, the concentrations of radioactive substances of anthropogenic origin in the Norwegian Sea are not high enough to cause adverse environmental impacts. On the other hand, this knowledge is limited and we also know little about possible combined effects of radioactivity and other pressures on species and ecosystems. There are also other sources of radioactive pollution, such as produced water from oil and gas activities on the continental shelf in the North Sea and the Norwegian Sea. If there are no accidents, and if releases of radioactive substances to the sea are reduced in accordance with international commitments, levels of man-made radioactive substances in sea water, sediments and marine organisms in the Norwegian Sea are expected to decline. However, an accident involving releases of radioactivity could result in considerably higher inputs of radioactive substances. The large stocks of liquid high-level waste at Sellafield are considered to pose a very high risk, and a worst-case scenario has been developed for the impacts on the Barents Sea of large releases of waste from Sellafield. This study, which is also relevant to the Norwegian Sea, showed that releases on this scale could result in substantial inputs of Cs-137 and Sr-90 via ocean currents, and a rise in activity concentrations of these substances. Increased releases of man-made radioactive substances could also result in higher concentrations in marine organisms, especially in seabirds. Nevertheless, the estimated doses to marine organisms are low. However, we do not know enough about the impacts of low-dose radiation on the environment and it is therefore difficult to assess the consequences for the Norwegian Sea.

5.5.2 Introduction of alien organisms

Today, the introduction of alien organisms is considered to be one of the most serious threats to biodiversity in marine ecosystems. The most important pathways of introduction (vectors) of alien species are via ballast water and fouling of ships' hulls, as described in section 5.4.4. In addition, organisms that have already been introduced to Europe or other nearby areas may spread further to the Norwegian Sea (secondary introduction) for example with the coastal current and Atlantic water or other means of dispersal. Alien organisms can threaten marine ecosystems and valuable marine resources in several ways, but mainly by competing for food with native species or through overgrazing or overforaging of resources. The establishment of a number of alien species in or adjacent to the Norwegian Sea has been documented, for example the red alga *Heterosiphonia japonica*, japweed (*Sargassum muticum*), Japanese skeleton shrimp (*Caprella mutica*) and the comb jelly *Mnemiopsis leidyi.*

Globalisation, international trade and transport will very probably contribute to the spread of alien species in the Norwegian Sea in the years ahead.

5.5.3 Petroleum activities outside the management plan area

Some petroleum activity in the North Sea is located relatively close to the management plan area. The potential consequences of any discharges from activities in the northernmost parts of the North Sea will be greater than for other adjacent sea areas, because they could be transported from the North Sea to the Norwegian Sea via ocean currents. Operational discharges have a more localised impact, and such discharges in the North Sea will probably not affect the Norwegian Sea. However, acute pollution from petroleum activities in the northern parts of the North Sea would affect parts of the Norwegian Sea if the oil were to drift northwards. This could affect important herring spawning grounds and important areas for seabirds and coastal seals in the same way as activities in the Norwegian Sea itself. The location, scale and timing of a spill, together with wind and weather conditions, will determine the impacts on species and habitats.

5.5.4 Maritime transport outside the management plan area

Maritime transport in areas outside the Norwegian Sea can affect the management plan area, and maritime transport in the internal waters, inside the baseline, is important in this context. Operational discharges from maritime transport outside the management plan area are so small that they are not likely to have much impact on the Norwegian Sea environment. However, discharges of oil from tank cleaning operations are a larger source of pollution and could probably harm seabirds that at certain times of year are outside the management plan area.

Emissions to air from ships in the North Sea and internal waters may be transported in the atmosphere and deposited in the management plan area. However, it is difficult to quantify the scale of this process.

Spills from tankers wrecked inside the baseline in the Norwegian Sea could have more serious consequences, particularly on coastal and nearshore species and habitats, such as seabirds, and marine mammals and the shoreline than similar accidents outside the baseline, because of their proximity to land and because the probability of affecting vulnerable species and areas is higher. Whether or not an accident has consequences for fish eggs and larvae will depend on whether it occurs in an area and at a time of year when eggs and larvae are present. In the same way as for accidents occurring in the management plan area itself, the location and timing of an accident will determine what consequences it may have for the Norwegian Sea environment.

5.5.5 Fisheries activities outside the management plan area

Most of Norway's commercial fish stocks are shared with other coastal states. External pressures on these stocks include fisheries outside the management plan area, and stocks that are found in the Norwegian Sea are also harvested in other sea areas. This is due to seasonal migration, which means that the stocks congregate in other areas at certain times of year for overwintering or spawning. Blue whiting migrate southwards from the Norwegian Sea and spawn west and south of the UK and Ireland in March–April. Mackerel is another species that only occurs in the Norwegian Sea at certain times of year. After spawning, mackerel migrate into the Norwegian Sea, but in autumn they gather in the northern parts of the North Sea, where most fishing for mackerel takes place. Norwegian spring-spawning herring also migrate between overwintering areas, spawning grounds and feeding areas. International agreements have been concluded for all these stocks in order to ensure sustainable harvesting.

5.6 Risk of acute pollution

Risk management, the risk of acute oil pollution and oil spill response systems are discussed in Chapter 7.5. In the present chapter the potential environmental consequences and the environmental risks are discussed using sample scenarios developed for the Norwegian Sea.

Scenarios were developed for accidents involving spills of oil, chemicals and radioactive waste. The rules for the carriage of chemicals divide chemicals into categories according to toxicity, and the special rules for carriage of the most toxic categories are designed to reduce both the probability of spills and the consequences of accidents. The small volumes of chemicals involved and the strict rules mean that both the probability of releases and the level of environmental risk during chemicals transport are considered to be low. Modelling of accident scenarios involving releases of radioactivity has shown that such incidents will result in substantial inputs of radioactive substances and a rise in the level of radioactive pollution, which will still persist five years after the accident. Modelling indicates that levels of radioactivity to which organisms are exposed after an accident are likely to be below the threshold levels at which damage is expected. However, we know too little about the effects of radioactive contamination on the natural environment.

Both petroleum activities (oil production and exploration drilling) and maritime transport in the Norwegian Sea involve a risk of oil spills. In both these sectors, there are several different types of incidents that may occur and that contribute to the overall risk level. In 2007 a total of 166 oil spills from petroleum activities were reported, 12 of them with a volume of more than 1 m^3. This is a rise of 44 compared with the previous year, and is the highest number of oil spills since 2002, when the number declined considerably. The total volume of acute discharges of oil in 2007 was 4 488 m^3 (4 400 m^3 of which was from the Statfjord A spill) (see Figure 5.9). No environmental impacts have been identified after any of the spills. The number of spills from ships has remained fairly constant over the last 11 years (see Figure 5.10). However,

the total volume in 2007 was larger than in the rest of the period, particularly the two previous years. Several of the major spills from ships have had impacts on seabirds and have resulted in extensive contamination of the shoreline. A large proportion of the total volume of acute discharges from both ships and petroleum activities consisted of spills larger than 1 m³.

The probability of a major oil spill varies according to a range of on-site operational and actor-specific factors. The probability (which can also be expressed as the recurrence frequency or recurrence interval) is normally calculated on the basis of historical data. The volume and duration of the spill vary from one incident or scenario to another, and a particular oil spill scenario may have a range of possible outcomes with different probabilities. Generally, the probability of a spill occurring is highest (the recurrence interval is lowest) for the smallest spills, and highest (longest recurrence interval) for the largest spills. It is generally assumed that the potential for serious environmental consequences is lower for small oil spills than for major spills, although there are exceptions to this rule. For both maritime transport and petroleum activities, the assessments of environmental impacts at current levels of activity are based on a number of different oil spill scenarios.

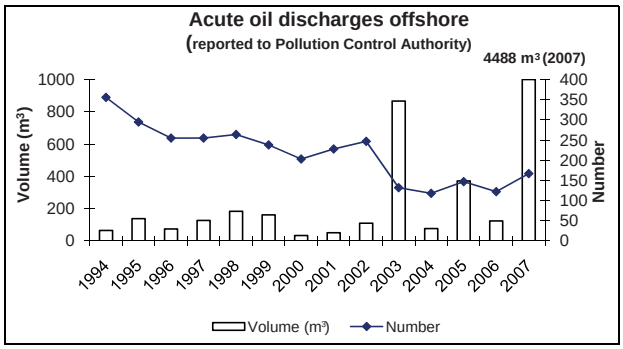

Figure 5.9 Acute discharges of oil from petroleum activities on the Norwegian continental shelf, 1994–2007. The figure for 2007 includes the oil spill from Statfjord A, when a hose on a loading buoy was severed, releasing an estimated 4 400 m3 of crude oil into the sea.

Source: Norwegian Pollution Control Authority

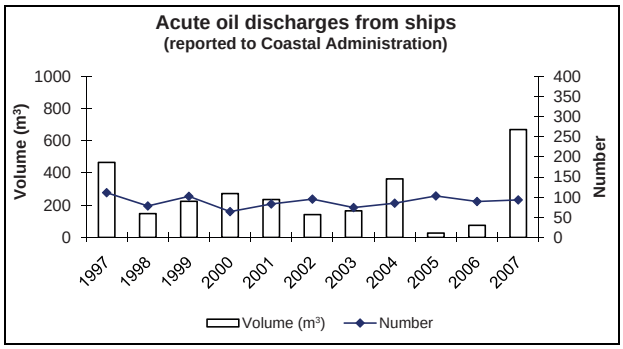

Figure 5.10 Acute discharges of oil from ships in Norwegian waters, 1997–2007, reported to the Department of Emergency Response, Norwegian Coastal Administration.

Source: Norwegian Coastal Administration

5.6.1 Acute oil pollution from ships

In all areas where ships sail, there is a certain risk of accidents (collisions, groundings and shipwrecks). A number of accident scenarios have been modelled involving oil pollution along the coast in order to illustrate different possible outcomes as regards environmental consequences and risk. The scenarios include accident sites that will affect some of the most valuable areas along the coast. The assessment of consequences and risk do not include the effects of protective measures in the form of oil spill response systems, which generally reduce the consequences and risk of an oil spill. The outcomes of these scenarios were used to assess the potential consequences of accidents in other parts of the management plan area. However, there are great variations in the volume of traffic within this area and consequently in the risk of accidents and acute pollution. Ship traffic density is particularly high in the coastal waters between Røst (southern tip of the Lofoten Islands) and Stad at 62°N, while traffic in the rest of the Norwegian Sea is small compared with the coastal traffic. The area from Stad and northwards along the coast of Møre og Romsdal has particularly dense traffic. There are four main traffic streams in the Norwegian Sea (see Figure 5.8 and Chapter 4.1), which meet relatively close to the coast off Stad. Almost all traffic passes less than 25 nautical miles from the coast in this area. The recurrence interval for ship accidents is shortest off Møre og Romsdal for all types of oil spills (crude oil, refined oil and bunker fuel). The probability of spills is highest for bunker fuel (recurrence interval 13 years, with the highest probability for spills of less than 400 tonnes), and lowest for major spills of crude oil (recurrence interval of over 800 years per 100 000 km² sea area and highest probability for spills of 2 000 to 20 000 tonnes). In other areas of the Norwegian Sea the recurrence intervals are much longer for all kinds of spills.

A general increase in traffic in the Norwegian Sea is projected in the period up to 2025, and the largest and most important rise will be in tanker

Box 5.3 Probability of exposure to and potential consequences of acute oil pollution

The consequences of acute oil pollution in the marine environment and the extent to which species and habitats are affected vary widely. The most serious impacts are likely if species that are very vulnerable to oil are affected. In addition, species and habitats that are known to be vulnerable to oil are generally found in larger numbers or at higher densities in coastal areas, and the distance to the shore is therefore another factor of importance in evaluating the potential consequences of a spill.

- Drifting oil slicks may contaminate seabirds that feed or rest on the water surface or dive from the surface. Seabirds are generally very vulnerable to oil pollution. In a number of species vulnerability varies through the year and is highest during breeding and moulting. Species that spend a lot of time on the surface of the sea are extremely vulnerable throughout the year. The distribution and numbers of such species in the Norwegian Sea can vary from year to year. Because their food is concentrated in shoals and swarms, pelagic seabirds congregate in correspondingly small areas. As a result many thousands of birds may be found in areas of only a few square kilometres. The distribution of seabirds influences the scale of the contamination.
- Oil that drifts on the water surface and onto beaches may contaminate mammals that are closely associated with the sea (for example seals, otters and mink). Their vulnerability to oil also varies between species and is generally greatest during the breeding season.
- Oil that is dispersed or dissolved in the water masses may have toxic effects on fish (particularly eggs and larvae) and planktonic organisms. Fish eggs and larvae are generally more vulnerable to oil than adult fish, partly due to their limited mobility.
- Oil that drifts ashore may foul or smother and cause damage to plants and animals in the littoral and supra-littoral zone, and may also penetrate deep into the soil and sediments. It will then leach into the water, causing long-term exposure to oil. Vulnerability to oil varies from one type of beach to another.
- Oil that drifts ashore may contaminate seabirds and other birds that use the littoral and supra-littoral zone.
- Oil that drifts ashore may be whipped up by strong winds and may foul beaches and salt marshes, where it will smother and have toxic effects on plants and animals that live in and above the spray zone.
- Oil drifting on the sea and/or that drifts ashore will reduce the recreational and tourist value of affected areas for varying lengths of time.
- Oil pollution may result in restricted access to certain areas and restrictions on sales of seafood for varying lengths of time, and this may have an impact on the fisheries and aquaculture industries.

The environmental risk, in other words the risk that an oil spill will affect seabirds, the supra-littoral zone or other elements of the ecosystem, depends on a number of factors. The most important of these are the probability of an oil spill, the size of a particular spill, its geographical position in relation to vulnerable areas and resources/ when it occurs in relation to periods when vulnerability to oil spills is particularly high, and the spill trajectory. The efficiency of the emergency oil spill response system, which may vary considerably depending on the weather conditions at the time, is another important factor. It is also vital that an oil spill is detected as early as possible.

traffic to and from Russia. These increases may result in a rise in the frequency of accidents during this period unless preventive measures are taken.

Ship accidents can have substantial environmental consequences. Their magnitude depends on several factors, particularly time, place and whether vulnerable species and habitats are present in the area. The main measures to reduce the probability of major oil spills occurring from ships are the introduction of a minimum sailing distance from the coast and traffic separation schemes and other routeing measures. Requirements relating to ship construction, crews and shipowners are also important protective measures. Risk management is described in more detail in Chapter 7.5.

In general, the modelled accident scenarios show that the potential consequences of an oil spill are greatest for seabirds, the shoreline, marine mammals, and fish eggs and larvae, all of which are extremely vulnerable to exposure to oil. However the various scenarios show great variations in the scale of the consequences. For example, the results indicate that major oil spills resulting from accidents to ships off Stad and in the Vestfjorden could have up to *major* consequences, with long recovery periods for large, important seabird colonies in these areas, while the consequences for seabird populations in the management plan area as a whole are likely to be smaller. Another scenario that was modelled was an oil spill off Jan Mayen; in this case, the slick remained in the open sea and seabirds were not as badly affected. The consequences were assessed as less serious (up to *moderate* for certain species present in the open sea). The potential consequences for fish eggs and larvae in the water column are greatest in areas and during periods when they are present in high concentrations. Recruitment is only reduced to an extent that gives population-level impacts if part of the stock (a year class) is exposed to oil concentrations resulting in death or permanent injury. This means that there must be an overlap between the parts of the oil slick where oil concentrations exceed the estimated effect level and the drift trajectory of fish eggs and larvae and/or areas of the seabed where eggs and larvae are present. In the worst-case scenario, a shipwreck on or near a spawning ground, a qualitative assessment indicates that there may be up to *moderate* consequences for fish eggs and larvae.

In periods when seals congregate in large numbers (especially in the breeding season), an oil spill may affect a significant proportion of a population. The modelled scenarios indicate that in general the consequences are likely to be *insignificant*, rising to *minor* to *moderate* for common seals. The vulnerability of the shoreline to oil varies considerably depending on morphology, type and so on, and the time needed for recovery also differs from one type of shoreline to another. Previous experience of oil spills has shown that the negative impacts on beaches may vary in extent and duration, from almost complete loss of biological communities to marginal, sub-lethal impacts on individuals. A spill of moderate size rarely seems to cause serious damage over a large area, but the recovery period can be long in certain localities. The consequences for the shoreline in the event of oil spills in the area extending from Stad to the Vestfjorden will vary from *minor* to *major*, depending on the volume of oil, weather conditions, location of the spill and course of events.

To assess the environmental risk associated with oil spills from ship accidents, the potential consequences must be considered together with the probability of an accident. According to the results of the accident scenarios, both the probability of accidents involving oil spills and the potential consequences, particularly for seabirds, are greatest in the area from Stad and northwards along the coast of Møre og Romsdal, which means that the environmental risk associated with accidents is probably highest in this area. Similarly, the probability of accidents and their potential consequences is higher along the coast from Røst to Stad than in the remainder of the management plan area. A major oil spill off Jan Mayen could for example have *major* impacts on seabirds, but since the volume of traffic in this area is very small, the probability of an accident involving a major oil spill is also low. The environmental risk is therefore ranked as low.

5.6.2 Risks associated with acute oil pollution from petroleum activities

The probability of accidents involving oil spills occurring can never be reduced to zero, but one of the main objectives of risk management in the petroleum industry today is to reduce the environmental risk of petroleum activities as far as is practicable. This is done by building knowledge of how accidents happen and systematically implementing measures that reduce the probability that an accident will happen and the environmental consequences if an accident does happen. This is treated in more detail in Chapter 7.5.

There is always a possibility of acute oil pollution during oil production or drilling in oil-bearing formations. During exploration drilling, acute oil pollution may generally result from a blowout. During production acute oil pollution may result from pipeline leakages or large-scale process leakages from installations, leakages during loading or blowouts, although a blowout is the least probable event. However the probability of a major spill is highest in the event of a blowout (probability of oil volumes of 2 000–20 000 tonnes over 40 %, and 30 % probability of larger oil volumes), and blowouts have therefore been used as a basis for assessing potential consequences. However, the recurrence interval is longer (i.e. the probability is lower) for blowouts than for other types of accidents, which are likely to involve smaller volumes of oil. For the management plan area as a whole, and for all petro-

leum activities, the recurrence frequency for a blowout has been estimated at one every 83 years. For the individual fields, the recurrence frequency for a blowout varies from one every 270 years to one every 20 000 years. The recurrence frequency for a major pipeline leak is assessed at one every 108 years, while minor oil spills such as leakages from pipelines within a field may occur once every second year for the management plan area as a whole. The volume of oil involved in such leakages depends on a number of factors, the most important of which is the time that elapses before the leak is detected and the pipeline closed. The magnitude of a spill varies from a few to several hundred cubic metres, depending on the pipeline diameter and length, the diameter of the hole, the wellstream and the topography of the seabed. The probability of small-scale spills is highest, and the largest spills occur much more rarely.

Historical data on oil spills on the Norwegian continental shelf show that the level of activity has increased substantially without a corresponding rise in the frequency or volume of oil spills. The typical pattern is varying numbers of minor spills and occasional large spills. Since the start of petroleum activities on the Norwegian continental shelf about 40 years ago, there have been only three oil spills larger than 1000 m^3: the Ekofisk Bravo blowout in 1977, the Statfjord C oil leak in 1989 and the Statfjord A oil spill in 2007. No environmental damage has been demonstrated as a result of these oil spills. Figures for incidents on the Norwegian shelf show only a small number of major accidents but a large number of small spills (see Figure 5.9). Although this is not a guarantee as regards future activities, it does show that risk management by the authorities and the oil and gas industry has so far helped to maintain a low risk of acute pollution in the Norwegian oil and gas industry.

The outcome of a blowout may vary considerably, even between two blowouts in the same field. Whether the oil spill occurs on the seabed or the sea surface, the duration of the blowout, wind and wave conditions and the time of year are all important factors. In general, formation pressure is higher in the Norwegian Sea than in the Barents Sea, which means that a blowout in the Norwegian Sea could result in a much larger or more long-lasting oil spill than one in the Barents Sea. Projections for developments in the management plan area indicate that a number of existing oil fields are expected to shut down, which will eliminate the risk of oil spills from these fields. The projections also show that a number of gas fields are likely to be developed in the area, which means that there will probably be fewer activities carrying a risk of an oil spill. Furthermore there are grounds for assuming that knowledge development, improvements in operations and technology, and legislative developments will reduce the risk of oil spills in the future.

Except in cases where there are large congregations of seabirds in the open sea, the most serious consequences of an oil spill are generally expected in the coastal zone and when oil drifts ashore. Modelling based on the scenario for the current level of activity, with nine fields on stream, indicates that a blowout on the Norne field would affect the largest area of sea and involve the largest volume of oil. This is because oil from the Norne field is very persistent, so that a slick would have a long lifetime in the sea. Results for the other fields generally indicate a smaller impact area, smaller volumes of oil and a probability of drifting ashore of less than 5 %. The Draugen field is an exception, since the distance to shore is shortest, and an oil spill from this field has the highest probability (16 %) of reaching the coast. As part of the 2025 scenario, the potential consequences of a blowout on a hypothetical oilfield have been investigated. The field was assumed to have a lighter type of crude oil and to be located closer to the coast, off the coast of Møre og Romsdal. The results showed that this field would have consequences for the smallest area of sea, both on the surface and in the water column, because a light oil evaporates and mixes more rapidly with the water masses and therefore has a shorter lifetime in the sea. However, the short distance from land means that oil from the Møre field would have a relatively high probability (27 %) of drifting ashore.

Two similar oil spills occurring in different places or at different times may have very different consequences. The potential consequences for fish eggs and larvae in the water column are most serious in areas and periods when they are present in high concentrations. Recruitment is only reduced to an extent that gives population-level impacts if part of the stock (a year class) is exposed to oil concentrations resulting in death or permanent injury. This means that there must be an overlap between the parts of the oil slick where oil concentrations exceed the estimated effect level and the drift trajectory of fish eggs and larvae and/or areas of the seabed where eggs and larvae are present.

Experts disagree on how large a proportion of a year class may be lost as a result of an oil spill and how this may affect recruitment to the fish stocks concerned. The consequences of accidents in connection with petroleum activities in the manage-

ment plan area have been modelled by Det Norske Veritas. The modelled scenarios for different types of accidents showed that in the event of an oil spill the potential consequences for eggs and larvae would be *insignificant* or *minor*. Models of an overlap between the distribution of larvae of Norwegian spring-spawning herring and Norwegian Arctic cod in oil-contaminated seawater (using 250 ppb as the threshold value for damage), indicated that in the event of a blowout from the Norne field or the hypothetical Møre field the proportion of fish eggs and larvae lost would be in the range less than 1 % to 5.6 %, with an expected value of less than 1 %. On the basis of this model, the potential consequences of a spill are ranked as *minor*.

The Institute of Marine Research believes that losses could be much higher than modelling indicates, particularly in periods when the stock is low. The institute bases its opinion on the fact that under normal conditions only a small proportion of eggs and larvae survive and contribute to recruitment. Thus the institute considers that a blowout or an oil spill that affects the proportion of eggs and larvae that is necessary for recruitment could result in the loss of up to 100 % of a year class. However, the probability of a loss of this magnitude is very low.

Seabirds as a group are particularly vulnerable to oil pollution. The slow sexual maturation and low recruitment rates of many of these species mean that populations have a relatively long recovery period. Modelling show relatively large differences between the potential consequences of blowouts from different oil fields, and considerable variations in the course of the year. Blowouts from the Norne field and the hypothetical Møre field were found to have the greatest consequences for seabirds, varying from *insignificant* to *major* depending on the outcome of the accident. The potential consequences were greatest for puffins in the event of blowout in the Norne field in spring/summer. The potential consequences were assessed as *major* for puffins, *minor* for common guillemot, common eider and shag, and *minor* for kittiwake. However, the probability of accidents that might have *major* consequences was assessed as low in the situations modelled.

Seals congregate in large numbers in limited areas at certain times of year and are more vulnerable to oil during the breeding season. For the common seal the potential consequences of an oil spill are ranked as *insignificant*, with a certain probability of *minor* and *moderate* consequences in the case of a blowout from two of the fields (Draugen and the hypothetical Møre field). The most serious consequences would arise if large concentrations of animals are exposed to oil during periods when they are most vulnerable. If oil reaches the shore, the probability of *minor* consequences for the shoreline is 22 % for Norne, 5 % for Heidrun, 12 % for Draugen and 57 % for the hypothetical Møre field. These levels are generally lower during the spring and summer. For the Norne field and the hypothetical Møre field the probability of *major* consequences is 1 % and 3.7 % respectively. Such consequences would be limited to certain localities in the affected area. The above probabilities have been calculated without factoring in oil spill response measures. These reduce the consequences of oil spills, since the oil is recovered as close to the source as possible to the source of the spill. The results discussed here are based on scenarios that have been modelled. Future changes in for example the geographical location of activities or an accident with different features from those modelled could change the potential consequences and environmental risk in the event of oil spills.

Risk scenario for acute pollution from the hypothetical Møre field

The 2025 scenario includes a hypothetical oil field near the coastline. A light type of crude oil and a location about 40 km from the coast of Møre of Romsdal were chosen as the basis for the dispersion models and impact assessment. Production mode is assumed to be subsea templates tied to an onshore facility.

Petroleum production will result in a certain probability of an accident involving an oil spill to the sea, which could have environmental consequences. In order to reduce these consequences, petroleum companies are required to establish an oil spill response system. These factors determine the risk of acute oil pollution from petroleum activities.

The probability of a major oil spill from the hypothetical field has been calculated. The probability of an accident involving a major spill of crude oil is very low. A major spill may be caused by a blowout, pipeline rupture or leakage, or a by a ship colliding with an installation. If there are assumed to be 12 wells on the Møre field, the generic recurrence interval for a blowout would be every 1400 years. Since the hypothetical Møre field is assumed to have a subsea production templates, the possibility of a ship collision is limited to the drilling period, which with 12 wells is assumed to last for one to two years. The recurrence interval

for a ship collision is found to be 12 300 years. Assuming that the oil pipeline to shore has a diameter of 18 inches, and that the distance to shore is about 40 km, the maximum volume of oil in the pipeline would be about 6 300 m³. The recurrence interval for a pipeline leakage is 3 200 years. The maximum size of the spill would be 6 300 m³, or the total volume of oil in the pipeline.

The potential consequences of a blowout have also been calculated. The most serious environmental consequences are expected if a large volume of oil reaches the coastal zone and possibly drifts ashore. The probability of oil drifting ashore from the Møre field is estimated at 27 %. If oil drifts ashore Det Norske Veritas has estimated that the probability of *major* consequences for the shoreline, meaning that recovery takes 3 to 10 years, is 3.7 %. The Norwegian Institute for Nature Research has conservatively estimated the maximum losses to seabird populations on the open sea as a result of a blowout on the Møre field at 4.3 % for common guillemots and 3.4 % for puffins in the summer, and 4.9 % for razorbills in the autumn. Det Norske Veritas has further estimated an expected loss of less than 1 % of a years class of herring. Fish are most vulnerable during the spawning period (and the early larval stages), which for herring in the Møre field mainly stretches from February to April. The Institute of Marine Research believes that losses could be considerably higher than modelling indicates, particularly in periods when stocks are low (see above). Det Norske Veritas has estimated a probability of 18 % for *moderate* consequences for common seals, which means that the population would recover within 1 to 3 years. Coastal seals are most vulnerable during the moulting and whelping periods.

All these examples show that for the hypothetical Møre field, the probabilities of environmental consequences resulting in a 3- to 10-year recovery period are low. In this impact assessment oil spill response measures are not taken into account. Analysis by the SINTEF Group state that a normal effort of mechanical oil spill containment and recovery in the event of a blowout in the Møre field would reduce the extent of affected sea area by 50 % and contamination of shoreline by over 75 %. Given the location of the field, there is a 5 % probability of an oil spill from the field reaching shore within 1 to 2 days. Drift time to shore is shortest when there are continual gale-force winds. In such situations, mechanical containment and recovery equipment is of little relevance, since the waves mix the oil into the water masses and speed up the natural degradation process. Under normal weather conditions there is sufficient time to mobilise oil spill response equipment and several time windows when conditions are good for mechanical oil spill response measures.

6 Climate change and ocean acidification

The average global temperature is expected to rise as a result of emissions of greenhouse gases. Possible consequences of global warming include rising sea levels and changes in ocean currents, ice cover and salinity. These changes may have a dramatic impact on the marine environment and marine biological diversity. Elevated levels of CO_2 in the atmosphere also lead to higher CO_2 uptake in seawater, which in turn increases the acidity of the seawater. Only a few years ago, ocean acidification was almost unheard of. Today, this is considered to be one of the most serious threats to the marine environment.

In its annual resolutions on oceans and the law of the sea, the UN General Assembly has expressed concern about the impacts of climate change and ocean acidification. Heightened interest in these issues has resulted in a focus on knowl-

Box 6.1 New challenges for marine environment conventions

Climate change and ocean acidification have generated new problems that must also be addressed within the framework of the international marine environment conventions. Regional cooperation under the Convention for the Protection of the Marine Environment in the North-East Atlantic (the OSPAR Convention) is particularly important for Norway. The Convention has assumed an active role with regard to

- assessing and monitoring the impacts of climate change and ocean acidification on the marine environment, and
- encouraging appropriate measures for climate change mitigation and regulating them to prevent negative impacts on the marine environment

Ocean acidification was included in the work of the OSPAR Commission, on Norway's initiative, as early as 2004. As a result, the OSPAR report *Effects on the marine environment of ocean acidification resulting from elevated levels of CO_2 in the atmosphere* was published in 2006. This report has subsequently been presented in a range of international forums, including the global Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter of 1972 (the London Convention) and its 1996 Protocol (the London Protocol). Climate change and ocean acidification, including an assessment of impacts, possible measures to mitigate climate change that may influence the marine environment and strategies for adaptation to a changed environment, will also be central topics in the Quality Status Report for the North-East Atlantic (QSR 2010) that is to be presented at OSPAR's ministerial meeting in 2010.

Measures to reduce atmospheric greenhouse gas levels, including new forms of energy production, may lead to new ways of using the oceans. These developments may in turn generate a need for adjustments and new forms of regulation under the conventions. Amendments to the OSPAR Convention were adopted in 2007 to allow the storage of carbon dioxide in geological formations under the seabed, which was previously prohibited unless the storage was an integral part of petroleum activities. The amendments will enter into force as soon as at least seven parties to the Convention have ratified them. Guidelines and reporting requirements to ensure environmentally safe storage were also adopted. Similar amendments to the London Protocol were adopted in 2006 and entered into force in 2007. The London Protocol has also adopted guidelines and reporting requirements for CO_2 storage.

Another example of new developments is OSPAR's work on offshore wind power. The Commission has adopted guidelines for assessing the environmental impact of offshore wind farms. Harnessing the ocean in new forms of energy production such as wind farms and wave power is also relevant in connection with marine spatial planning, which is a priority area for cooperation under the Convention.

edge building and research into adaptation measures in recent years, both internationally and nationally.

The rise in temperature, other forms of climate change and ocean acidification are expected to progress more quickly at our latitudes than further south. According to the Intergovernmental Panel on Climate Change (IPCC), ocean acidification may damage marine ecosystems in the course of only a few decades.

The Government's targets and measures for reductions of greenhouse gas emissions are not the subject of this white paper. However, a reduction in global greenhouse gas emissions will be of crucial importance for the state of the Norwegian Sea environment in the future.

6.1 Expected developments

Developments in climate change and ocean acidification are difficult to predict on a regional scale, for example for the Norwegian Sea. Models used to predict changes on a global scale cannot be applied directly to a limited sea area, and there is substantial uncertainty in the results from the regional models that have been developed, particularly with regard to climate change.

However, northern sea areas are known to be early indicators of the impacts of global warming and ocean acidification. Very little is known about how climate change and ocean acidification will interact, but it is possible that the negative impacts will reinforce one another.

Climate change

The rising temperature is expected to lead to changes in precipitation, winds, solar and UV radiation, ocean currents, melting of ice, salinity and sea level. However, it is very uncertain how quickly and in what way climate change will become apparent and affect the marine environment of the Norwegian Sea. It is particularly difficult to model brief extreme weather periods that can have implications for emergency response systems. A reduction in ice cover, a higher frequency of extreme weather events and a displacement in the distribution of some species towards the north are, however, expected in the relatively near term. The impacts of climate change in the Norwegian Sea may be partially masked over the next few years by natural fluctuations.

Warming in the Arctic is taking place at about twice the global average rate, and the Arctic is expected to be ice-free in summer before the end of this century. Ice reflects sunlight, and with a loss of sea ice, less energy is reflected, causing the Arctic seawater temperature to rise more quickly. Global warming may reduce surface-water cooling and inhibit the «conveyor belt» process whereby the cold water sinks to the depths. This may in turn affect ocean circulation and currents in the Atlantic.

Ocean circulation in the Atlantic is expected to be weakened, resulting in lower inflow of Atlantic water to the Norwegian Sea. In spite of this, the temperature will rise due to global warming. Changes in wind fields are of great importance to the climate in the Norwegian Sea. If westerly winds become more prevalent over the Nordic seas, the westerly extent of warm Atlantic water in the Norwegian Sea will be reduced, and transport of cold Arctic water to its western parts will increase. However, it is very uncertain how the low pressure activity will actually change. In addition, as already mentioned, the climate of the Norwegian Sea is highly variable, and this may in the short term mask the effects of global warming.

Ocean acidification

In the period since the industrial revolution, the ocean has absorbed just over half of the CO_2 emitted to the atmosphere. This has reduced the atmospheric concentration of CO_2, but has at the same time resulted in ocean acidification. A slight increase in the acidity of the deep water in the Norwegian Sea has already been detected, and marked changes are expected in the decades ahead. Greater changes are expected towards the end of the century, and forecasts for the next 100 years

Box 6.2 The Monaco Declaration

In October 2008, 155 scientists from 26 countries issued a declaration from an international symposium in Monaco on ocean acidification. In the declaration, the scientists express deep concern about rapid ocean acidification and its potential, within decades, to severely affect marine ecosystems and fisheries. The declaration calls for research into the effects of ocean acidification on ecosystems and socioeconomic conditions, improved dialogue between policymakers and scientists, and the development of ambitious, urgent plans to cut greenhouse gas emissions.

Box 6.3 Higher concentration of CO_2 increases ocean acidity

According to the laws on the solubility of gases in liquids, CO_2 dissolved in surface sea water will always be in equilibrium with atmospheric CO_2. When CO_2 dissolves in water, it forms carbonic acid, increasing ocean acidity. Since the industrial revolution, global surface ocean acidity has increased by 30 %. This means that the concentration of positive, acidic hydrogen ions (H^+) has risen by 30 %. Acidity is expressed as pH, which is defined as the negative logarithm of the hydrogen ion (H^+) concentration. A pH of 7 is neutral, solutions with a pH less than 7 are acidic and solutions with a pH greater than 7 are basic or alkaline. The 30 % increase in the hydrogen ion concentration means that the average surface-water pH has dropped from 8.2 to 8.1. The water is still on the basic side of neutral, but has become more acidic. In the decades ahead, a further reduction of 0.1–0.2 pH units is expected.

suggest that seawater will become more acidic than it has been for the past 20 million years.

Due to the oceanographic features of the Norwegian Sea, ocean acidification will occur rapidly here. As individual species and populations are affected, changes at ecosystem level can also be expected. Damage to ecosystems is expected as early as 2025, and severe damage by the end of this century.

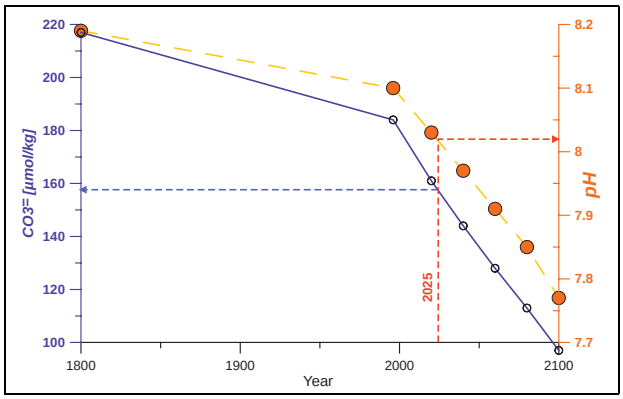

Figure 6.1 pH and carbonate concentration (global mean values) in surface ocean waters between 1800 and 2100. The values for 1800 are to close to those for pre-industrial conditions. Projected values are based on continued greenhouse gas emissions. The dotted lines show the projected levels in 2025

Source: Norwegian Institute for Water Research. Based on Brewer (1997)

The global warming of surface water may reduce the capacity of seawater to absorb CO_2, which may curb acidification in deep water. If the capacity of seawater to absorb CO_2 is reduced as a result of global warming and lower buffering capacity, this may in turn lead to a more rapid increase in atmospheric greenhouse gas levels and thereby in global warming. There is limited knowledge about how the interaction of climate change and increased ocean uptake of CO_2 will affect the marine environment. It is therefore essential to strengthen research on these processes.

6.2 Impacts of climate change and ocean acidification on ecosystems

Climate change

There is considerable uncertainty as to how and how quickly climate change will affect ecosystems in the Norwegian Sea. However, impacts on distribution, density and reproduction for a number of fish, seabird and marine mammal stocks in the area covered by the management plan can be expected. Warming of the Norwegian Sea is expected to lead to a northward and westward shift of the front zone between Atlantic and Arctic water, where biological production is high and feeding conditions for fish, seabirds and marine mammals are good. New species may expand their distribution northwards towards Norwegian waters. Southerly species along the Norwegian coast are expected to move northwards along the coast towards Svalbard and the eastern part of the Barents Sea. Northerly coastal species may disappear from the Norwegian Sea, shifting northwards to the Barents Sea. Some alien species may more easily gain a foothold in a warmer marine environment. Climate change can also lead to changes in health status, including an increase in parasitic disease, for example in fish and marine mammal populations.

In isolation, a somewhat warmer ocean is expected to result in increased growth in fish stocks. The expected impacts of climate change on certain important fish and seabird populations have therefore been assessed as positive, although these assessments are highly uncertain. At worst, climate change may result in the collapse of food chains and major changes in for example fish, seabird and marine mammal populations. For coral

Box 6.4 Frozen subsea gas

Subsea gas hydrates in frozen form (ice) occur in vast amounts all over the world. Under high pressure and/or at low temperatures, methane gas is trapped in a lattice of ice. Total global carbon reserves bound in frozen gas hydrates are roughly estimated to equal the combined oil, gas and coal reserves worldwide.

Gas hydrates are believed to occur in large quantities on the Norwegian continental shelf. The first gas hydrate samples on the Norwegian continental shelf were taken ten years ago at the Håkon Mosby mud volcano. In summer 2006 and 2008, gas hydrates were recovered in the Nyegga area of the Norwegian Sea. There are also believed to be large volumes of gas hydrates in the Barents Sea. Research into the quantities and formation of gas hydrates is being conducted by the GANS project (Gas Hydrates on the Norway – Barents Sea – Svalbard margin), which is partly financed by the Research Council of Norway.

Gas hydrates are regarded as a potential energy resource, and international pilot projects to assess extraction are being developed. However, extraction is challenging as gas hydrates readily decompose if pressure is reduced or the temperature rises. In addition, it will be necessary to ensure that the use of gas hydrates does not result in higher greenhouse gas emissions.

Methane may also be released from gas hydrates as a result of anthropogenic global warming. Initially, frozen methane gas in permafrost on land (particularly in Siberia) is most likely to be affected. An increase in the methane content of seawater above the Siberian continental shelf has already been recorded, and as global warming spreads to deep water, gas hydrates in seabed surface sediments may be affected. Methane is 25 times more potent as a greenhouse gas than CO_2. Methane emissions to the atmosphere from thawing gas hydrates will in turn boost global warming, resulting in a positive feedback mechanism.

reefs, the impacts of climate change have been assessed as clearly negative.

Higher water temperature can in isolation be expected to result in an increase in the biomass of phytoplankton, seaweed and kelp, which may in turn provide richer food supplies for organisms higher up the food chain, for example some fish populations. However, a rise in temperature can also lead to changes in which species of plankton, seaweed and kelp thrive best. In the Skagerrak, for example, an overall assessment concluded that high seawater temperature is probably the most important single factor behind a regionwide loss of sugar kelp.

Ocean acidification

The projected impacts of ocean acidification are more clearly negative. Higher levels of CO_2 and lower pH in the ocean are expected to have particularly severe impacts on living organisms that build calcium carbonate shells and skeletons. Calcifying phyto- and zooplankton species, corals and molluscs are among the organisms expected to be adversely affected.

There are particularly large coldwater coral reef complexes in the Norwegian Sea, and the deepest reefs are already being affected by acidification. Most corals in Norway grow at depths of 200–600 metres. At greater depths, the temperature is too low and the pressure too high in Norwegian waters for corals to produce calcium carbonate for reef-building. As the water becomes more acidic, the depth at which calcification is possible shifts upwards towards shallower water. When corals are no longer able to build calcium carbonate skeletons, they will stop growing. Their coral skeletons will gradually dissolve. Recent studies indicate that most coral reefs in Norwegian waters will have stopped growing in 100 years' time and will be negatively affected much earlier.

Other animal groups that are particularly dependent on calcareous structures and are therefore sensitive to ocean acidification include some plankton species, crustaceans, molluscs and echinoderms such as starfish and sea urchins. Acidification and higher CO_2 levels can also affect other physiological and biochemical parameters. Thus, it is not only calcifying organisms that may suffer the negative impacts of acidification. In general, it appears that the early development stages of animals (eggs, larvae, spawn) are more sensitive to ocean acidification than adults. Recent results have shown that cephalopods are also sensitive to ocean

acidification. Impacts on marine mammals and seabirds are mainly expected to be indirect, and will depend on the extent to which their food supplies are affected by acidification.

Overall, the adverse impacts of ocean acidification on phyto- and zooplankton, fish eggs, coral reefs and herring are expected to be moderate in the period up to 2025. By 2080, these groups are expected to suffer major negative impacts, while the impacts on other fish stocks, fish larvae, benthic communities and marine mammals that have been evaluated are expected to be moderately negative. Some species can be expected to disappear within decades.

Climate change and ocean acidification interact

Separately and together, climate change and ocean acidification may result in changes in ecosystems, so that previously less important species take on a key role. Such changes at low levels in food chains may have a greater impact at higher trophic levels. Together, the loss of species or changes in the relative proportions of species at different levels of the food chains and in their temporal distribution may disrupt the structure and functioning of ecosystems, with unprecedented consequences. Such developments would probably be impossible to reverse in a controlled manner. For management purposes, it will be of crucial importance to be able to predict change as early as possible.

Knowledge about how climate change and ocean acidification will affect species and ecosystems is limited, and almost nothing is known about how they will interact. Change is taking place so rapidly that ecosystems have little time to adapt.

It is very important both for the marine environment and for business interests in the management plan area to focus on these issues in research and in the development of adaptation strategies in the time ahead.

7 Strengthening the legislation and the management regime

7.1 Legislative developments

The legal basis for implementing an integrated, ecosystem-based management regime for marine and coastal waters is provided by a number of Norwegian acts and regulations. These are administered by the Ministry of the Environment or other ministries, particularly the Ministries of Fisheries and Coastal Affairs, Petroleum and Energy, Trade and Industry (shipping) and Labour and Social Inclusion (inspection and enforcement in the petroleum industry), see Box 7.1. All in all, this legislation provides a sound and comprehensive basis for the management regime. On 1 January 2009 the new Marine Resources Act entered into force, and a Nature Management Act has been presented in Proposition No. 52 (2008–2009) to the Storting. These will further strengthen and update the legislation. The Marine Resources Act emphasises the precautionary principle and the ecosystem approach as a basis for fisheries management. The precautionary principle is also a key element of the Nature Management Act, together with knowledge-based management, assessment of cumulative environmental effects, and the user-pays principle. See Boxes 7.1, 7.2, 7.3 and 7.4 for more information.

The Ministry of Petroleum and Energy has started a public consultation on the draft Marine Energy Act, which is to regulate the planning, development, operation and decommissioning of installations for renewable energy production and infrastructure for transmission grids outside the baseline.

Applicability of the Nature Management Act in sea areas

The Nature Management Act will apply to all sectors that have an impact on or utilise nature and its diversity. The geographical scope of the Act includes Norway's land territory and its waters out to the 12-nautical-mile territorial limit. However, the provisions on the purpose of the Act (section 1), management goals (sections 4 and 5), general principles of sustainable use (sections 7–10), the principle for the management of wild salmonids and seabirds (sections 15 and 16), and access to genetic material (sections 57 and 58) are also applicable on

Box 7.1 Legislation of relevance to integrated, ecosystem-based marine management

- Act of 19 June 2009 No. 100 relating to the management of biological, geological and landscape diversity (Nature Management Act)
- Act of 6 June 2008 No. 37 relating to the management of wild living marine resources (Marine Resources Act)
- Act of 13 March 1981 No. 6 relating to protection against pollution and to waste (Pollution Control Act)
- Act of 29 November 1996 No. 72 relating to petroleum activities
- Act of 19 June 1970 No. 63 relating to nature conservation (Nature Conservation Act)
- Maritime Safety Act of 16 February 2007 No. 9
- Act of 11 June 1976 No. 79 relating to the control of products and consumer services (Product Control Act)
- Act of 22 June 1990 No. 50 relating to the generation, conversion, transmission, trading, distribution and use of energy, etc. (Energy Act)
- Act of 8 June 1984 No. 51 relating to harbours and fairways, etc. (Harbour Act). The Storting adopted a new act on 3 February 2009, but this has not yet entered into force (Proposition No. 75 (2007–2008) to the Odelsting)
- Act of 29 May 1981 No. 38 relating to wildlife (Wildlife Act)
- Act of 15 May 1992 No. 47 relating to salmonids and freshwater fish, etc.
- Act of 19 December 2003 No. 124 relating to food production and food safety (Food Act)
- Act of 16 June 1989 No. 12 relating to the pilot service

Box 7.2 Key principles of the Nature Management Act

The precautionary principle (section 9)

When a decision is made in the absence of adequate information on the impacts it may have on the natural environment, the aim shall be to avoid possible significant damage to biological, geological or landscape diversity. If there is a risk of serious or irreversible damage to such diversity, lack of knowledge shall not be used as a reason for postponing or not introducing management measures.

The principle that cumulative environmental effects must be assessed (section 10)

Any pressure on an ecosystem shall be assessed on the basis of the cumulative environmental effects on the ecosystem now or in the future.

the continental shelf and areas under Norwegian jurisdiction beyond the territorial sea (12 nautical miles) to the extent appropriate.

The provisions mentioned above will be generally applicable, and will thus supplement sectoral legislation when the authorities for specific sectors make assessments and decisions in accordance with such legislation, for example the Marine Resources Act and the Petroleum Act. The remaining provisions of the Nature Management Act will not be made applicable to Norway's continental shelf or areas of jurisdiction established outside the 12-nautical-mile territorial limit. The Government will make a thorough evaluation of whether and in what way any other provisions are to be made applicable outside the territorial limit.

Rights to harvest or otherwise utilise wild living marine resources follow from the Marine Resources Act. The provisions on harvesting and other removal set out in sections 16, 20 and 21 of the Nature Management Act will therefore not be applicable to marine living resources. However, section 1 (purpose) and Chapter II (general principles of sustainable use) of the Nature Management Act will supplement the Marine Resources Act when the fisheries authorities make assessments and decisions on rights to harvest or otherwise utilise wild living marine resources under the Marine Resources Act.

The provisions on priority species will also apply in the sea out to the territorial limit. This paragraph will be particularly relevant if a species is rare or in danger of becoming extinct in Norway, or if a species needs protection across sectors.

The provisions of the Nature Management Act on alien species will apply out to the territorial limit, and have been harmonised with those of the Marine Resources Act and the Aquaculture Act. This means that any deliberate introduction or release of organisms to the sea within the territorial limit must be in accordance with the provisions of both the Nature Management Act and the Aquaculture Act. Outside the territorial limit, the management of alien species will be regulated by the Marine Resources Act and the Aquaculture Act. Species that themselves spread to areas under Norwegian jurisdiction (for example the red king crab and the comb jelly *Mnemiopsis leidyi*) are to be managed in accordance with the provisions of the Marine Resources Act. Species that have been introduced to sea areas in contravention of the Nature Management Act or as an unforeseen consequence of lawful activities are to be regulated by the provisions of sections 69 and 70 of the Nature Management Act. Species that were originally introduced and have become established in Norwegian waters are to be managed under the provisions of the Marine Resources Act.

The chapter of the Nature Management Act on protected areas includes a provision on marine protected areas, which applies out to the territorial limit. The provision provides the authority to establish purely marine protected areas. Such areas may be established on the grounds of their marine conservation value, but also to safeguard valuable marine areas that are ecologically necessary for terrestrial species. Marine protected areas may be established for a wide variety of purposes, and according to specific criteria that to a large extent correspond with those for the establishment of national parks, nature reserves and habitat management areas which are set out in sections 35, 37 and 38. When a marine protected area is established, it must be specified whether the purpose of the protection measure and restrictions on activities apply to the seabed, the water column, the water surface or a combination of these. This means that if fisheries are the only activity that must be regulated to achieve the purpose of protecting an area, restrictions would be imposed under the Marine Resources Act. Such areas would then be marine protected areas, but not protected areas under Chapter V of the Nature Management Act.

The provisions on selected habitat types will apply out to the territorial limit. Selected habitat types will be designated in regulations under the Act. In evaluating whether or not a habitat type is to be designated as selected, particular importance is to be attached to whether it is:

- endangered or vulnerable,
- important for one or more priority species,
- a habitat type for which Norway has a special responsibility, or
- a habitat type to which international obligations apply.

The substantive provisions on selected habitat types are intended as national guidelines on sustainable use for sectoral authorities and individual people. The provisions provide guidance for decision makers on the considerations that must be weighed up and the interests that must be safeguarded in managing selected habitat types. The provisions are therefore not intended to safeguard all areas of selected habitat types.

The provisions on access to genetic material will apply in Norway's territorial waters out to the territorial limit, on the continental shelf and in areas under Norwegian jurisdiction beyond the territorial sea. There are similar provisions on the regulation of harvesting and sharing of the benefits of marine bioprospecting in the Marine Resources Act. The Act emphasises that Norway should manage genetic material as a common resource that belongs to Norwegian society as a whole. The utilisation of genetic material must be to the greatest possible benefit of people and the environment at both national and international level. Due regard must also be paid to fair and equitable sharing of the benefits arising out of the utilisation of genetic resources, so that the interests of indigenous peoples and local communities are safeguarded.

Regulations may be adopted under the Act introducing a general system of permits for harvesting and utilisation of genetic material. Furthermore, regulations may be adopted prescribing that the benefits arising out of harvesting and utilisation of genetic material from Norway shall accrue to the state. Both financial and non-financial benefits may be regulated.

The Nature Management Act and the Marine Resources Act contain very similar provisions on permits for harvesting biological material and sharing of the benefits arising from such activities. There are plans to regulate harvesting and utilisation in one set of regulations under both these acts, so that only one application process is necessary, and the fisheries authorities are responsible for the provisions of the regulations that apply to sea areas.

The Marine Resources Act

The Marine Resources Act entered into force on 1 January 2009, and replaced the Seawater Fisheries Act. It applies to all harvesting and other utilisation of wild living marine resources and genetic mate-

Box 7.3 Excerpts from the Marine Resources Act

Section 1 Purpose

The purpose of this Act is to ensure sustainable and economically profitable management of wild living marine resources and genetic material derived from them, and to promote employment and settlement in coastal communities.

Section 7 Principle for management of wild living marine resources and fundamental considerations

The Ministry shall evaluate which types of management measures are necessary to ensure sustainable management of wild living marine resources.

Special importance shall be attached to the following in the management of wild living marine resources and genetic material derived from them:

a) a precautionary approach, in accordance with international agreements and guidelines,
b) an ecosystem approach that takes into account habitats and biodiversity,
c) effective control of harvesting and other forms of utilisation of resources,
d) appropriate allocation of resources, which among other things can help to ensure employment and maintain settlement in coastal communities,
e) optimal utilisation of resources, adapted to marine value creation, markets and industries,
f) ensuring that harvesting methods and the way gear is used take into account the need to reduce possible negative impacts on living marine resources,
g) ensuring that management measures help to maintain the material basis for Sami culture.

Box 7.4 Principle for the management of wild living marine resources

The management of wild living marine resources is based on the premise that people should be able to harvest these resources in a way that contributes to food production, employment and settlement. However, it is essential that such harvesting is sustainable and does not cause unacceptable damage to marine ecosystems. Wild living marine resources are to be managed in accordance with the precautionary principle and using an ecosystem approach that takes into account both habitats and biodiversity. This is in accordance with international agreements and guidelines, including the Convention on the Law of the Sea and the FAO *Code of Conduct for Responsible Fisheries*.

Section 7 of the Marine Resources Act establishes the principle that the fisheries authorities must regularly evaluate the types of management measures that are necessary to ensure sustainable management of wild living marine resources. Thus, the principle requires the fisheries authorities to practise integrated, sound, long-term management of these resources.

Sustainable harvesting in accordance with this management principle entails a greater need for monitoring of sea areas and fish stocks. Up to the present, the fisheries authorities have focused their efforts on monitoring and management of the stocks that are most important in commercial terms. However, the management principle set out in the Act requires the authorities to make regular assessments of *all* stocks that are harvested, and the effects of harvesting on ecosystems. The management principle therefore entails a major challenge, which the fisheries authorities are now addressing.

Norway's management of the commercially most important fish stocks is based on extensive research and management advice. In addition, fishermen are required to provide extensive reports to ensure that knowledge of the various harvesting activities is as complete as possible. All catches landed in Norway are registered on landing notes and sales notes. The owner or user of any vessel above a certain size must also keep a catch logbook in which catches are recorded. This means that catches from all stocks and areas are systematically registered, and that the data form part of the basis for advice and management. This information is of fundamental importance for application of the management principle.

Depending on the conclusions of the required regular assessments by the fisheries authorities, it may be necessary to regulate catches by means of quotas, to introduce other types of regulation such as minimum sizes, to close areas to fishing, to restrict the types of gear that may be used or to extend reporting requirements. It is particularly important to take a cautious approach to new harvesting activities, since the knowledge base may be inadequate.

According to the principle for the management of living marine resources, management measures must be evaluated at regular intervals, and must be based on the principle of long-term sustainability and the precautionary principle.

This management principle will be a very important management tool, and is intended to ensure that regulatory measures are adapted to the state of the stocks and that harvesting is sustainable.

rial derived from them. Its scope is thus wider than that of the Seawater Fisheries Act, and it provides a basis for sound, integrated resource management. All provisions of the Marine Resources Act apply within Norwegian land territory with the exception of Jan Mayen and Svalbard, in the Norwegian territorial sea and internal waters, on the Norwegian continental shelf, and in the areas established under sections 1 and 5 of the Act of 17 December 1976 No. 91 relating to the Economic Zone of Norway.

Section 7, first paragraph, of the Marine Resources Act introduces a principle for the management of wild living marine resources under which the fisheries authorities must regularly evaluate the types of management measures that are necessary to ensure a sustainable management regime. Furthermore, section 19 of the Act provides the authority to establish marine protected areas where harvesting and other forms of use of wild living marine resources are prohibited. However, exemptions may be granted for harvesting activities and other forms of use that will not be in conflict with the purpose of protecting the area.

The management principle of the Marine Resources Act is supplemented by the purpose,

management goals and general principles set out in the Nature Management Act. In addition, decisions on priority species and the protection of areas under the Nature Management Act will be among the instruments that can be used in sea areas out to the territorial limit.

The Marine Resources Act also provides the legal authority for regulating the use of marine genetic resources. The provisions on the use of marine genetic resources apply throughout the territorial extent of the Act. Marine bioprospecting has not previously been regulated in Norway. It involves searching for natural products and biochemical resources from marine organisms and subsequent testing of the material with a view to commercial utilisation. Marine bioprospecting is a research and development tool with potential in a number of industrial sectors. The discovery and utilisation of genetic resources can yield considerable financial gains, for example in the pharmaceutical industry, that are based on resources that belong to the community as a whole. Examples include new medicines, flavour-enhancing food and feed additives, nutrients, enzymes and micro-organisms used to process food and feed, industrial processes used in the production of textiles, cellulose, biomass/renewable energy, and products and processes used in the oil industry.

Sections 9 and 10 of the Marine Resources Act provide the legal basis for laying down rules for harvesting and investigations and for prescribing that a proportion of the benefits arising out of the use of Norwegian marine genetic material shall accrue to the state. A further assessment will be made of how such rules should be formulated. The development of such rules is important in safeguarding the state's economic interests and ensuring sound management of these genetic resources. The provisions of the Nature Management Act and the Marine Resources Act on permits for harvesting biological material and sharing of the benefits arising from such activity are very similar.

7.2 Spatial management

Spatial management tools are important in the management of the marine environment and marine resources in Norway. The integrated management plans for Norwegian sea areas consider existing spatial regulatory measures in relation to each other and supplement them as necessary. The management plans themselves are spatial management tools on a large scale. Within each management plan area, a wide range of management tools can be used, ranging from various types of protection (closing areas to harvesting for a limited period of time; using different types of legislation to protect areas permanently; protecting particularly vulnerable and valuable areas; establishing areas with some form of international conservation status, such as world heritage sites; and rules on sustainable use of selected habitat types) to steps such as opening new areas for petroleum activity and establishing routeing and traffic separation schemes for shipping.

7.2.1 Marine protected areas

Norway has adopted the goal of establishing an international network of Marine Protected Areas (MPAs) in accordance with decisions to achieve this by 2010 under the OSPAR Convention on the protection of the marine environment of the North-East Atlantic and by 2012 under the Convention on Biological Diversity (CBD). Protection of selected MPAs under the Nature Management Act or other legislation is an important element of ecosystem-based management, and is intended to play a part in halting the loss of biodiversity, safeguarding the natural resource base and maintaining a representative selection of marine environments as reference areas for research and monitoring. Norway's network of MPAs will consist of marine protected areas that are included in the marine protection plan and other relevant processes.

In 2001, the Ministry of the Environment, in consultation with the Ministry of Fisheries and Coastal Affairs, the Ministry of Petroleum and Energy and the Ministry of Trade and Industry, appointed an advisory committee to give advice on areas that could be included in a national marine protection plan and on the appropriate degree of restriction on activities in such areas. In 2004, the committee presented its recommendations on the protection of 36 marine areas for the first phase of the plan.

The next important steps will be to publish notification of the start of the planning process and to obtain information from local interest groups. The areas that will be considered initially are presented in Chapter 10. The municipalities and counties involved will be included in the process so that they can play their role as local and regional planning authorities. After this, an environmental impact assessment for the draft plan will be carried out, and a public consultation process will take place at national level. In accordance with the Government's policy platform, the integrated management plans will be used as the main tool for managing petroleum activities. For areas more than 12 nautical

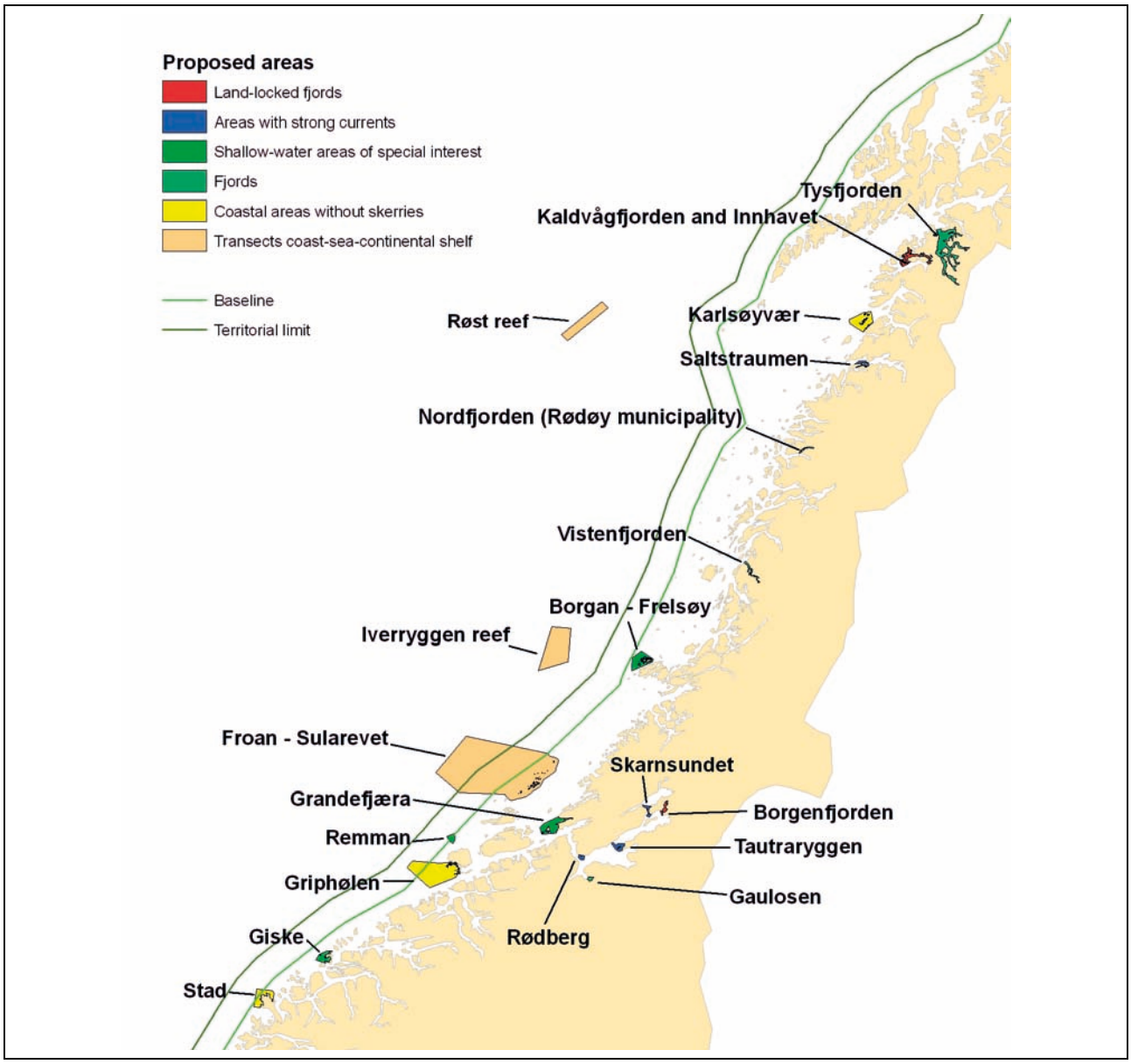

Figure 7.1 Areas of the Norwegian Sea management plan area proposed by its advisory committee for inclusion in the national marine protection plan

Source: Directorate for Nature Management

miles from the baseline, general principles and decisions on the spatial management of petroleum activities are therefore to be set out in the management plans for Norway's sea areas (see Chapter 10). After the public consultation, the draft plan will be finalised in consultation with relevant directorates and sent to the Ministry of the Environment. Together with other relevant ministries, the Ministry of the Environment will draw up the final proposal for a national marine protection plan. Any adjustments to the draft plan, including the possible removal of some of the areas proposed, can be made at this stage. The protected areas should as far as possible form a coherent network, and the final decision on the plan will be made by the Government (formally by the King in Council). The initial network will be updated, adjusted and supplemented as necessary during the second phase of the work.

7.2.2 Protection under the fisheries legislation

Under the fisheries legislation, protective measures have been implemented both in the form of prohibitions on fishing in specific areas in annual fisheries regulations and in the form of more permanent restrictions. Several of the annual prohibitions on fishing are extended year after year and in

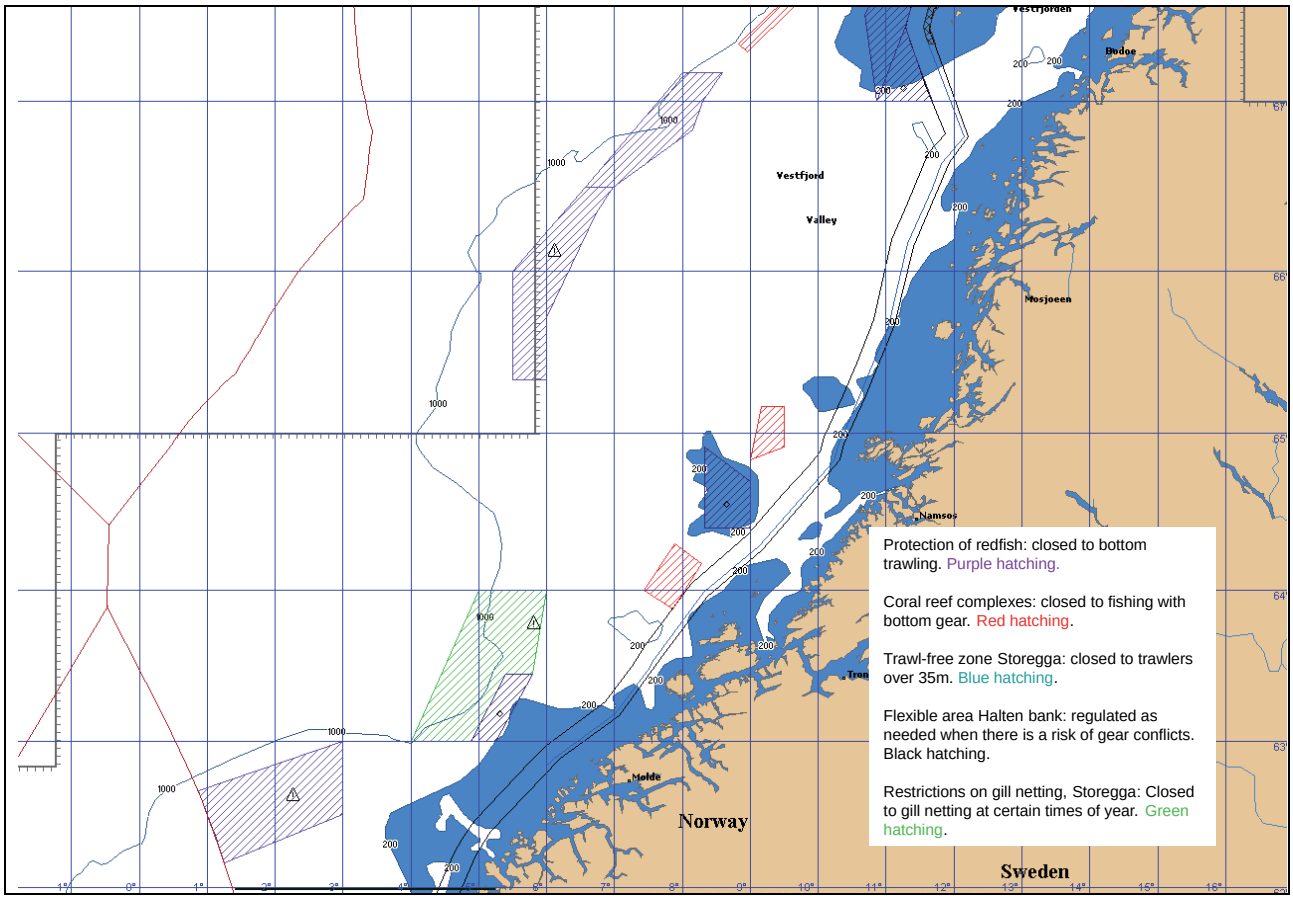

Figure 7.2 Marine spatial management in the fisheries sector in the Norwegian Sea

Source: Norwegian Institute of Marine Research

practice represent permanent protection. The Marine Resources Act continues and extends options for establishing marine protected areas as a tool in marine spatial management.

The following are some examples of spatial management by the fisheries authorities in the management plan area:

- prohibition against fishing for redfish with trawls in the Norwegian exclusive economic zone north of 62°N;
- establishment of «fjord lines», which define areas inside which fishing is restricted to protect coastal cod during the spawning period;
- opening and closure of fishing grounds to protect larvae and juvenile fish;
- trawl-free zones and flexible areas;
- the Marine Resources Act sets out a general duty to exercise special care during fishing operations near known coral reefs. In addition, there is a general prohibition against deliberate damage to coral reefs in all areas under Norwegian jurisdiction.

In addition, there are three specific areas in the management plan area (the Iverryggen, Røst and Sula reefs) where fishing using gear that is towed during fishing and may touch the seabed has been prohibited. This has been done to protect coral reefs against damage from fisheries activities.

7.2.3 Protection under environmental legislation

The Nature Conservation Act provides the legal basis for permanent protection of geographically defined areas against all activities that may have an impact on or damage the environment and natural resources. The Act applies to Norway's land areas, to lakes and rivers and to the waters out to the 12-nautical-mile territorial limit.

In the Nature Management Act, a separate category of protected area has been retained to make it possible to give permanent or temporary protection to geographically defined sea areas against all activities that may damage or destroy their conservation value. In addition, marine protected areas

may be established to safeguard valuable marine areas that are ecologically necessary for terrestrial species.

In addition, the Nature Management Act contains provisions on selected habitat types. The designation of selected habitat types is to be made by the Government (formally by the King in Council). The purpose is to ensure that these habitat types are managed sustainably. The provisions provide guidance for decision makers on the considerations that must be weighed up and the interests that must be safeguarded in managing selected habitat types.

The provisions on the protection of areas and on selected habitat types will apply out to the 12-nautical mile territorial limit. So far, only one purely marine protected area has been established under the Nature Conservation Act (Selligrunnen coral reef, Trondheimsfjorden). This has been temporarily protected as a nature reserve pending a final decision as part of the work on the national marine protection plan. Areas of sea are also included in many other protected areas that have not been established purely for marine protection purposes. These include a number of nature reserves established partly to protect seabirds or marine mammals, and landscape protection areas such as those in coastal areas within the management plan area.

For example, 205 km^2 of sea around the Froan archipelago off Sør-Trøndelag has been protected under the Nature Conservation Act to safeguard seals and seabirds. In Nordland and Troms, the protection needs of seabirds and marine mammals in the coastal zone are met through the integrated coastal protection plans adopted in 2002 and 2004 respectively. The coastal protection plan for Nordland includes 74 areas, the three largest of which are around the Helgeland skerries (southern Nordland), the Svellingsflaket area (inner Vestfjorden) and the Røst archipelago.

Protection plans for breeding seabirds in Nord-Trøndelag and Sør-Trøndelag were adopted in 2003 and 2005 respectively, and include a total of 32 areas. A protection plan for breeding seabirds in Møre og Romsdal is being drawn up for adoption in 2009. A protection plan for the Smøla archipelago in Møre og Romsdal was adopted in January 2009, and includes 10 protected areas covering a total area of 270 km^2, of which 188 km^2 is sea. Remman nature reserve, which includes a large area of undisturbed kelp forest, is particularly relevant to the Norwegian Sea management plan.

The Directorate for Nature Management is holding a public consultation on a proposal to protect Jan Mayen as a nature reserve. The proposed reserve includes the whole island except for the area along the east coast that is already being used for various activities, and a smaller area on the west coast, together with the surrounding territorial sea with the exception of a small area off Båtvika near the buildings on the east coast. The purpose of the proposed nature reserve is to preserve a virtually untouched Arctic island and contiguous areas of sea, including the seabed, with a distinctive landscape, active volcanic systems, a characteristic flora and fauna and many cultural remains. The protection regulations will not prevent the use of permitted harvesting gear in the sea, with the exception of gear for dredging molluscs. The proposal takes into account that it may be necessary to establish infrastructure to fulfil certain functions on Jan Mayen in connection with fisheries activities and if petroleum activities are initiated in the area between Jan Mayen and Iceland.

7.2.4 World heritage sites

The World Heritage Convention does not specify any clear commitments with regard to protection of cultural properties. However, according to Articles 3 and 5, parties to the Convention are obliged to identify and protect their cultural and natural heritage, although the convention says little about legal protection under national law. The Operational Guidelines for the Implementation of the World Heritage Convention list the requirements that must be met when a property is nominated for inscription on the World Heritage List. These include «adequate long-term legislative, regulatory, contractual, planning, institutional and/or traditional measures» to protect the property. There must also be a sound management plan or other management regime that safeguards the outstanding universal value of the property and ensures that it is not subject to development or changes that would have a negative impact.

A strict management regime is required for sites that are inscribed on the World Heritage List. Norway has therefore drawn up a management plan for the Vega Archipelago (the only World Heritage Site within the management plan area, see Box 4.4) for the period 2005–2010. Large areas of the seascape are shallow, with high species diversity and substantial biological and commercial resources. The decision to inscribe the property on the World Heritage List recommended that Norway should consider expanding the property to include a buffer zone consisting of islands and sea areas to the north and north-west.

7.2.5 Petroleum activities

While fishing activities are not subject to spatial restrictions unless these are specifically introduced for a particular area, the opposite principle applies to petroleum activities. Petroleum activities are not permitted in an area until the Storting makes a specific decision to open it for this purpose.

The Petroleum Act regulates the management of petroleum resources. It states the basic principle that a long-term approach must be taken to resource management, which will benefit Norwegian society as a whole. Section 3–1 of the Act requires that an area must be formally opened for petroleum activities before any activity is started. Proposals to open new areas are put before the Storting. An environmental impact assessment forms part of the basis for any opening process, as described in Chapter 2A of the Regulations relating to petroleum activities.

Acreage for petroleum activities is allocated through licensing rounds for immature areas, which are normally held every other year. In more mature areas, where more is known about the geology and that are closer to existing production infrastructure, blocks are allocated every year through the system of awards in predefined areas (APA). A public consultation has recently been held as part of the basis for an evaluation of the APA system during the first six months of 2009.

The Petroleum Act requires companies to draw up plans for development and operation (PDO) or plans for installation and operation of facilities (PIO) when new fields are developed or pipelines laid. Both types of plan consist of a development/installation part and an impact assessment. A public consultation is held on the impact assessment to ensure that all possible impacts of the project have been adequately assessed. The Ministry of Petroleum and Energy considers the plan and all responses received during the public consultation, and weighs up the different interests and considerations involved. Its conclusions are presented to other relevant ministries. A review of all responses received during the public consultation is published as part of the Ministry's proposal, which is sent either to the Storting or to the Government for further consideration (all projects with costs exceeding NOK 10 billion must be approved by the Storting). This ensures that the process is fully transparent. Once the Storting or Government has discussed the matter, the project can be approved, subject to any conditions laid down on the basis of their deliberations. Chapter 7 of the Petroleum Act governs liability for pollution damage, and Chapter 8 sets out special rules for compensation to be paid to Norwegian fishermen for any inconvenience arising from petroleum activities.

Parts of the Norwegian Sea have been gradually opened for petroleum activities since 1979. Within the management plan area, further deepwater areas in the Møre and Vøring Basins and western parts of Nordland IV and Nordland V were opened in 1994. The Storting also decided that the eastern parts of Trøndelag I, Nordland IV and Nordland V were not to be opened up for petroleum activities at that stage.

Restrictions on the times of year when seismic surveys and drilling in oil-bearing formations are permitted are other 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 may be particularly vulnerable, for example during spawning migration or spawning. These are well-established tools, and the restrictions apply to individual production licences.

7.3 Species and stock management

7.3.1 Fisheries management

The legal basis for fisheries management used to be the Seawater Fisheries Act, which was replaced by the Marine Resources Act from 1 January 2009. As mentioned previously, the Marine Resources Act introduces a principle for the management of wild living marine resources that involves considerably stricter requirements for ecological documentation. The practical implementation of fisheries management is illustrated by the regulatory cycle.

The regulatory cycle

Most fish stocks are harvested by vessels from several different countries. This means that international negotiations are needed to determine each country's quotas.

- At the beginning of the regulatory year, relevant authorities and organisations meet to give their input to the Ministry of Fisheries and Coastal Affairs before terms of reference for the international negotiations are drawn up.
- The International Council for the Exploration of the Sea (ICES) publishes scientific advice that forms the basis for international negotiations.

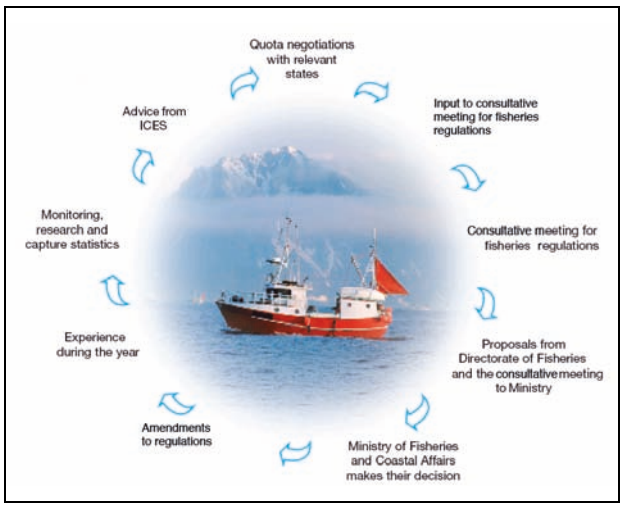

Figure 7.3 The regulatory cycle

Source: Ministry of Fisheries and Coastal Affairs

- Negotiations on management measures are conducted with relevant countries, focusing on determining total allowable catches (TACs) for stocks that occur in the exclusive economic zones of several countries or in international waters.
- The TACs are then split between the parties through international fisheries negotiations, which take place in October, November and December each year.
- The quotas Norway is allocated during the international negotiations form the basis for regulation of the Norwegian fisheries in the subsequent year.
- The Directorate of Fisheries draws up proposals for quota regulations which are discussed at a consultative meeting. Ordinary public consultations are held on certain issues. On the basis of these processes, the Directorate sends draft regulations to the Ministry of Fisheries and Coastal Affairs, which adopts the quota regulations.
- The national quota regulations apply for one calendar year at a time, but may be amended in the course of the year. As far as possible, structural changes in the regulation of a fishery are made during the preparations for the next year's regulatory measures, but amendments such as changes in quotas, provisions on bycatches, changes in quotas for specific periods, closure of areas, etc., may be made during the year.

The overall regulatory cycle is illustrated in Figure 7.3.

In addition to the annual quota regulations, Norway has a number of national and local regulations that are not time-limited. These include provisions on the use of gear, types of gear, mesh sizes, and so on.

Regulation of fishing with bottom gear

The use of all trawls, including bottom trawls, is completely prohibited in areas less than 12 nautical miles from the baseline unless specific exceptions have been made. Any exceptions must be based on an evaluation of the types of management measures that are necessary to ensure sustainable management. Large sea areas outside the 12-nautical-mile limit are also closed to trawling all year round. In addition, further areas are closed at times of year when biological considerations make this necessary, for example if the risk of taking fish below the minimum size or of excessive bycatches is too high.

To protect coral reefs from damage resulting from fisheries activities, the fisheries authorities have also imposed a complete prohibition against deliberate damage to coral reefs in all areas under Norwegian jurisdiction. This means that it is not permitted to use gear that will damage corals near known coral reefs. There is also a requirement to exercise special care during fishing operations near known coral reefs. Five specific coral reef areas are specially protected against fishing with bottom trawls and other gear that is towed along the seabed during fishing.

In accordance with guidelines drawn up by FAO, the North East Atlantic Fisheries Commission (NEAFC) has adopted rules to protect specific coral reefs and other vulnerable ecosystems. These prohibit fishing with bottom trawls and other gear that is towed along the seabed. They also apply to other types of gear that can damage the seabed, such as gill nets and longlines.

NEAFC has also decided, in accordance with FAO guidelines, that bottom fisheries in new areas are to be considered as experimental fisheries, and must comply with restrictive rules and reporting requirements. Strict rules for fishing operations and reporting have also been adopted for areas that have been trawled previously, to avoid damage to benthic habitats.

According to these rules, which Norway has implemented for Norwegian vessels, a vessel must always stop fishing if it comes into contact with a possibly vulnerable deep-water habitat. This rule applies not only to corals, but also to other indica-

tors of vulnerable habitats. In such cases, the vessel must change position and report the incident.

These rules will also be made applicable in Norway's exclusive economic zone, so that the same rules apply to Norwegian fishing vessels regardless of where they are fishing. Using the NEAFC rules as a basis, the Ministry of Fisheries and Coastal Affairs has therefore started to draw up similar legislation for Norwegian waters.

Safe seafood

The fisheries authorities are also responsible for the safety of seafood. These responsibilities are met through controls at sea and when catches are landed, organised by the Directorate of Fisheries, and through hygiene and quality controls by the Norwegian Food Safety Authority.

Marine mammals

Norway has traditionally exploited the minke whale stock, and much of the catch is taken in the area covered by the present management plan. The Scientific Committee of the International Whaling Commission (IWC) has developed a system called the Revised Management Procedure for calculating catch quotas for all baleen whale stocks. The Norwegian quota is based on this system and set by Norway.

7.3.2 Wildlife management

The Wildlife Act applies to all wild species of terrestrial mammals and to birds including seabirds. According to the Act, wildlife and wildlife habitats must be managed in such a way that ecosystem productivity and species diversity are maintained. Within this framework, wildlife may be harvested in the interests of agriculture and outdoor recreation. During any activity, consideration shall be shown to wildlife species and their eggs, nests and lairs to avoid any unnecessary suffering or injury. All wildlife species are protected unless otherwise provided. Hunting seasons for specific species are set by the Directorate for Nature Management.

7.3.3 Management of endangered and vulnerable species

The loss of marine biodiversity may limit the capacity of the seas to produce food, maintain good water quality and withstand change.

Norway has signed a number of conventions on species protection and management, see Box 2.4. The Convention on Biological Diversity provides the general framework for these efforts, and proposals and decisions on which species should be given special protection are made under the regional and global nature conservation conventions, primarily the Bern, Bonn and CITES Conventions. The environmental authorities cooperate closely with other sectoral authorities on work under these agreements and on their implementation at national level.

Norwegian Red List

The 2006 Norwegian Red List was drawn up by the Norwegian Biodiversity Information Centre, and for the first time, it included systematic assessments of marine species. The Red List is drawn up using the criteria developed by the International Union for Conservation of Nature (IUCN). The criteria have been developed to make it possible to classify species as realistically as possible according to the risk of global extinction. In 2007, the Norwegian authorities asked ICES to evaluate how suitable the IUCN criteria are for assessment of marine fish species. The need to evaluate the criteria is illustrated by the fact that both sandeels and Norway pout are included on the 2006 Red List, but fishing for both species was permitted in 2008 on the basis of advice from ICES.

Fewer species and populations have been classified as vulnerable or endangered in the marine environment than in fresh water and on land. This may be partly due to the ecological conditions in Norwegian marine areas, where for example many species have larvae that are free-swimming in the water column. There are also relatively few habitat types that combine distinctive qualities with limited extent and distribution. On the other hand, the low proportion of red-listed species in the marine environment may also be due to methodological problems. We have only limited information on species diversity, distribution and population changes for many groups of marine species that are not used commercially. Knowledge of genetic variation within species, for example the existence of local or regional populations, is very limited for both commercial and non-commercial species.

If evidence indicates that a species with a negative population trend is or may be at risk of extinction if the trend continues, it is listed as critically endangered, endangered or vulnerable on a national red list.

The 2006 Norwegian Red List includes 36 species or stocks of marine fish that occur in the management plan area. The European eel and spiny

dogfish have been classified as critically endangered (CR), while coastal cod north of 62° N is classified as endangered (EN). Eleven of the red-listed bird species found in the management plan area are associated with marine environments. The common guillemot and lesser black-backed gull (subspecies *Larus fuscus fuscus*) are considered to be critically endangered (CR), and the Slavonian grebe is endangered (EN). The puffin, kittiwake and Steller's eider are all considered to be vulnerable (VU).

Ten species of mammals (nine whales and seals and the polar bear) that occur or have occurred in the Norwegian Sea are also included on the Red List. The North Atlantic right whale is the only species that is regionally extinct (RE) in Norwegian waters. The bowhead whale is categorised as critically endangered (CR), the hooded seal as vulnerable (VU) and the blue whale as near threatened (NT).

In addition, Norway has special responsibility for several of the species that occur in the management plan area. The Directorate for Nature Management is drawing up action plans for endangered species of seabirds in Norway.

The fisheries authorities are reviewing which marine species and stocks need to be monitored and managed particularly carefully. Their work is based partly on the 2006 Norwegian Red List. Species that are relevant here include lobster, eel and coastal cod (see Table 7.1).

Table 7.1 Directorate of Fisheries' plans for monitoring and managing species and stocks in accordance with the management principle set out in the Marine Resources Act. Priority list as of January 2009

Species/stock	Comments
Coastal cod north of 62° N	Working group appointed by Ministry of Fisheries and Coastal Affairs, report due at the end of 2009. Wide-ranging measures already implemented, including establishment of «fjord lines». Inside these, only vessels under 15 m using passive gear are permitted to fish cod.
Lobster	Stricter regulatory measures introduced in 2008. Important to evaluate their effect after they have been in force for some time.
Eel	Working group appointed by Director of Fisheries presented a report with recommendations for measures to improve management on 15 October 2008. Consultation in progress on the report, time limit for comments 15 February 2009.
Sandeel	Relatively stationary key species in the North Sea ecosystem. Changeover to spatial management is being evaluated.
North Sea cod and coastal cod south of 62° N	Director of Fisheries is evaluating measures for coastal cod south of 62° N on the basis of a report from the Institute of Marine Research.
Redfish (*Sebastes marinus* and *S. mentella*)	Year-round prohibition against directed trawl fishery for these species. NEAFC has adopted restrictions on fishing in international waters in the North Atlantic. Close seasons introduced for fishing with conventional gear (coastal fleet). These measures are evaluated annually.
Halibut	Stock increasing, especially in the north. North of 62° N, closure in the spawning season (20 December–31 March) for bottom gear (gill nets, trawls, Danish seines, etc.).
Blue ling	Introduction of measures being evaluated in 2009.
Basking shark	Directed fishery prohibited since 2006.
Spiny dogfish	Directed fishery prohibited since 2007, except for coastal vessels under 28 m in length.
Porbeagle	Directed fishery prohibited since 2007.

Source: Directorate of Fisheries

7.4 Pollution

Preventing and reducing pollution in the Norwegian Sea and thus ensuring that the marine environment is as pollution-free as possible is an essential basis for maintaining species and habitat diversity and value creation, for example in the fisheries. The key legislation in this field, and an important instrument for achieving these goals, is the Pollution Control Act and appurtenant regulations. The Act lays down a general prohibition against all activities that may entail a risk of pollution, unless exceptions are set out in the Act itself, in regulations or in individual permits. Discharge permits issued to individual enterprises (both land-based industry and the offshore petroleum industry) under the Pollution Control Act set out requirements limiting the quantities of pollutants they may release.

As a «downstream» country, Norway is to a large extent a recipient of pollutants both from the rest of Europe and from other sea areas. Long-range transport of pollutants with air and ocean currents also has a considerable impact on the Norwegian Sea. Norway has played an active part in the development of a number of international agreements of importance for the marine environment. Requirements to make use of the best available technology (BAT) and best environmental practice (BEP) are important principles in Norwegian pollution legislation, international agreements and EU legislation.

International law relating to chemicals and long-range air pollution is also highly relevant in connection with efforts to maintain the state of the environment in the management plan area. These rules have been considerably strengthened in recent years with the entry into force of several important agreements. Key conventions include the Stockholm Convention, which regulates the twelve most dangerous persistent organic pollutants (POPs) and the Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, both of which entered into force in 2004. The comprehensive new EU chemicals legislation (REACH – Registration, Evaluation, Authorisation and Restriction of Chemicals) has been incorporated into the EEA Agreement and was implemented in Norwegian law in 2008. Moreover, two new protocols on POPs and heavy metals under the ECE Convention on Long-range Transboundary Air Pollution (LRTAP) entered into force in 2003. The Convention on Climate Change, the Kyoto Protocol, and the international agreements on emissions of NO_x, SO_2 and VOCs are also relevant in this context. The white papers on the Government's environmental policy and the state of the environment in Norway describe developments in this legislation.

The new Maritime Safety Act, which entered into force in 2007, takes the same approach as the Pollution Control Act and sets out a general prohibition against pollution from ships. It also provides the authority to lay down regulations specifying what is considered to be pollution in this connection. It thus provides the legal authority to regulate releases of organisms from ships with ballast

Box 7.5 What is BAT?

In 1996, the EU adopted a directive on integrated pollution prevention and control (the IPPC Directive, Directive 96/61/EC, now replaced by Directive 2008/1/EC). The purpose of the directive is to coordinate the regulation of all releases of pollutants to air, water and soil, so that a particular installation needs only one permit, issued by a single authority. This is a way of achieving more integrated evaluation and control of the overall pollution from an installation, and thus better protection of the environment. The Directive has been incorporated into the EEA Agreement. In Norway, existing provisions in the Pollution Control Act had already met most of the requirements of the Directive, but the Pollution Regulations nevertheless include a chapter that implements the requirements more fully.

One important principle introduced in the IPCC Directive was that operators must as a general rule make use of the «best available techniques», or BAT. Emission limits set in a permit must be based on the application of BAT. The European Commission is responsible for obtaining information that can be used to draw up BAT Reference Documents (BREFs), which describe what is considered to be BAT in specific sectors. These are primarily intended for use by national authorities and industry. BREFs are drawn up by the European IPPC Bureau (EIPPCB), which is located within the European Commission's Joint Research Centre in Seville, with the assistance of technical working groups. A working group including representatives of the authorities and the relevant sector is set up for each BREF.

water, and is in line with the International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Convention). This was adopted in 2004, and Norway played a key role in its development. The Norwegian Maritime Directorate has recently held a public consultation on draft regulations to implement the Convention in Norwegian law, and these are expected to be adopted in the near future. International law relating to shipping is further described in 7.5.3 below.

7.5 The risk of acute pollution and risk-reduction measures

No human activity can be carried out entirely without a risk of unforeseen incidents. To achieve the Government's goals as set out in this management plan, it is therefore essential that risk analyses are conducted for commercial activities. The goal is to reduce the risk of adverse impacts on the environment as much as possible, primarily through preventive measures. In addition, the Government considers it important to ensure that there is an emergency response system in place that can prevent adverse environmental impacts in the event of an accident – or if this is not possible, reduce them as far as possible.

7.5.1 General discussion of risk and risk analysis

Risk

Risk identification requires an understanding of possible accident scenarios and their consequences. An understanding of risk is an essential basis for implementing effective measures to prevent accidents and establishing an appropriate emergency response system. In the Norwegian Sea this is particularly important with respect to the petroleum industry and maritime transport. Risk is not static, but changes over time along with factors such as traffic developments, implementation of measures. introduction of new technology, development of new working methods, updating of legislation and follow-up activities initiated by the industry and by the authorities. Historical data and incidents provide important information for an assessment of future developments, but they must not be used uncritically.

All risk-based decisions involve some uncertainty. It is therefore important to be open about the limitations of risk analyses and their results, and to provide information about opportunities for reducing uncertainty, for example by applying the precautionary principle, the cautionary principle or the substitution principle, or through research and development.

Risk analysis and risk management

Risk analysis is an integral part of risk management, and includes both quantitative and qualitative tools. Risk analyses are based on assumptions and evaluations, supported to a varying degree by knowledge, scientific methods, experience and

Box 7.6 Key concepts related to risk

Risk: The risk associated with an activity is a combination of the probability of an event occurring and the consequences of the event. It can be expressed both quantitatively and qualitatively.

Environmental risk: Defined in the same way as risk generally, but only environmental consequences are considered.

The environmental risk associated with an activity is a combination of the probability of an event occurring and the consequences of the event in the form of:

1. damage to the environment (releases of pollutants, oil spills, etc.) or
2. loss of/damage to specific resources (populations, species, etc.) and
3. any secondary consequences resulting from 1 and 2.

Environmental risk = Probability x Consequence

Probability: Likelihood of an event or frequency of spills (recurrence interval).

Consequence: The effects of an event on the natural environment and society. Consequence is the product of the value assigned to a parameter/variable (for example a spawning stock) and the impact of the event on this parameter.

Risk-reduction measures: Measures to reduce the probability or consequences of an accident. Measures to reduce probability (preventive measures) should be given higher priority than measures to reduce consequences.

Source: Forum on Environmental Risk Management, ISO Guide 73, and MIRA environmental risk assessment method (Norwegian Oil Industry Association).

future expectations. A number of recognised accident models have been developed, based on analyses of historical data. They show different mechanisms behind accidents, and it is necessary to recognise that every activity is unique, complex and constantly evolving. This in turn means that one model for risk assessment cannot cover all factors of importance for preventing accidents, and that using several models and approaches is an essential part of risk management.

Understanding how accidents happen is crucial for understanding and managing risk. Risk analysis is a tool for dealing with uncertainty and identifying where risk reduction measures are needed and possible to implement. However, risk analysis cannot determine with any certainty how many accidents will occur in the future, or precisely what their consequences will be. It is therefore essential to know what a risk analysis is based on and communicate this information, and to be aware of the inherent limitations of such analyses. This will clarify what opportunities are available for reducing risk so that activities can be carried out more safely.

Risk management in the management plan area must be based on an integrated model for analysing and managing the risk of acute pollution. The Forum on Environmental Risk Management for the Barents Sea–Lofoten area has developed a general model for integrated management of environmental risk. The model (Figure 7.4) shows where steps can be taken to reduce the risk of acute pollution to the lowest possible level, either through preventive measures or by means of an appropriate emergency response system adapted to the vulnerability of an area and other regional characteristics.

7.5.2 Petroleum activities: legislation and risk management

The oil companies on the Norwegian continental shelf (licensees) have the primary responsibility for preventing and dealing with any acute pollution

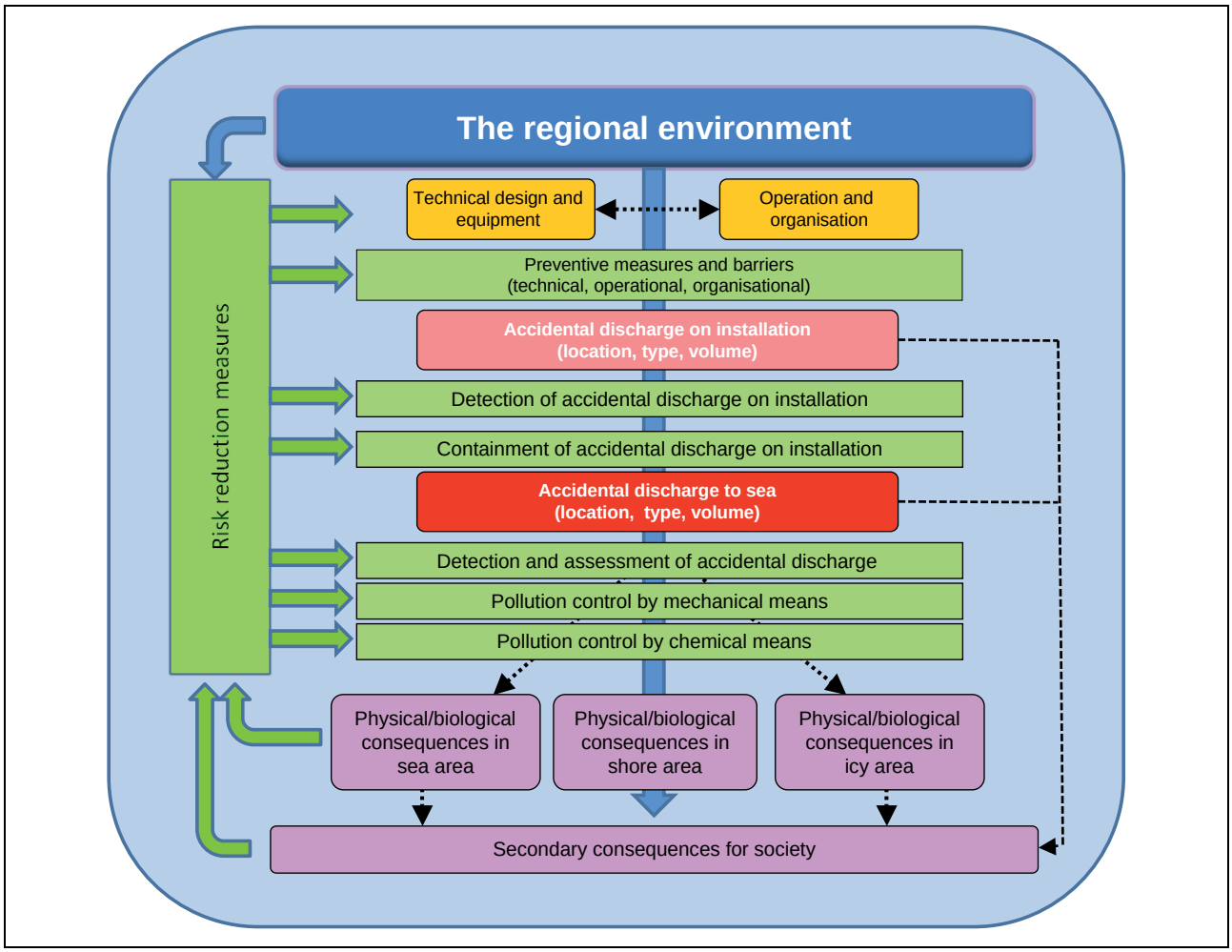

Figure 7.4 Model for integrated environmental risk management drawn up by the Forum on Environmental Risk Management for the Barents Sea–Lofoten area

Source: Forum on Environmental Risk Management

Box 7.7 Responsibilities of the public authorities

The Petroleum Safety Authority Norway is responsible for ensuring compliance with rules relating to technology, operations, organisation and management of petroleum activities to prevent accidents that may lead to oil spills. In addition, the legislation requires companies to take steps to deal with any accidents at source (e.g. using well control equipment) in order to minimise pollution in the event of an unforeseen incident. The Petroleum Safety Authority is also responsible for ensuring compliance with requirements on preventive measures against incidents and accidents that may threaten human life and health and on working environment standards. Such measures often help to prevent spills and other accidents as well.

The Norwegian Pollution Control Authority is responsible for legislation on requirements to report releases of pollutants, remote sensing measurements, analysis and testing of oil and chemicals, testing of emergency response equipment, and emergency response systems for acute pollution. Based on assessment of a specific activity, the Authority may lay down requirements for the emergency response that are additional to those set out in the health, safety and environment (HSE) regulations.

The Petroleum Safety Authority and the Norwegian Pollution Control Authority are jointly responsible for the HSE regulations, and cooperate on processing applications for approval and licences, supervisory activities, development of legislation and so on. There are also cooperation agreements between the Petroleum Safety Authority and the Norwegian Maritime Directorate and between the Authority and the Norwegian Coastal Administration. The agreements facilitate practical cooperation between the private and governmental emergency response systems, and make it easier to deal with conflicts of interest between petroleum activities and shipping. The Norwegian Coastal Administration is the supervisory authority for oil spill response operations run by the petroleum industry.

from their own activities. Comprehensive legislation and control and enforcement procedures have been drawn up to ensure optimal management of the possible impacts of petroleum activities on the environment and of any problems this could cause for other industries.

The Petroleum Act, the Pollution Control Act and the HSE regulations for the oil and gas industry apply from the time when an area is opened for petroleum operations. The HSE regulations were adopted under the Petroleum Act, the Working Environment Act, the Pollution Control Act and the health legislation, and the supervisory authorities are the Petroleum Safety Authority Norway, the Norwegian Pollution Control Authority and the Norwegian Board of Health. A white paper on health, safety and environment in the petroleum industry (Report No. 12 (2005–2006) to the Storting) set out the goal of making the Norwegian petroleum industry a world leader in this field. The petroleum industry is to be at the forefront of developments, with a clear focus on quality, knowledge and constant improvement.

The HSE regulations are risk-based, which means that safety and emergency response systems must be dimensioned in accordance with the specific risks involved in each activity. This ensures that systems for preventing acute pollution and the oil pollution emergency response system are adapted to the characteristics and location of an activity. Under the regulations, characteristic features of different parts of the management plan area will also have to be taken into account in risk management, for example stricter requirements can be imposed in vulnerable areas. The industry may therefore incur considerably higher costs in

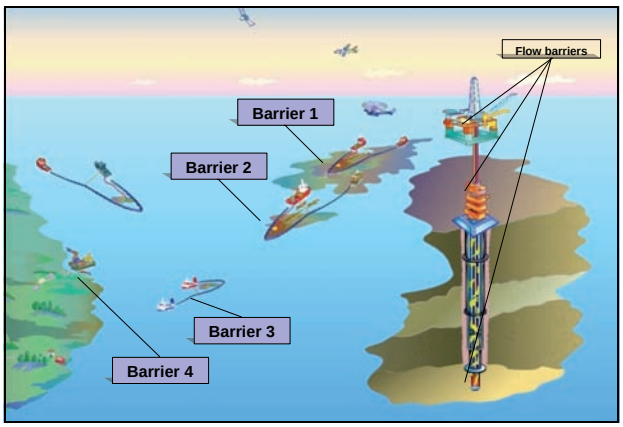

Figure 7.5 Well barriers to reduce the risk of spills (drilling mud, blowout preventer (BOP), redundant valves, open drainage system to collect any oil spilt on the platform), and to limit the release of oil in the event of a spill (emergency response system)

Source: Norwegian Oil Industry Association

connection with activities in vulnerable areas for technological development, both for building knowledge and expertise and in the form of higher operating costs, even if the legislation remains unchanged. Strict regulation and control of the petroleum industry are important in preventing oil spills and minimising their impact.

Furthermore, the HSE regulations build on a general system for assigning responsibility and principles of risk management to ensure sound and responsible operations in all phases of petroleum activities. Licensees, operators and contractors are all responsible for planning and control of risk management in different phases. In addition to the authorities' inspection and enforcement responsibilities, there is a statutory requirement for the actors in the industry themselves to maintain an internal control system.

The HSE legislation does not generally specify particular solutions, but sets out functional requirements, leaving each actor responsible for developing or using solutions that provide adequate safety standards. The overall goal is for solutions for meeting the functional requirements to be adapted to the specific risks in each case, taking into account the form of organisation and technical solutions chosen, the operations to be carried out, the location of these operations and so on. A key principle is that it must not be possible for one isolated fault or error to result in an accident. This means that more than one barrier must be used to reduce the probability of escalation as a result of an error, hazard or accident, and to limit the damage and nuisance that may result from such situations. The concept of barriers is of key importance in efforts to minimise the risk of oil spills and environmental damage. As a general principle, at least two independent barriers must be used in any situation where there is a risk of oil spills. These may be physical barriers or other measures to reduce the risk of spills or to limit the size of a spill in the event of an accident.

Strict regulation and an effective inspection and enforcement system for petroleum activities are important in preventing acute oil spills and minimising their impact. Risk management is necessary at all stages, from planning to decommissioning, and requires actors to analyse their own activities in detail and to update the analyses if the assumptions on which they are based change. The HSE legislation is therefore an important tool for ensuring that operations meet adequate safety standards in environmentally vulnerable areas as well.

Environmental standards for the petroleum industry, both general requirements and requirements applying to specific installations, are set under the Pollution Control Act, the Petroleum Act and regulations under these acts. Under the Pollution Control Act, operators must hold permits for the use and release of chemicals, injection, and emissions to air. General requirements have also been laid down in connection with the zero-discharge targets for the oil and gas industry. These apply to oil, chemical additives and naturally-occurring substances discharged with produced water.

The emergency response requirements that apply to petroleum activities are discussed in 7.5.4 below.

7.5.3 Shipping: legislation and risk management

Like the petroleum industry, the shipping industry is subject to comprehensive legislation and to control and enforcement procedures to ensure that environmental impacts are dealt with as effectively as possible. The legislation is constantly evolving. In addition, the Government attaches importance to enhancing safety at sea through preventive measures, including both maritime infrastructure and services. The Norwegian Maritime Directorate is an administrative agency under the Ministry of Trade and Industry, and under the Ministry of the Environment in cases concerning pollution from ships and protection of the marine environment. It plays a key role in ensuring maritime safety in a clean environment.

The Ministry of Fisheries and Coastal Affairs is responsible for safeguarding Norway's interests as a coastal state, and does so by promoting maritime transport within safe limits. Preventive measures are the most important aspect of this work. In the event of an accident, an emergency response system with sufficient resources to prevent or limit negative environmental impacts must be in place. The interests of coastal states are important in the development of the international framework in this field. Norway is playing an active part in developing routeing measures to reduce risk, strengthening traffic surveillance and developing new electronic navigation aids and oil pollution emergency response systems.

A white paper on maritime safety and the oil spill response system (Report No. 14 (2004–2005) to the Storting) presented an environmental risk analysis of predicted developments in maritime transport. It also recommended measures to address the challenges that are likely to arise with

the expected increase in the volume of maritime transport along the Norwegian coast. The analysis showed that the risk of environmental damage within specified geographical areas will increase in the years ahead unless further preventive and response measures are implemented. The white paper's recommendations relating to maritime safety and the oil spill response have been or are being followed up. More lessons have been learnt from internal and external evaluations of incidents such as the *Rocknes* and *Server* accidents, and the Government is focusing on regular evaluations and on introducing new measures when new needs are identified.

International developments

The shipping industry is international in nature. The framework conditions for safe, environmentally sound and efficient transport are therefore largely laid down at international level, and shipping is regulated to a large extent in international law. International rules thus provide an important framework for how Norway can regulate maritime transport in the Norwegian Sea. There is an international trend towards increasingly stringent environmental standards, with Norway playing a leading role. The general requirements relating to ships and crews following from international law apply to all vessels regardless of where they are. Flag states are required to inspect their own ships and ensure that they comply with the rules. Norway also inspects foreign ships that call at Norwegian ports (port state control).[1] The Norwegian Maritime Directorate is responsible for such inspections. Port state control is carried out in accordance with the Paris Memorandum of Understanding of Port State Control (Paris MOU), which applies to 25 coastal states in Europe and Russia and Canada, and requires each country to inspect 25 % of all ships that call at its ports over a three-year period.

The International Maritime Organization (IMO) is responsible for developing an international regulatory framework for shipping. In the present context, the most important instruments are the International Convention for the Safety of Life at Sea (SOLAS) and the International Convention for the Prevention of Pollution from Ships (MARPOL).

Since the *Erika* and *Prestige* accidents, the EU has adopted three legislative packages to strengthen maritime safety. The third maritime safety package was presented in November 2005, and includes seven key measures to improve the European maritime safety regime. These deal with rules for flag states and classification societies, traffic monitoring in the EU, the port state control regime, and requirements relating to compensation to passengers, shipowners' liability and accident investigation. In addition, the international legal framework for liability and compensation for damage caused by oil pollution from ships has been considerably strengthened in recent years. New limits for compensation and the establishment of funds also apply to accidents in Norwegian sea areas.

The UN Convention on the Law of the Sea lays down the general principle of freedom of navigation outside territorial waters, but also provides for regulation of shipping on the grounds of maritime safety and environmental protection. Under IMO rules, mechanisms have been developed making it possible for coastal states to regulate maritime transport outside their territorial waters, in their exclusive economic zones. Some of the international processes that can be followed to meet special needs are as follows:

- A sea area may be classified as a Special Area (SA) under the MARPOL Convention. Stricter rules apply to the discharge of chemicals, oil and waste in an SA. Guidelines have been drawn up for applications for SA status. The North Sea, parts of which are under Norwegian jurisdiction, currently has Special Area status under Annexes 1, 5 and 6 of the Convention (prevention of pollution by oil, prevention of pollution by garbage and SO_x emission control).
- Establishing routeing systems in areas outside their territorial waters for safety and environmental reasons. Norway has established a traffic separation scheme between Vardø and Røst in North Norway.
- Designation of a sea area as a Particularly Sensitive Sea Area (PSSA). These areas are marked as such on international navigation charts. An application for PSSA designation should also include a proposal for protective measures, for example navigational measures such as traffic separation schemes, areas to be avoided and/or reporting requirements. After an evaluation of the question, no Norwegian sea areas are currently designated as PSSAs.

[1] Port state control is also becoming an increasingly important tool in fisheries control. A distinction is often made between port state measures (PSM) and port state control (PSC). Inspections of fishing vessels are known as port state measures.

Applications for these designations are assessed separately, and the designations are not mutually exclusive.

Preventive measures – maritime infrastructure and services

Norway is promoting maritime transport within the framework of a sustainable maritime policy. A framework for maritime safety that minimises the risks to people and the environment is an essential basis for sustainable maritime transport. It must include both preventive measures and an emergency response system to deal with any accidents that do happen. Maritime transport is an international industry, and globally applicable rules are in Norway's interests. The legal framework should therefore preferably be developed by IMO. In Europe, a stronger focus on the interests of coastal states was developed during the 1990s, partly in response to several serious accidents in European waters.

Norway has implemented a comprehensive range of maritime safety measures in its coastal waters by establishing and operating maritime infrastructure and services to reduce the likelihood of incidents and accidents at sea. The maritime infrastructure consists of lighthouses, buoys, signs and the physical improvement of channels to keep them clear and safe. Maritime services include the pilot service, traffic surveillance and control by the Norwegian Coastal Administration's vessel traffic service centres, electronic navigation aids, charts and notification and information services (information about ice, wave conditions, currents and navigation), and various forms of local regulation, such as restrictions on traffic in the dark and in poor visibility.

There is a growing focus on traffic regulation and surveillance and reporting systems as key accident prevention measures for maritime transport.

- *SafeSeaNet (SSN)* is a European electronic notification and information system for shipping, and is important in terms of both maritime safety and emergency response. Norway has established the system at national level, and is playing an active part in its development in the EU and the European Maritime Safety Agency (EMSA).
- *The Long-Range Identification and Tracking (LRIT)* system is based on satellite tracking, and has been established as part of IMO's work on maritime safety and antiterrorism measures. LRIT will be a global system, and is to be operative by summer 2009. According to plan, Norway will be linked to the EU LRIT Data Centre, and will be able to make use of LRIT data in connection with traffic surveillance, for search and rescue purposes, and in connection with environmental and natural resource management.
- *Regulations on the traffic separation scheme between Vardø and Røst* entered into force on 1 July 2007. They require tankers of all sizes and other cargo ships of 5 000 tonnage and upwards to sail about 30 nautical miles from land. There are two traffic lanes for shipping in opposite directions, and a separation zone between them. The Government is continuing its work with a view to establishing further routeing measures off the coast of Southern and Western Norway.
- *The Norwegian Coastal Administration's vessel traffic service centres* in Horten, Brevik, Kvitsøy, Fedje and Vardø play a part in preventing hazardous situations and accidents and are an important part of the Coastal Administration's operative system for oil pollution response. The centres can also use automatic identification system (AIS) data for surveillance of high-risk vessels sailing along the coast. Infrastructure for AIS coverage of Norwegian waters was established along the entire coast out to about 30 nautical miles from land in 2005. AIS data enables the vessel traffic service centres to identify drifting ships and to notify the tugboat service if assistance is needed, even before such ships take contact themselves. It is therefore important to ensure adequate emergency tugboat services. In North Norway, a government service has been established, since the private service is not considered to be adequate. In the management plan area, there is more commercial activity, and the available private tugboat service is considered to be sufficient. Among other things, there are tugboats used in connection with the offshore industry, and these have a duty to provide assistance in emergencies. This system results in more flexible use of the available resources. AIS transmitters and receivers on board vessels combined with other electronic navigation instruments can also reduce the number of ship collisions.
- *The Norwegian Coastal Administration works closely with the Norwegian Defence Forces* on surveillance and rapid response to prevent incidents involving vessels from causing acute pollution. The two agencies exchange AIS data

and other surveillance data. Naval vessels, particularly Coast Guard vessels, are important for the Coastal Administration in operations to deal with vessel emergencies, both because they can provide tugboat capacity and because they can be used for on-scene command. Many Coast Guard vessels also carry oil spill recovery equipment supplied by the Coastal Administration. If the Coastal Administration is unable to assume immediate command of a recovery and clean-up operation, an agreement between the two agencies ensures that the Defence Forces' coastal emergency response and on-scene command can take immediate measures on behalf of the Coastal Administration until the latter can take command.

The Coastal Administration and the Norwegian Maritime Directorate have a cooperation agreement on dealing with shipping accidents that entail a risk of acute pollution, whereby the Directorate provides maritime and technical expertise on a round-the-clock basis.

7.5.4 Emergency response system for acute pollution

Organisation and responsibilities

Norway's emergency response system for acute pollution consists of three parts – private, municipal and governmental services. The Pollution Control Act assigns the main responsibility for maintaining an emergency response system to private enterprises. Emergency response systems must be in reasonable proportion to environmental risk and must be able to deal with acute pollution from the enterprise's own activities. The Norwegian Pollution Control Authority has set special requirements for enterprises that represent a risk of acute pollution, including petroleum companies, tank farms, refineries, and land-based enterprises that handle environmentally hazardous chemicals.

In the petroleum sector, the Norwegian Clean Seas Association for Operating Companies (NOFO) has been made responsible for maintaining the required oil spill emergency response system and dealing with any oil spills on the Norwegian continental shelf on behalf of the operating companies. In the event of an accident, the Coastal Administration will make equipment available to NOFO under an agreement between them, and is also responsible for supervising the oil spill operation. Private emergency response organisations like NOFO have a statutory duty to assist the government. The HSE regulations also set out requirements for coordination of private and public emergency response resources. NOFO has established regional plans on behalf of its members, which include both the ocean-going response and the near-shore and shoreline response.

The municipal emergency response system is based on risk assessments of normal activities in each municipality. The country is divided into 34 regions, each administered by an intermunicipal acute pollution control committee. The intermunicipal system is dimensioned to deal with smaller spills, but also has a duty to take action whenever spills are not dealt with by the private sector.

The governmental emergency response system is a supplement to private and municipal services, designed to deal with major spills from ships or unknown sources and the risk of such spills. The Coastal Administration is responsible for running and developing the governmental emergency response system for acute pollution, including the personnel involved in response operations. If a recovery and clean-up operation is run by the polluter or at municipal level, the Coastal Administration is the supervisory authority. If the private or municipal response system is not adequate, the Coastal Administration can take over part or all of the responsibility for running the operation. In such cases, private, municipal and government bodies cooperate under the command of the Coastal Administration. The Coastal Administration also has agreements with other authorities and organisations on assistance in response operations.

The oil pollution emergency response system

Response equipment in the management plan area is provided by the Coastal Administration (five depots) and NOFO (five depots). The depots contain equipment for oil spill response operations at sea and in coastal areas, including booms, skimmers, workboats, pumps and generators. In addition, several of the Coast Guard vessels carry oil pollution response equipment on board. In the event of an operation, equipment from other depots along the coast can also be deployed if necessary. The intermunicipal acute pollution control committees can also provide resources for oil spill response operations. Thirteen of them are responsible for areas bordering on the management plan area. The committees mainly have lighter equipment designed for use along the shoreline and in coastal waters, and personnel resources that can be deployed in the initial phase of shoreline clean-

Box 7.8 Oil spill response operations

Notification procedures

- The rescue coordination centres, coastal radio services, Norwegian Defence Forces, Petroleum Safety Authority Norway and emergency telephone services have effective routines in place for notifying the Coastal Administration if an accident results in acute pollution or a risk of acute pollution. The Coastal Administration's hotline is manned round the clock. The vessel traffic service centres and the pilot service can also receive notification of accidents involving acute pollution or a risk of acute pollution.

The Coastal Administration: routines when notified of an incident

- The Emergency Response Department in Horten rapidly mans its operation centre with the team(s) that are on call. Procedures have been established for cooperation with other government authorities, municipal authorities and private actors.

Priorities

- The general priorities for operations are 1) human life and health, 2) the environment and 3) business interests.
- There is an established system for setting priorities between environmental resources under point 2.
- The aim is not necessarily to recover as much oil as possible, but to protect priority environmental assets as effectively as possible. If possible, steps are taken to prevent the release of oil or other pollutants into the marine environment. In the event of a spill, the goal is to deal with it as near to the source as possible.

Cooperation on oil spill response operations

- In addition to personnel from the Coastal Administration (who can provide operational, maritime, nautical and environmental expertise), other relevant authorities, the insurance company used by the responsible party and other experts are drawn into operations. The Norwegian Maritime Directorate provides maritime and technical advice for the Coastal Administration during operations and when there is a risk of acute pollution, and has inspectors on duty 24 hours a day. *The Directorate of Fisheries, the Institute of Marine Research, the Directorate for Nature Management and the Norwegian Polar Institute* provide environmental advice. The county governors are responsible for quality assurance of regional and local environmental information of importance for the operation. The Coastal Administration also has agreements with other partners, including specialists with cutting-edge expertise, to provide equipment and personnel.
- The *Defence Forces*' coastal emergency response and on-scene command has the authority to assume command in situations that require an immediate response, until the Coastal Administration is able to take over command. The Coast Guard also has considerable vessel resources and expertise in on-scene command. Furthermore, the Coastal Administration can ask for assistance from other Nordic countries under the *Copenhagen Agreement* and from the North Sea states under the *Bonn Agreement*. Norway also has a bilateral agreement with Russia concerning cooperation on the oil pollution emergency response, including cooperation on notification.
- Furthermore, the Coastal Administration can ask for assistance from other Nordic countries under the *Copenhagen Agreement* and from the North Sea states under the *Bonn Agreement*. Norway also has a bilateral agreement with Russia concerning cooperation on the oil pollution emergency response, including cooperation on notification.

up. During an operation, further equipment will be supplied as needed by contractors and public and private emergency response organisations. Information on the equipment and personnel available for operations on the Norwegian continental shelf is also available on the Coastal Administration's website.

Oil spill response operations

The environmental impacts of oil spills depend mainly on weather conditions, oil type, time of year, size of the spill and the extent to which oil drifts to areas where there are vulnerable biological resources. The scale of the impacts will also depend on the source of the spill, whether it is possible to limit further releases, and what emergency response resources (personnel and equipment) are available. The operational strategy chosen may therefore vary from one area to another and from one incident to another. The purpose of an operation is to prevent, reduce or limit damage to the natural environment, in that order.

A major spill in the management plan area could present the Coastal Administration with a major challenge. This is because the emergency response system must cover large and geographically varied areas, and a wide variety of possible accident types. It will be important to obtain adequate information on the different crude oil types transported through the area. Experience from shipwrecks shows that oil spills in nearshore areas often reach the coast and shoreline. This can necessitate prolonged shoreline clean-up operations, which requires a great deal of stamina. If oil reaches the shore, the municipal emergency response services have a key role to play. A large number of the municipalities in the management plan area have little experience of oil spill response operations, and the resources available are often limited.

Exercises and training are of crucial importance in making it possible to run effective oil spill response operations. The Coastal Administration holds several exercises every year with participation from the municipalities.

However, it is a challenging task to retain adequate and properly qualified personnel resources and maintain their expertise, since there are no standing teams for on-scene clean-up.

Effectiveness of the oil spill response

The effectiveness of the oil spill response varies, and is strongly dependent on the site of the spill, the time of year and weather conditions. In good weather, it is possible to recover considerable amounts of oil. The results are thus to a large extent determined by weather conditions in the area of the spill. If there is a prolonged period of poor weather conditions, when containment, recovery and clean-up are difficult, other factors – the type and properties of the oil, currents and wind conditions, and the distance from the spill site to land – will play an important role in determining whether and how much of the oil is beached.

The effectiveness of oil spill response equipment decreases if the significant wave height exceeds 2.5 metres. This is both because it is difficult to operate the equipment in high waves, and because less oil remains on the surface and the slick is thinner under these conditions. Most types of crude oil and condensate show a growing degree of natural dispersion in the water masses in stronger winds and higher waves.

Significance of the type of oil in a spill

The varying properties of different types of oil mean that their behaviour in the sea varies. There are differences between the properties of different types of crude oil and between crude oil, condensate and bunker fuel. In Norway, the SINTEF Group has carried out studies of weathering for most types of oil that are produced in the Norwegian exclusive economic zone. Good documentation of their properties and how they are expected to behave in the sea after a spill is therefore available. However, there is very little information on Russian oil types. In general, a slick formed from a lighter oil will have a shorter lifetime on the sea surface, and therefore affect a smaller area than a heavier oil. Spills of bunker fuel from ships can result in serious environmental problems, since these are heavy oils. Natural weathering processes are therefore slow, and the oil absorbs large amounts of water. Knowledge of the properties of the oil is therefore very important in choosing the most effective strategy for an oil spill response operation. The IMO has adopted new global limits for the sulphur content of bunker fuel, which is to be progressively reduced from 4.5 % at present to 0.5 % in 2020. This will result in the use of lighter oil types, and mean that future oil spills involving bunker fuel should have less serious impacts.

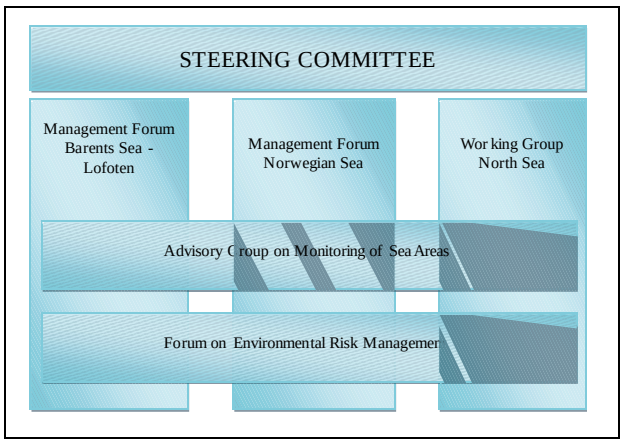

Figure 7.6 Organisation of the work on the management plans for Norway's sea areas

Source: Ministry of the Environment

7.6 Organisation of the management regime

The development of an integrated, ecosystem-based marine management regime is based on the overall management system for Norwegian environmental policy. The Ministry of the Environment has the main responsibility for national goals, management systems and performance monitoring, and also plays a key role in coordinating the efforts of various line ministries. At the same time, sectoral responsibility is also a key concept, and means that authorities and industries in individual sectors have an independent responsibility to integrate environmental considerations into activities that have an impact on marine and coastal areas. In the context of the management plans for Norway's sea areas, other important ministries are the Ministry of Fisheries and Coastal Affairs, the Ministry of Petroleum and Energy, the Ministry of Trade and Industry (shipping) and the Ministry of Labour and Social Inclusion (inspection and enforcement in the petroleum sector).

On the basis of these considerations and the purpose of the management plans, extensive cooperation has been established between all the authorities involved in preparing and implementing the management plans for Norway's sea areas, as described in Chapter 2. A Steering Committee has been appointed with representatives of all the ministries involved, chaired by the Ministry of the Environment. In connection with the management plan for the Barents Sea–Lofoten area, the following were established: the Management Forum, which is responsible for coordination and overall implementation and headed by the Norwegian Polar Institute; the Forum on Environmental Risk Management, headed by the Coastal Administration, and the Advisory Group on Monitoring of the Barents Sea, which will be headed by the Institute of Marine Research. A Forum for Integrated Management of the Norwegian Sea will be appointed, and an expert group has already been appointed, headed by the Norwegian Pollution Control Authority, to prepare the scientific basis for a management plan for the North Sea. The terms of reference of the Forum on Environmental Risk Management and Advisory Group on Monitoring of the Barents Sea will be expanded to include all three sea areas, and they will cooperate with the management forums for all three sea areas, see Figure 7.6.

The interministerial Steering Committee will draw up the terms of reference for the management forums, the Forum on Environmental Risk Management and the Advisory Group on Monitoring.

Participation by the various interests involved, including business and industry and environmental organisations, is an important part of the development of the management plans. The terms of reference of the Reference Group established for the Barents Sea–Lofoten area will therefore be expanded to include the Norwegian Sea and the North Sea.

8 Conflicts of interest and coexistence between industries

In addition to their impact on the environment, human activities within and outside the management plan area may involve conflicts of interest between different sectors, particularly between the petroleum and fisheries industries, but also to some extent between maritime transport and the fisheries industry and between the maritime transport and the petroleum industry. The current extensive fisheries activity, combined with the establishment of new petroleum activities and the growing volume of maritime transport, will make close coordination essential. In addition, the establishment and operation of offshore wind farms could pose new challenges. Figure 8.3 gives an overview of sectorial activities in the Norwegian Sea.

8.1 The petroleum industry and the fisheries industry

Ever since oil and gas activities started on the Norwegian continental shelf more than 40 years ago, the authorities have emphasised the importance of coexistence with other industries and with the fisheries industry in particular. This has laid the foundation for value creation both from Norway's valuable oil and gas resources and from its rich fisheries resources. Two of the key elements of the Government's model for coexistence with other industries are a comprehensive system of impact assessments at all stages of petroleum activities and the prohibition of certain operations, such as exploration drilling and seismic surveying, at times of year that are particularly important periods for fish stocks and the fisheries industry. However, there are problems related to the occupation of areas and the acquisition of seismic data.

When new areas are opened up for petroleum activities, environmental and fisheries-related requirements are drawn up for each block.

8.1.1 Acquisition of seismic data

Seismic surveys are carried out at all stages of petroleum activities, from the early exploration phase and well into the production phase, when they are used for reservoir surveillance purposes. Such surveys are needed to map petroleum deposits and ensure that proven resources are utilised effectively. The basic method used for seismic surveying is to discharge sound pulses from a survey vessel or from a signal source towed behind the vessel. These are reflected back from the boundaries separating the geological layers beneath the seabed, and the reflected signals are recorded by hydrophones (receptors) attached to one or more long cables that are towed behind the vessel.

A seismic vessel tows between six and 16 several-kilometre-long streamers, which limits its ability to manoeuvre. This increases the potential for conflict with those types of fishing vessels that also have limited manoeuvrability. Seismic activities in areas of importance for fisheries are currently regulated to take into account both fish resources (spawning, etc.) and fisheries. The most important instruments for regulating these activities are:

- temporal and spatial restrictions on seismic data acquisition
- requirement for seismic survey vessels to carry a fisheries expert on board.

The potential impacts of seismic activities on fisheries can be divided into two types: acoustic disturbance of fish, and conflicts of interest over use of the same areas. During seismic surveys, sound pulses may affect marine organisms either directly (physiologically) or indirectly (in terms of behaviour). Direct injury to for example fish eggs and larvae has been found to be local (limited to a few metres from the noise source), while behavioural effects are believed to extend over a longer distance. Fish respond in different ways to anthropogenic noise. The mildest response is a small change in swimming activity, where the fish change direction and increase swimming speed[1]. Another, stronger, response takes the form of changes in vertical swimming depth and shoal behaviour, while the strongest response takes the

[1] Report on the effects of seismic sound on fish and marine mammals by an expert group for the Norwegian Petroleum Directorate, the Directorate of Fisheries and the Norwegian Pollution Control Authority, 2008

Box 8.1 Seismic surveys

Under section 6 of the Petroleum Regulations the licensee must no later than five weeks prior to the commencement of a seismic survey, submit notification of the survey to the following authorities:

- the Norwegian Petroleum Directorate (the competent authority),
- the Directorate of Fisheries (provides opinions on fisheries activities to the Petroleum Directorate),
- the Institute of Marine Research (provides opinions on biological resources to the Petroleum Directorate),
- the Norwegian Armed Forces, National Joint Headquarters.

The notification must include information on the timing of the survey, charts of the area, information on the methods to be used, the name of the fishery expert and the data format. If the authorities have objections to the survey, for example on the grounds of expected fisheries activities, the Petroleum Directorate will propose adjustments to the survey to take this into account, and will include a condition that the survey must be terminated if fishing operations are started in the area. While the survey is in progress, the licensee must on a weekly basis submit information to the above authorities and also to the Norwegian Coast Guard.

Prior to the commencement of the survey, the Petroleum Directorate publishes an announcement containing information on the area and the time period of the survey, the vessel's call sign, etc. Any changes are published on the Petroleum Directorate's website.

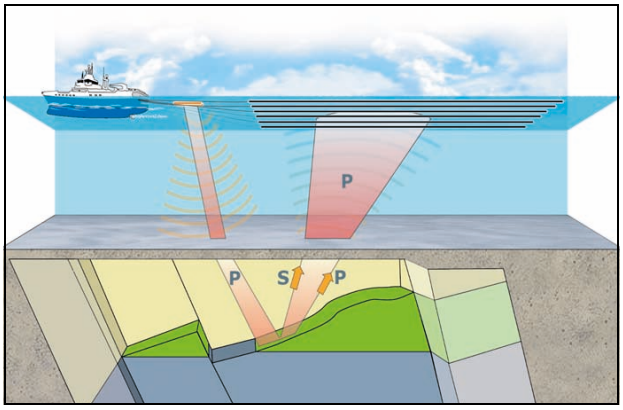

Figure 8.1 Principles of 3D seismic surveys. P = P-wave, S = S-wave

Source: StatoilHydro

form of sudden flight. If fish are exposed to seismic noise during migration to spawning grounds or during spawning, spawning success may be affected. Spawning migration patterns may be altered, and shifts may occur in spawning times and locations. To avoid such impacts, restrictions have been introduced on when seismic activities are permitted in important spawning areas and in areas fish move through on spawning migration. When fish are frightened away by seismic surveying, catch rates may be reduced for a short period after completion of the survey. The decline in catch rates seems to vary from species to species and from one type of gear to another. Local reductions in catches may have serious implications for individual fishermen, particularly in the case of seasonal fisheries. Any direct conflicts of interest that arise will be due to competition for use of the same sea area.

To reduce conflicts of interest between the fisheries industry and the petroleum industry, environmental and fisheries-related requirements are included in the licensing procedures for new blocks. These include a requirement to take special account of fisheries activities and the possible presence of marine organisms when planning drilling activities. Steps must be taken to inform interested parties of such plans prior to exploration drilling. When planning seismic surveys, licensees must take special account of fisheries activities and the presence of marine organisms at critical stages in their life cycles. As a result of these requirements, restrictions on where and when seismic surveys are permitted have been introduced. Their purpose is to avoid seismic surveying at times when marine organisms are especially vulnerable, for example during spawning and spawning migration. Such restrictions already apply to some licences in the Norwegian Sea.

There has been growing concern about seismic surveys, and the level of conflict of interest over different uses of the same areas seems to be rising. A working group with representatives from the Petroleum Directorate and the Directorate of Fisheries was established in September 2007 to review the problems and propose measures to deal with them. During its work the group maintained a dialogue with the industries concerned and other

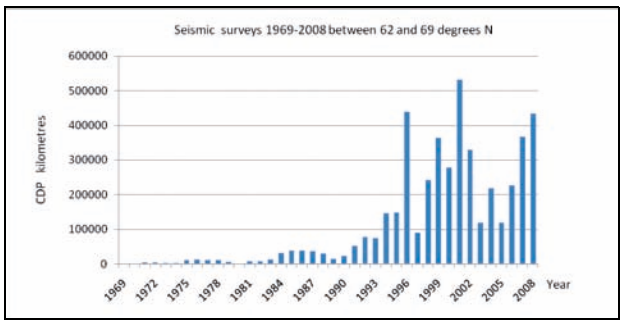

Figure 8.2 Acquisition of seismic data between 62° and 69°N in the period 1969–2008

Source: Norwegian Petroleum Directorate

stakeholders. In its final report, which was presented in April 2008, the group proposed measures in the following areas:

- administrative procedures – notification of seismic surveys, pipeline route surveys and other baseline studies, consultations;
- announcements;
- fisheries experts – role, number, organisation, competence/training, approval, contact with the authorities, reporting;
- conflicts of interest related to different uses of the same areas;
- tracking of seismic vessels;
- potential for rationalisation.

As a result of the report, a steering group was established consisting of representatives from the Norwegian Petroleum Directorate, the Directorate of Fisheries and the Norwegian Pollution Control Authority. The committee was asked to review acoustic disturbance and other negative impacts on fish and marine mammals caused by seismic activity, with a view to establishing a recommended minimum distance from fishing activities, fish farming, and whaling and sealing. It was also asked to assess the need for legislative amendments and make proposals based on its conclusions concerning negative impacts. The group also proposed measures to regulate other testing activities.

The steering group presented its report on 30 April 2009.

8.1.2 Occupation of areas by the oil and gas and the fisheries industries

The development and operation of petroleum installations on the Norwegian shelf occupy areas of the sea for varying lengths of time. This also applies to seismic surveys, although only for limited periods. When activities are terminated, the area must be cleared and restored to its original state.

Norwegian legislation requires operators to establish safety zones round petroleum installations that project above the surface of the sea. A safety zone covers an area extending to a distance of 500 m from the outer limits of the installation. An exploration rig including its anchor spread occupies an area of about 7 km^2 for a period of one to two months for each well. On the Norwegian shelf, safety zones occupy about 100 km^2 of the total area of 675 571 km^2 that is open for petroleum activities. The impacts of occupied areas depend greatly on the position of the safety zones in relation to important fishing grounds.

The spatial requirements of trawl fishing differ from those of fishing with passive gear such as gill nets and longlines. The area occupied by fisheries depends on the availability of the fish, on whether or not they are seasonal fisheries and to some extent on the fishing gear that is used.

The space required for gill netting and longlining depends both on the location of the fishery and on the type of vessel used. During the major seasonal fisheries off parts of the coast, the fishing grounds are utilised to the full, and if an area is occupied by the oil and gas industry, it is unavailable to the fishing industry. In such cases, it is not possible to compensate for the loss of fishing areas by intensifying efforts in other catch areas, since the fishing grounds are already fully utilised. At other times gill netting and longlining are less intensive, and in such cases the occupation of fishing areas is not expected to result in loss of catches.

Pelagic fisheries use purse seines or trawls to catch pelagic species such as herring and capelin. Spatial restrictions resulting from petroleum activities are not expected to lead to catch losses in these fisheries.

8.1.3 Fishing in the vicinity of subsea structures

Subsea structures do not normally occupy areas used by vessels fishing with conventional gear such as gill nets and longlines, or engaged in pelagic fisheries using purse seines and trawls, nor do they impede them in other ways. All subsea structures are required to be constructed in such a way that they can withstand mechanical damage caused by other forms of activity and do not damage fishing gear or otherwise interfere with fisheries activities to an unreasonable extent; they must

be overtrawlable. However, in practice many fishing vessels avoid them for fear of trawl gear becoming snagged and damaged. After pipelaying has been completed, pipelines are no hindrance to fisheries using conventional gear such as gill nets and longlines or fisheries using purse seines and pelagic trawls. Only fisheries using bottom gear such as trawls and Danish seines can be impeded by pipelines on the seabed. However, there have been no reports of major problems linked with fisheries using Danish seines near these pipelines on the Norwegian shelf.

It is very unlikely that existing pipelines will be the cause of noticeable catch losses for trawlers fishing on the Norwegian shelf. Most of the problems experienced by trawl fisheries are caused by pipelines with rock armour or by external damage. Such pipelines can cause major disruptions in the operations of certain fisheries, and in some cases they cause problems by occupying space, damaging gear and reducing catch rates. Pipelines and cables that are buried in the seabed and stabilised do not interfere with fishing.

These problems can be further reduced by advance information about new developments, by inspections and by information about alterations to subsea structures.

8.2 Maritime transport and fisheries

In the management plan area, there is considerable fisheries activity over the whole of the continental shelf and along the continental slope towards the deep-water areas of the Norwegian Sea. This means that the route that most vessels follow along the coast from the Lofoten Islands to Stad at 62°N passes through or close to intensively used fishing grounds. Some fisheries operate year round, with vessels scattered over the whole area, while others are seasonal fisheries, with large concentrations of fishing vessels in certain areas.

A considerable proportion of the ship traffic into and out of the Norwegian Sea passes Stad, most of it at distances within 25 nautical miles of land, and traverses areas that are intensively fished at certain times of year. The risk of collisions and accidents involving loss of fishing gear rises with increasing traffic density. It might be necessary to establish traffic lanes or other routeing measures in this area in order to divert high-risk traffic further away from the coast.

Conflicts can arise between the fisheries and maritime transport if vessels sail through or very close to fishing grounds, particularly during the seasonal fisheries, when there are large concentrations of fishing vessels. Problems may also arise in areas where fixed gear is used at certain times of year.

The International Regulations for Preventing Collisions at Sea apply to all vessels on the high seas, whether they are fishing vessels, cargo vessels, leisure craft or other vessels. Under the international regulations, vessels that are under way are required to keep out of the way of vessels that are engaged in fishing. However, fishing vessels are obliged to display signals showing that they are engaged in fishing. They must also keep watch and show due care in order to avoid collisions. This is also important to ensure safe and predictable conditions for navigation.

Coastal states have the right to establish mandatory and recommended routeing and traffic separation schemes inside their own territorial limits. These help to increase the predictability of general traffic movements for all vessels, including fishing vessels, and thus also help to reduce the risk of collisions between fishing vessels and other ship traffic.

Outside territorial limits, mandatory and recommended routeing and traffic separation schemes must be approved by the IMO. Plans for the establishment of routeing and traffic separation schemes outside territorial waters take account of fisheries activities and the sailing patterns of fishing vessels, as well as other traffic and activities such as petroleum activities.

8.3 Maritime transport and petroleum activities

The risk of conflict between these sectors is mainly related to wrecked or drifting vessels colliding with installations, and anchor damage to pipelines.

However, experience from the North Sea shows that there is little conflict between petroleum activities and maritime transport. Most sailing routes are positioned well away from petroleum installations, and the probability of a vessel colliding with an installation is low. Only two collisions with ships have been registered by the Norwegian oil industry, and the ships were not being used in connection with petroleum activities.

Should a collision take place, it is very unlikely to result in the breakdown of an installation, a broken riser pipe or a blow-out. Stringent standards have been set for the design of load-bearing structures, and there must be at least two independent physical barriers between the reservoir and the

surface. For a major blow-out to occur, both barriers must fail.

Petroleum legislation sets strict safety standards, and activities are monitored very closely by operators and authorities. A safety zone is established round every petroleum installation that projects above the surface of the sea. The purpose is to keep a safe distance between the installations and general maritime transport and other activities. The health, environment and safety legislation gives operators both a right and an obligation to prohibit traffic in safety zones and the regulations require safety zones to be monitored to ensure early intervention if there is a danger of collision. They also require that an emergency response system should be established that is designed for the types of hazards and accidents that may arise.

When mandatory or recommended routeing and traffic separation schemes are being planned outside the territorial limit, the position of petroleum installations are taken into account, so that the location of traffic lanes minimises conflict with petroleum activities and does not increase the risk of collisions. Surface installations are not permitted in traffic lanes.

Pipelines are shown on navigation charts. It is therefore very unlikely that under normal circumstances a vessel will drop anchor over a pipeline. This could, however, happen as a result of a navigation error or in a shipboard emergency, and the possibility cannot therefore be ruled out.

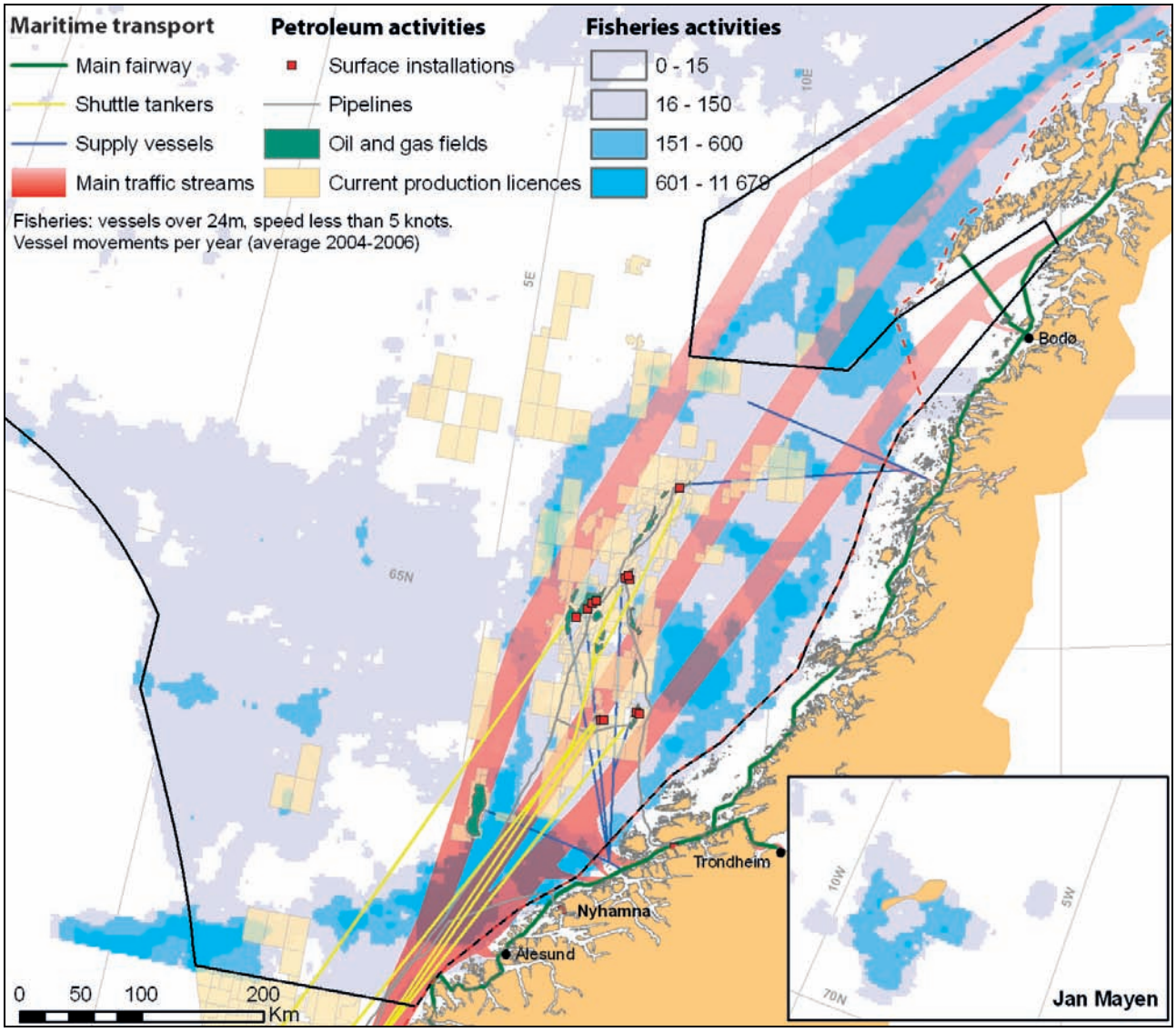

Figure 8.3 Overview of maritime transport, petroleum activities and fisheries activities in the Norwegian Sea

Source: Directorate for Nature Management/Coastal Administration/Norwegian Petroleum Directorate

8.4 Offshore wind power and other industries

8.4.1 Wind power and fisheries

Large-scale offshore wind farms will occupy relatively large areas. The distances between wind turbines may be as much as 1 km, and wind farms may contain as many as 50–100 turbines. The turbines are linked by a network of power cables on the seabed and these are joined to a cable that transmits the generated electricity to shore. It may be necessary to impose restrictions on traffic, passage and other activities in the area occupied by a wind farm. The nature of the restrictions is unclear, since no offshore wind farms have yet been established in Norway. In Denmark there is no general prohibition on traffic in or through wind farms, nor is there a general prohibition on fishing in Danish offshore wind farms, but there are restrictions on fishing methods, for example trawling.

Studies conducted in Denmark and Sweden indicate that offshore wind turbines do not frighten away fish in the operational phase, except when noise levels are higher due to high wind speeds. Some findings indicate that offshore turbines may to some extent function as artificial reefs, and thus attract fish. However, wind power production will occupy sizable areas, and this must be weighed against the needs of maritime transport, fisheries and other maritime activities.

Knowledge about important fishing grounds and shipping lanes will be of crucial importance in planning offshore energy production. The authorities can introduce spatial planning processes to ensure that energy production takes place in areas where the potential for conflict with fisheries and maritime transport is low enough to be acceptable.

Offshore power cables will have to be buried in the seabed or covered by rock armour so that they are overtrawlable. The presence of cables will therefore not make it necessary to introduce formal restrictions on fishing. However, it is known that armoured cables can damage fishing gear. Less rock is required for power cables than for pipelines, but the risk of damage cannot be excluded.

Currently there is no legislation regulating the establishment of wind power production outside the baseline, and this situation must be remedied before areas can be opened for development. The Ministry of Petroleum and Energy is holding consultations on a draft Marine Energy Act, which provides for procedures for evaluating the different interests.

8.4.2 Wind power and the petroleum industry

All petroleum exploration licences for the Norwegian Sea are for areas with waters deeper than 100 m, and with current technology wind turbines cannot be mounted on the seabed at depths of more than 100 m. This means that there would be no direct conflicts of interest between fixed petroleum installations on the seabed and seabed-mounted wind turbines over use of the same area. Since the location of wind farms is flexible with regard to existing petroleum installations and to shipping lanes between oil and gas fields and shore, conflicts of interest over use of a particular area are unlikely to arise in the future either. In addition a requirement could be imposed that wind turbines may not be mounted in areas where they would directly impede the establishment of petroleum installations.

8.4.3 Wind power and maritime transport

Any conflicts of interest arising between these two industries would be over competing uses of the same area or risk of collisions.

The degree to which offshore wind farms would come into conflict with maritime transport will depend on the location and number of turbines and the size of the area occupied. A large-scale wind farm may occupy an area of about 200 km^2, and such installations in the vicinity of shipping lanes or maritime transport routes could increase the distances sailed and thereby reduce the competitiveness of maritime transport. However, the difference is unlikely to be noticeable unless a sizable number of large-scale wind farms are established in the vicinity of shipping lanes, and wind power development on this scale is not expected to take place during the period up to 2025.

Given the above restrictions in terms of depth and distance from shore for seabed-mounted wind turbines, there are few parts of the management plan area that are suitable for wind power development. Seabed-mounted turbines are therefore only expected to occupy a relatively small area during the period covered by the management plan, and the impacts on maritime transport will be small and localised.

If there are important shipping lanes or transport routes in the area where a wind farm is planned, this may reduce location flexibility for the wind farm.

The risk of conflicts of interest between wind farms and maritime transport can be reduced by

making accurate surveys of shipping lanes and transport routes, by marking wind farms on charts and by drawing up legislation that sets out clear procedures for siting wind farms. Normally plans for a wind farm can be adjusted to coastal traffic routes. The distance between wind turbines will be up to 1 km, which allows for shipping lanes to pass right through a wind farm. Furthermore, ships usually sail in deep waters, while initially wind farms will have to be established in shallow waters. The development of technology for building floating wind turbines could alter this situation over time.

9 Goals and knowledge-based management

9.1 Goals for management of the Norwegian Sea

The Government has decided on a set of goals for the management of the Norwegian Sea, which include both general objectives concerned with value creation and coexistence between industries, and more specific goals for managing biological, geological and landscape diversity, combating pollution and ensuring safe seafood. The Government's general objectives are set out in Chapter 2, and more specific goals for the Norwegian Sea are listed below. These objectives and goals, together with the assessment of cumulative environmental effects in the Norwegian Sea, form the basis for the overall assessment of the need for measures and tools presented in Chapter 10. The goals will be followed up by the authorities in the relevant sectors. In order to measure progress systematically, the Government will establish a system for monitoring the state of the environment and environmental risk by means of indicators, reference values and action thresholds.

The Government's overall objective is to ensure that management of Norwegian sea areas is based on knowledge of ecosystem structure and functioning and of how this is affected by human activities. Gaps in our knowledge could result in political objectives and priorities that are decided at random and are not cost-effective. More knowledge is also needed for assessing progress towards the goals.

Knowledge of the Norwegian Sea is being built up through research, surveys, environmental monitoring, reporting and other knowledge-related activities in the relevant sectors and institutions. The knowledge base for the present management plan is extensive. Our knowledge about fish stocks is based on over 100 years of research and monitoring of living marine resources and the marine environment, and Norway has been transporting goods and passengers by sea for centuries. We also have data from comprehensive surveys, studies and monitoring in connection with petroleum activities in the area. Nevertheless, there are still a number of gaps in our knowledge about ecosystems in the Norwegian Sea. This chapter provides an overview of our current knowledge about the most important fields covered by the management plan. It is not comprehensive and focuses on the main knowledge gaps that need to be filled.

Objectives for the protection and sustainable use of the Norwegian Sea

Management of biological, geological and landscape diversity

- 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.
- 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 in 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.

Litter

- Litter and other environmental damage caused by 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 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.

9.2 Monitoring and performance

Ecosystem-based management of human activity in the Norwegian Sea must be based on regular assessments of trends in the state of the ecosystem in relation to the goals of the management plan. Through a system for monitoring ecological quality, the management authorities will be warned of changes that require action. However, choosing the necessary and appropriate measures requires information that clearly distinguishes between anthropogenic pressures and changes that occur independently of human activity. The system for monitoring the state of the ecosystem in the Norwegian Sea will be coordinated with the integrated system for monitoring the state of the ecosystem that has been developed as part of the management plan for the Barents Sea–Lofoten area, and will be based to some extent on experience of the Barents Sea–Lofoten system. The indicators, reference values and action thresholds selected for the new monitoring system will have to be appropriate for the conditions and monitoring needs in the Norwegian Sea, but it would be an advantage to have as many common indicators as possible for all sea areas so that trends can be compared more easily. The question of whether more specific indicators are needed for some of the particularly valuable and vulnerable areas should also be considered. Action thresholds will be set in cases where indicators reflect the impacts of human activity. The system of indicators must also be adapted to the EU's

Marine Strategy Directive so that trends in the Norwegian Sea can be evaluated in a European context.

9.2.1 Monitoring of selected indicators in the Norwegian Sea

The elements of the monitoring system for the Barents Sea–Lofoten area are described in the management plan for this area and are also applicable to the monitoring system for the Norwegian Sea that is proposed in Appendix 2.

As in the management plan for Barents Sea–Lofoten area, the pollution indicators and action thresholds have been chosen with a view to measuring performance in relation to biodiversity, pollution and seafood safety goals. The choice of indicators is determined by their role in the ecosystem, whether they are feasible in practice, and their relevance to ecosystem management and in relation to Norway's international obligations.

Species that are important in a monitoring system for the Norwegian Sea include Norwegian spring-spawning herring, blue whiting, mackerel and demersal species such as Greenland halibut, ling and tusk. A number of seabird species, such as kittiwake, common guillemot, puffin, common eider and shag, are also useful as indicators, since they occupy different ecological niches and have different ecological functions, and can therefore serve as indicators of different kinds of changes in ecosystems. Identifying good indicators for monitoring the status of benthic fauna will be a difficult task, and attention will be concentrated on species that are vulnerable to physical disturbance. Pollution indicators (for heavy metals, persistent organic pollutants, radioactivity and so on) will be based on those used in the Barents Sea–Lofoten management plan. The pollution indicators are intended to provide information on current pollution levels and trends in pollution and their possible impacts on seafood safety. Spring-spawning herring, Greenland halibut and hooded seal are proposed as replacement indicators for the northernmost species in the Barents Sea–Lofoten plan.

Data for many of the proposed indicators for the Norwegian Sea are already part of long time series that are updated annually. However, for other indicators, new time series will have to be started or existing data reorganised.

Many of the indicators will need a certain amount of development, and these are indicated in Appendix 2. Generally speaking, there is a need to further develop and refine indicators and action thresholds for seabirds and many mammal species. Data and data series already exist for these species, but have not previously been used in a management context or for setting reference values. This must be done by experts in consultation with the authorities. We need to know much more about pollution in the areas beyond the continental shelf in the Norwegian Sea, and a review must be conducted of the risk factors and the corresponding necessary indicators and action thresholds. Appendix 3 lists the current and proposed pollution indicators and recommended sample types. Long time series should be built up for monitoring pollutants. Aggregate indicators should be tested to identify combinations of indicators that taken together provide a clearer picture and/or help the management authorities to identify changes in ecosystem status.

The work on environmental quality monitoring in OSPAR, ICES and the management plan for the Barents Sea–Lofoten area has shown that it takes time to develop good indicators. This applies both to the selection and description of indicators and to how they should be used. Thus the indicators proposed in this report are not intended to be final but to be the first step in the development of good management tools for the Norwegian Sea.

9.2.2 Implementation

The monitoring system for the Norwegian Sea, like that for the Barents Sea–Lofoten area, will be built on existing and planned monitoring programmes and will be in line with Norway's international obligations. This will ensure that existing time series can be continued and that future research and monitoring needs are taken into account in the ongoing development of the management plan. New monitoring programmes should as far as possible be carried out within the framework of existing programmes. The Marine Pollution Monitoring Programme, which monitors inputs of oil and environmentally hazardous substances into sea areas, is based on this principle and will in the long term provide the necessary data on pollution for all Norway's management plan areas.

9.3 Priority knowledge areas

Although in general a good deal is known about the ecosystems in the Norwegian Sea, there are still knowledge gaps in certain areas. The following is an outline of the most important areas where these gaps need to be filled:

- ecosystem structure and functioning, for example interactions between habitat-forming species, predators and prey,
- ecosystem services, for example climate regulation, food production and water purification,
- the impacts of human activities, separately and together, on different parts of the ecosystem,
- the geographical distribution and recruitment mechanisms of herring, blue whiting and mackerel,
- variations in seabird populations and possible relationships with human pressures, food supplies and climatic conditions,
- information about the physical and chemical environment of the seabed and associated habitats and biodiversity, including the presence of particularly valuable and vulnerable habitats, for example from surveys under the MAREANO programme,
- knowledge of species and population diversity in the Norwegian Sea, including genetic diversity in selected populations,
- surveys, studies and monitoring of alien marine organisms,
- the mechanisms behind changes in wind patterns, ocean circulation and distribution of water masses in the Nordic seas in order to obtain more reliable predictions about the impacts of climate change,
- trends in climate change and ocean acidification and the impacts of interactions between these processes on ocean ecosystems, with a focus on particularly vulnerable groups of organisms, groups of particular importance in food chains, commercially important species and interactions between all groups in food chains,
- potentiating effects of interactions between hazardous substances and between hazardous substances and other factors such as ocean acidification and climate change,
- effects of seismic activity on fish, including gadids, and how to mitigate these effects,
- impacts of human activity on seafood safety.

A more detailed overview of knowledge needs can be found in the scientific basis developed for the management plan.

9.3.1 Ecosystem structure and functioning

Our understanding of interactions between organisms in food chains needs to be improved. Ecosystem-based management requires knowledge of population sizes and production at lower levels in food chains, such as plankton, and their significance for higher trophic levels, such as fish, seabirds and marine mammals. We also need more knowledge about the key interactions between ecosystem components.

Generally speaking, we know too little about the ecological interactions between particular species and their prey, and between competing species in ecosystems. Large numbers of samples and data collected during research and monitoring cruises have not been processed, and this situation must be remedied so that the data can be used to address ecosystem-related issues. In cases where the underlying data are adequate, priority must be given to developing and refining models with a view to improving our understanding of ecosystems.

There are also gaps in our knowledge of the ways in which human activity affects the different ecosystem components and of the combined impacts of different pressures on individual species and on ecosystems as a whole. For example, climate change could result in changes in long-range transport of hazardous substances (due to changes in ocean currents and winds) or affect the environmental behaviour of such substances (degradation, uptake by organisms, etc.). Plants and animals that are already exposed to one or more environmental pressures may not tolerate further pressure. Sound ecosystem-based management therefore depends on ecosystem monitoring and adequate knowledge of the combined impacts of different pressures.

9.3.2 Individual species

Fish

Although in general we know much more about commercial fish stocks in the Norwegian Sea than about other animals and plants in the area, we have far more information about some fish species than others. We know most about Norwegian spring-spawning herring. Considerable research has been done on this herring stock and there are time series that date back at least 100 years. We know that climatic conditions and stock structure help to regulate its geographical distribution, a key factor in resource management, especially with regard to Iceland. However, we are still far from understanding the distribution dynamics of the stock and even farther from being able to predict its geographical distribution. Further statistical analyses and numerical simulation models are needed.

The underlying data on saithe, mackerel and blue whiting stocks are weaker than those for herring, capelin and cod in the Barents Sea. In the case

of blue whiting it is especially important to understand the causes of the large variations in recruitment to the stock in recent years.

In the last few years a good deal of research has been done on Greenland halibut and redfish, but we know less about stocks that are not much used commercially, such as tusk, ling, halibut and greater argentine, and also about mesopelagic fish, sharks and skates.

There is a pressing need for more knowledge about the interactions between the ecologically and commercially most important fish stocks, and between fish and other species in the food web at both higher and lower trophic levels. We also need to understand more about the impacts of climate change on recruitment and of fishing on stock structure (fisheries-induced evolution).

Distribution, numbers, condition, reproduction and recruitment should also be monitored for stocks other than those of commercial value, since such knowledge is essential to our understanding of ecosystem functioning and thus for ecosystem-based management. An ecosystem approach also requires knowledge about the distribution, habitat use and food habits of fish stocks that are not harvested commercially.

Food safety is important, not least in relation to fish exports. There is increasing international emphasis on food safety, and common limit values have been set for a number of substances in seafood. A thorough survey of hazardous substances should be conducted for all species used for food in Norway and for all those that are exported. A good deal has already been done in this area, and major surveys of Greenland halibut and mackerel are being conducted. Further surveys should be made, for example of cod and saithe, which are the most important exports from capture fisheries.

Marine mammals

We do not know enough about the seasonal diet of marine mammals, the competitive relationships between them and whether they have strict dietary preferences or are more adaptable to variations in food supply. We also need to know more about the spatial distribution and ecological roles of marine mammals in the management plan area.

The knowledge base for migratory species of marine mammals should be expanded and updated. In order to understand their migration routes and the impact of environmental pressures, we need more information about stock components, recruitment, migration patterns, main areas used on migration and for overwintering, spatial distribution at different times of year, and the seasonal dietary and habitat requirements of different species. This will require both monitoring and research.

There is also a pressing need for quantitative data on the impacts of the strength, trends and temporal variations in climate change on biological production and trophic interactions at all levels in the food web up to marine mammal level, from primary production to marine mammal food supplies, reproduction and survival.

Seabirds

Although the large seabird colonies have been extensively monitored and studied for many years, integrated monitoring of seabirds in Norway only began with the introduction of the SEAPOP (SEAbird POPulations) monitoring programme. Adult survival, reproduction and food preferences are being studied at Røst, Sklinna and Runde, which are key locations for seabirds.

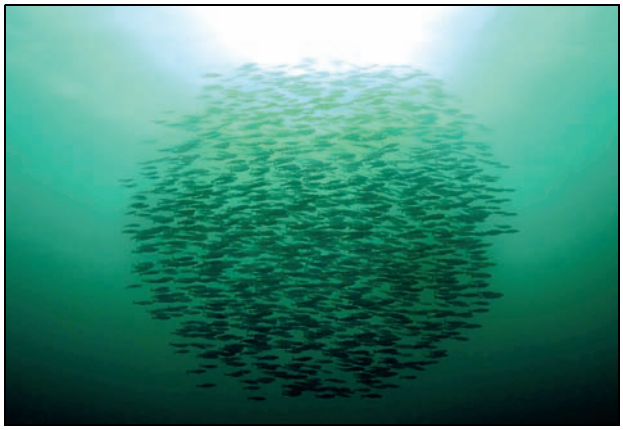

Figure 9.1 Shoal of saithe

Photo: Erling Svensen

Figure 9.2 Cormorants

Photo: Lars Løfaldli

More knowledge is required about the numerical, temporal and spatial distribution of seabirds, including distribution patterns, migration, variations in population density, population affiliation and total population size.

Most seabirds show slow maturation, are long-lived and have a low reproduction rate. This means that they are not very adaptable to changes in their habitat, and are therefore particularly vulnerable to anthropogenic pressures. More studies are needed on the direct, indirect and cumulative effects of such pressures on seabirds.

Corals and other benthic fauna

Much of the seabed of the Norwegian Sea has not been studied, and our knowledge of the biological, chemical and physical environment is inadequate. We know little about which habitats are to be found where on the seabed, and even less about benthic species. This means that surveys of the physical, chemical and biological seabed environment are needed. Certain areas of the seabed have been surveyed in connection with planning and impact assessments related to petroleum activities, for example on the mid-Norwegian continental shelf, including the continental slope and the Vøring Plateau, and in deeper waters west of Svalbard, and the data from these surveys are valuable inputs to the knowledge base.

Monitoring programmes are needed for example for habitats that are particularly vulnerable or are expected to be affected by climate change and ocean acidification, such as coral reefs, cold seeps and black smokers. Research on benthic ecosystems and habitat types should also be intensified. Two particularly important research areas are the separate and combined impacts of anthropogenic pressures, climate change and ocean acidification; and ecosystem services, including their importance for biodiversity, the resource base and climate regulation.

Introduction of alien species into the marine environment

In 2007 the Norwegian Biodiversity Information Centre published a Black List of alien species in Norway and in this connection, ecological risk analyses have been conducted for a selection of alien species. The Black List contains 44 marine species. Activities such as international trade and transport are contributing to the spread of alien species.

Figure 9.3 Corals

Photo: Institute of Marine Research

At present no alien marine species are being systematically monitored apart from the red king crab, which has not yet spread as far as the management plan area. The current system of surveying and monitoring marine ecosystems needs to be further developed with a view to revealing the presence of invasive alien species. There is also a need for more research on alien species that are now established in the wild, and their impacts on ecosystems.

9.4 Climate change and ocean acidification

Climate change and ocean acidification may have far-reaching impacts on ecosystems in the Norwegian Sea. However, the interactions between these factors are so complex, and the level of knowledge is still so low, that it is impossible to say with any certainty what these impacts will be. We therefore need to survey the current status, further develop the necessary long-term monitoring programmes, and give priority to research in cooperation with international research programmes. The focus should be on climate and acidification trends and the combined effects on ecosystems and the resource base, and on measures to address these problems.

Long time series obtained from monitoring and research are the most important basis for all climate research. The permanent monitoring transects across the Atlantic current are of key importance for monitoring in the Norwegian Sea, and data from the weather observation station M in the Norwegian Sea (the weather ship *Polarfront,* stationed at 66° N, 2° E) have provided an important supplement to oceanographic climate studies. As from 2010 the weather observation system at station M will be replaced by more up-to-date methods such as satellite monitoring. However, it is important to maintain the time series and ensure that oceanographic monitoring is also continued, and various alternatives are being considered. Extending the monitoring programme by establishing a number of monitoring stations along the front zones in the west and north to record interannual variations should also be considered. Studies should be conducted on the mechanisms behind changes in wind patterns, ocean circulation and distribution of water masses in the Nordic seas so that more accurate predictions can be made about the impact of climate change on the ocean climate. More knowledge is also needed on interactions between the impacts of climate change and acidification on individual species, groups of organisms and ecosystems, including on ecosystem dynamics. The focus should be on groups that are expected to be particularly vulnerable, such as calcifying species and early life stages, groups of particular importance in the food chain such as copepods, especially *Calanus finmarchicus*, commercial species, and interactions between these groups in food chains.

9.5 Pollution

In order to assess the impacts of pollutants on species and ecosystems, we need a thorough knowledge of releases, levels and impacts of individual substances in the management plan area. It is also essential to know how the substances are metabolised or accumulate in the environment and in organisms, how substances interact, and how they are affected by other environmental changes such as climate change and acidification. A number of hazardous substances occur naturally in the sea, for example petroleum compounds, radioactive substances and heavy metals, which leach from the bedrock in many areas. It is important to know the natural background levels for such substances so that anthropogenic inputs and their impacts can be assessed. Climate change and acidification affect transport routes and the ways in which substances are metabolised and accumulate. Moreover, temperature and the chemical composition of seawater strongly influence the state in which substances are found and how they affect living organisms. There are large gaps in our knowledge in all these areas.

Using improved and coordinated methods for data collection, the Norwegian Marine Pollution Monitoring Programme has provided reliable general data on inputs of many hazardous substances into Norwegian sea areas, but there are still many substances for which no data have yet been collected. New measurements of the levels of hazardous substances in the various management plan areas will make a valuable contribution to the work, which is being coordinated by the monitoring group. The programme involves cooperation between all the authorities involved in the regular monitoring of sea areas, and the results will be used at national and international levels.

There is still some uncertainty about the long-term effects of discharges of produced water, but research and monitoring have not so far demonstrated any impacts at population level. However, investigations are being continued in the form of a separate research programme and other studies.

It is also important to be able to document levels of pollutants in fish and other seafood. A thor-

Box 9.1 The Marine Pollution Monitoring Programme

The objective of the Marine Pollution Monitoring Programme is to collect data on inputs of oil and other hazardous substances to the various management plan areas from all sources (local and long-range transport). The programme also monitors pollution status in these sea areas using the pollution indicators listed in the management plans and focusing on particularly valuable and vulnerable areas. The programme started in 2006, and the first phase involved surveys and modelling of inputs. The regular monitoring phase is starting in 2009, and involves measurement of levels of environmentally hazardous substances at a representative network of stations that cover the management plan areas. The network extends as far as the coast, which means that the data can also be used by the river basin district authorities in their management plans. This will make it easier to coordinate the plans for coastal and sea areas. All the main institutions responsible for monitoring programmes in Norway are taking part in this programme (Institute of Marine Research, Norwegian Institute for Water Research, Norwegian Institute for Air Research, National Institute of Nutrition and Seafood Research, Norwegian Radiation Protection Authority, in addition to the Norwegian Pollution Control Authority).

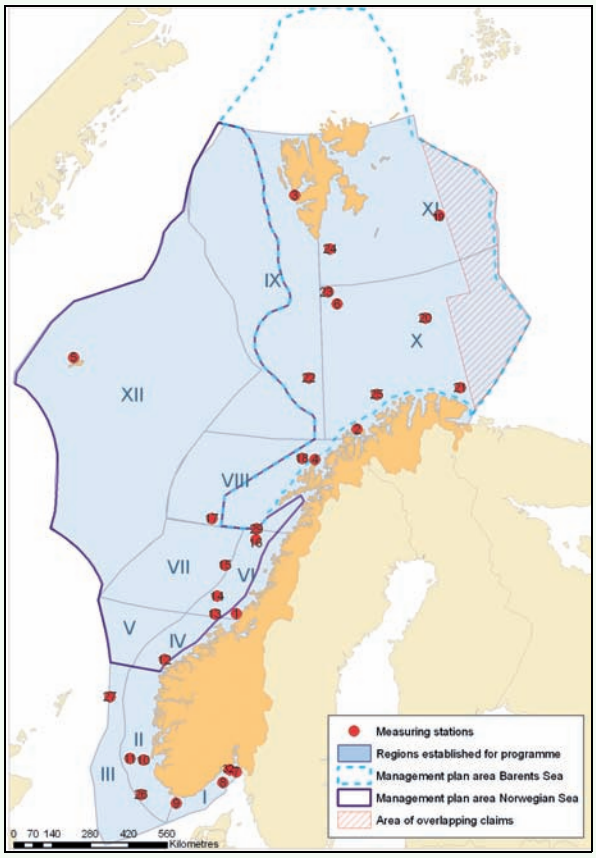

Figure 9.4 Measuring stations for the Marine Pollution Monitoring Programme in the Norwegian Sea

Source: Institute of Marine Research, Norwegian Institute for Water Research, Norwegian Institute for Air Research, National Institute of Nutrition and Seafood Research, Norwegian Radiation Protection Authority, Norwegian Pollution Control Authority

ough baseline study of hazardous substances in Norwegian spring-spawning herring was conducted in 2008, and will be followed up with studies of other species. The international market for fish and seafood is particularly interested in this information. Some seafood species are also being used as indicators in the management plans, and pollution levels in these species will be measured under the Marine Pollution Monitoring Programme.

9.5.1 Knowledge needs as regards seismic activity

Research on seismic surveys and their impacts on fish has been conducted in Norway in three periods: 1984–86, 1991–96 and 2002–04, most of it under the auspices of the Institute of Marine Research. Together with research findings from other countries, this has provided a knowledge base concerning seismic activity and its impacts on fisheries and biological resources that can be used for advising ministries, directorates and companies concerning the use of seismic surveys in exploration for oil and gas.

Seismic surveys at sea influence fish mainly through their sense of hearing. Scientists at the University of Oslo have been studying fish hearing for many years, and the research community here is now leading the way internationally in studies of how fish perceive sound and the ways in which different sounds and sound levels affect their behaviour. However, there are still major gaps in our

knowledge in this field, especially with regard to the commercially important gadids. The sense of hearing in gadids is complex and we know that these fish can detect sonic acceleration and pressure, but we do not know which types of sound and sound levels trigger fright and flight behaviour in gadids. We need to know more about how fish perceive sound and which aspects of seismic waves trigger flight and avoidance behaviour in different species and groups of fish in order to understand the large-scale impacts of seismic activity on pelagic fish.

9.6 The risk of acute oil pollution

More knowledge is needed on the risk of accidents in petroleum activities and how technological advances and new organisational models in the industry affect the level of risk. Priority should be given to investigating how new organisational structures and models resulting from changes in the actors involved, globalisation, ICT advances and the introduction of integrated operations will affect risk levels.

When the lifetime of petroleum installations is extended, safety challenges arise as regards materials technology and continued operations. Priority should be given to further developing models to describe material degradation mechanisms and to developing technology and methods for monitoring technical status and management of technical and operational integrity.

There is also a need to develop technology for early leak detection in subsea installations, and technology and best practices for activity in high-pressure and high-temperature fields.

The Petroleum Safety Authority's project «Trends in Risk Level» is an important tool for monitoring risk levels, and provides annual reports on trends in a number of risk indicators. The project should be further developed so that the annual reports on risk levels provide better information on the risk of acute pollution. This would allow negative trends to be identified at an early stage and provide the authorities and the industry with a better basis for assigning priorities in their efforts to avoid acute pollution.

Providing a more effective oil spill response system in the Norwegian Sea is not just a question of increasing material resources and manpower, it also means ensuring that equipment is adapted to the conditions there and improving expertise in oil spill response operations. The following areas are especially important in this connection:

- improving our knowledge of the properties of the crude oil and oil products transported through the area,
- developing technology that will make it easier to detect and monitor oil drifting on the sea in the dark,
- developing technology and expertise for improving recovery of oil at sea in the dark and in icy waters, including the development of oil spill response equipment and alternative methods for dealing with the problem, including the use of chemical dispersants,
- developing systems for temporary storage of oil and large quantities of waste,
- increasing knowledge about the temporal and spatial distribution of ecological goods and services and their sensitivity to oil,
- increasing the scope of oil spill response exercises during the darkest part of the winter,
- developing effective methods and techniques for beach-cleaning.

9.7 The impacts of exposure to oil on fish eggs and larvae

The most serious impacts of oil and gas activities are considered to be those associated with major oil spills. There is a particular need for knowledge development with regard to the ways in which technological advances and new activities in the petroleum industry affect the nature and level of the risk of accidents. Further development of methods for overall risk assessment, assessment of environmental and social impacts of acute pollution, and indicators for monitoring risk trends in the petroleum sector are also needed.

We still do not know enough about the distribution, drift and survival of fish eggs and larvae. There are analytical tools that can be used to calculate environmental risk levels for fish eggs and larvae in the event of oil spills. However, experts disagree on whether individual results can appropriately be used in impact assessments and on the extent and significance of losses of eggs and larvae in a particular year class with regard to future recruitment to the stock, see Chapter 5.6.

10 Measures for the conservation and sustainable use of the ecosystems of the Norwegian Sea

The state of the Norwegian Sea environment is generally good. However, management of the area poses considerable challenges, particularly as regards 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. The Government considers it important to safeguard the ecosystems of the Norwegian Sea in the long term, so that they continue to be clean, rich and productive. The present integrated, ecosystem-based management plan will serve as a basis for these efforts.

In the implementation of the management plan, the Government will seek to ensure that the Norwegian Sea is managed through conservation and sustainable use, in accordance with the goals set out in Chapters 2 and 9. Furthermore, the management regime is to be based on national goals, the precautionary principle and the principle that cumulative environmental effects must be assessed. The management regime for the Norwegian Sea is to be knowledge-based.

10.1 Spatial management

Eleven particularly valuable and vulnerable areas have been identified in the Norwegian Sea (see Chapter 3.3). They were identified as particularly valuable on the basis of the ecological goods and services they provide, which vary in their vulnerability to anthropogenic pressures. The Government emphasises that particularly valuable and vulnerable areas should be managed with special care. This means that special importance must be attached to knowledge development and environmental impact assessment, and that a cautious approach must be taken to activities in such areas.

The Nature Management Act introduces provisions on selected habitat types. The habitat types to which these apply will be determined in regulations under the Act. The provisions on selected habitat types are intended to safeguard endangered and vulnerable habitats through sustainable use. The authorities will continue to apply sectoral legislation to the designated habitat types, but they will be required to take particular account of the possible impacts of activities on such habitat types, and procedures will be better coordinated.

10.1.1 Protection of coral reefs and other marine habitats

Very little is known about seabed habitats in the Norwegian Sea, and we have little information about where there are vulnerable areas. This makes it particularly important to apply the precautionary principle to management of the Norwegian Sea. In accordance with the target of halting the loss of biodiversity by 2010, the Government will work towards the protection of coral reefs, gorgonian forests and other vulnerable habitat types. A public consultation is currently being held on a proposal for special protection of a further three areas. These are an area called «Korallen» northwest of Sørøya island in Finnmark, the Træna reefs off the Lofoten Islands and an area called «Breisunddjupet» off Ålesund. The latter two are within the present management plan area.

The Norwegian Biodiversity Information Centre plans to publish a Norwegian Red List of endangered and vulnerable habitat types in 2009. If the list classifies marine habitat types in the Norwegian Sea other than coral habitats as endangered or vulnerable, the need for special protection measures will be considered for these as well.

Seabed surveys under the MAREANO programme will improve our knowledge of the distribution of habitat types and provide a basis for better protection of vulnerable habitat types. As regards kelp forests, it is particularly important to develop an integrated management regime and gain a better understanding of overgrazing by sea urchins.

The Government will:
- continue the MAREANO programme;
- map known coral habitats so that they can be more effectively protected against damage

from fishing operations under existing legislation;
- lay down strict requirements for demersal fisheries and reporting requirements for such fisheries in order to avoid damage to benthic habitats;
- step up efforts to further develop bottom gear to minimise impacts on the seabed;
- introduce restrictions on the use of gill nets and longlines in all coral habitats that are already protected against the use of bottom gear;
- complete the preparation of regional regulations relating to seaweed and kelp in Møre og Romsdal in the course of 2009;
- in 2010, present a national action plan for protection of coral reefs and other vulnerable seabed habitats;
- consider bottom trawl fisheries in areas that have not previously been trawled to be experimental fisheries. Such fisheries must follow restrictive rules including requirements to report any bycatches of corals, sponges, etc. The fisheries and coastal authorities will systematically review the data they receive and assess whether continued fishing in these areas is to be permitted. Information concerning experimental fisheries is to be made available to the environmental authorities. The environmental authorities will also take part in the development of the legislation and in regular reviews of the data reported;
- regularly consider whether coral reefs in the management plan area that have been mapped should be given special protection against damage from fishing operations;
- not permit drilling in coral reef areas or discharges of drill cuttings in areas where scientific opinion indicates that there is a high probability of damage to coral reefs;
- in areas where the benthic fauna is vulnerable or that are key spawning areas for bottom-spawning fish, require the use of technology for dealing with drill cuttings and drilling mud to prevent sediment deposition.

10.1.2 Marine protected areas

Norway has adopted the goal of establishing an international network of Marine Protected Areas (MPAs) in accordance with decisions to achieve this by 2010 under the OSPAR Convention on the protection of the marine environment of the North-East Atlantic and by 2012 under the Convention on Biological Diversity (CBD). Norway's contribution will be to establish an ecologically coherent national network of well-managed MPAs. Under Norwegian fisheries legislation, protective measures have been implemented both in the form of prohibitions on fishing in specific areas in annual fisheries regulations and in the form of more permanent restrictions. The areas that are to be included in the national marine protection plan will be an important contribution to the network of Marine Protected Areas.

The process of developing Norway's national marine protection plan is further described in Chapter 7.2.

The Government will:
- start the formal planning process for a national marine protection plan in 2009. This means that an evaluation of the various proposals for protected areas will be started, but no prior conclusions have been drawn on which areas to include. The following will be used as a basis for the process:
  - any spatial and general restrictions on petroleum activities in areas more than 12 nautical miles from the baseline are to be set out in the management plans for Norway's sea areas and not modified during the process of selecting areas for protection under the marine protection plan;
  - outside the 12-nautical-mile limit, legislation may be used to restrict all forms of use and activities except petroleum activities in areas selected for inclusion in the marine protection plan;
  - for areas within 12-nautical-mile limit, protection under the Nature Conservation Act/Nature Management Act and/or relevant sectoral legislation will be considered;
  - the 17 areas that will be considered for inclusion in the marine protection plan initially are as follows: Skagerrak transect, Framvaren, Jærkysten, Gaulosen, Rødberg, Skarnsundet, Tautraryggen, Borgenfjorden, Vistenfjorden, Nordfjorden (Rødøy municipality), Saltstraumen, Karlsøyvær, Ytre Karlsøy, Kaldvågfjorden and Innhavet, Rossfjordstraumen, Rystraumen, and Lopphavet. The Government has not drawn prior conclusions on protection of these areas.

10.1.3 Framework for petroleum activities

Petroleum activities are already in progress or planned in large areas of the Norwegian Sea, and

must be organised in such a way that they can coexist with the fisheries and comply with general environmental requirements. Comprehensive legislation has been established to ensure this. The oil and gas industry has had to meet specific requirements and has implemented a wide range of measures to ensure that fisheries interests and environmental concerns are taken adequately into account, for instance as regards discharges of produced water. Nevertheless, ecological goods and services in some areas require special protection.

Vulnerability to oil pollution varies between the areas that have been identified as particularly valuable.

- The Møre banks, Halten bank, Iverryggen reef and Sklinna bank are important spawning grounds, particularly for herring; the Vestfjorden is particularly important as a spawning area for Northeast Arctic cod. Fish eggs and larvae are highly vulnerable to oil pollution.
- There are large numbers of seabirds and coastal seals all along the coastal zone including the Froan archipelago, in the Vestfjorden, and around Jan Mayen. They are highly vulnerable to oil pollution, either all year round or at certain times of year or particular stages of their life cycle. Large numbers of seabirds may also congregate on herring spawning grounds on the shallow bank areas and in nutrient-rich areas along the edge of the continental shelf.
- There are particularly valuable benthic habitats (corals, kelp forests, and probably other valuable benthic communities) in the following areas: the Remman archipelago, the Sula reef, the Iverryggen reef and the edge of the continental shelf. These areas are considered to be particularly vulnerable to physical disturbance of the seabed.

On the basis of an overall evaluation of the particularly valuable and vulnerable areas that have been identified (see the descriptions above and in Chapter 3), the risk of acute oil pollution and the possible environmental impacts of accidents, and the social benefits of petroleum activities, the Government has decided to establish the following framework for petroleum activities in the Norwegian Sea:

The Møre banks

- No blocks will be announced in this area before the first update of the management plan, in 2014 at the latest. The Government will then consider the issue again. This does not apply to the parts of the Møre banks that are included in the system of awards in predefined areas (APA).
- The Government will build up knowledge of the impacts of oil spills on fish stocks. There is currently scientific disagreement about the extent of losses and the likely importance of the loss of fish eggs and larvae from a year class for later stock recruitment. The Government will reconsider the question of petroleum activities on the Møre banks when more information is available.

Delimitation of the area – blocks/parts of blocks (parts of blocks shown in italics):
6304/*12*; 6305/*12*; 6306/*7,8,9*,10,11,12; 6307/*7,8,*10,11; 6204/*2,3,4,5*,6,*7,8,9*,*11*,*12*; 6205/1,2,3,4,5,6,*7,*8; 6206/1,2,3,4.

Halten bank, open part

- No exploration drilling in oil-bearing formations in the spawning season (1 February–1 June).
- No seismic surveys during spawning migration/in the spawning season (1 January–1 May).
- Use of technology to deal with drill cuttings and drilling mud on herring spawning grounds.
- Given the risk-based approach of the health, safety and environment legislation, stricter requirements will apply in vulnerable areas to avoid damage.

Delimitation of the area – parts of blocks:
6408/*4,7*.

Sklinna bank, open part

- No exploration drilling in oil-bearing formations in the spawning season (1 February–1 June).
- No seismic surveys during spawning migration/in the spawning season (1 January–1 May).
- Use of technology to deal with drill cuttings and drilling mud on herring spawning grounds.
- Special steps to strengthen the oil spill emergency response system, including short response times.
- Given the risk-based approach of the health, safety and environment legislation, stricter

requirements will apply in vulnerable areas to avoid damage.

Delimitation of the area – parts of blocks:
6509/*9,12* and 6510/*7,10*.

Coastal zone, northern part

- No steps will be taken at present to initiate opening of areas of the coastal zone that are not currently open for petroleum activities. When the management plan for the Barents Sea–Lofoten area is updated in 2010, the Government will consider whether to initiate opening of these areas for petroleum activities; this process would also include an environmental impact assessment.

Remman archipelago and coastal zone, southern part

- No exploration drilling in oil-bearing formations in the spawning season and breeding and moulting seasons (1 March–31 August).
- Special steps to strengthen the oil spill emergency response system, including short response times.
- Given the risk-based approach of the health, safety and environment legislation, stricter requirements will apply in vulnerable areas to avoid damage.

Delimitation of the area – blocks/parts of blocks:
6307/*2,3,4,5,*6,*7,8,*9;6308/*1,2,*4; 6204/*11*,*12;* 6205/*7*,10.

Entrance to the Vestfjorden, open part

- No blocks will be awarded in this area in the 20th licensing round. If blocks are awarded in later rounds, the following requirements will apply:
- No exploration drilling in oil-bearing formations in the spawning season (1 February–1 June);
- No exploration drilling in oil-bearing formations in the breeding and moulting seasons (1 March–31 August);
- No seismic surveys during spawning migration/in the spawning season (1 January–1 May);
- Special steps to strengthen the oil spill emergency response system, including short response times;
- Given the risk-based approach of the health, safety and environment legislation, stricter requirements will apply in vulnerable areas to avoid damage.

Delimitation of the area – blocks:
6609/1, 2, 3 and 6610/1, 2, 3, 6611/1, 2.

The Iverryggen reef

- In the parts of the Iverryggen reef area that are currently open for petroleum activities, no blocks will be announced before the first update of the management plan, in 2014 at the latest. The Government will then consider the issue again. In its evaluation, the Government will attach importance to new knowledge that has been gained about the area.

Delimitation of the area – parts of blocks:
6509/*10,11*.

Froan archipelago/Sula reef

- In the parts of the Froan archipelago/Sula reef area that are currently open for petroleum activities, no new blocks will be announced before the first update of the management plan, in 2014 at the latest. This does not apply to the parts of the area that are included in the APA system. The Government will reconsider the question of petroleum activities in connection with the first update of the management plan. In its evaluation, the Government will attach importance to new knowledge that has been gained about the area.

Delimitation of the area – blocks/parts of blocks:
6408/*7*,10,11,12; 6409/10; 6307/*2,3*; 6308/*1,2,*3.

The edge of the continental shelf

Special importance will be attached to the following two points:

- New production licences must include requirements for surveys to identify any coral reefs or other valuable benthic communities that may be affected by petroleum activities and ensure that they are not damaged. Special conditions may be included in licences to avoid damage;
- Given the risk-based approach of the health, safety and environment legislation, stricter requirements will apply in vulnerable areas to avoid damage.

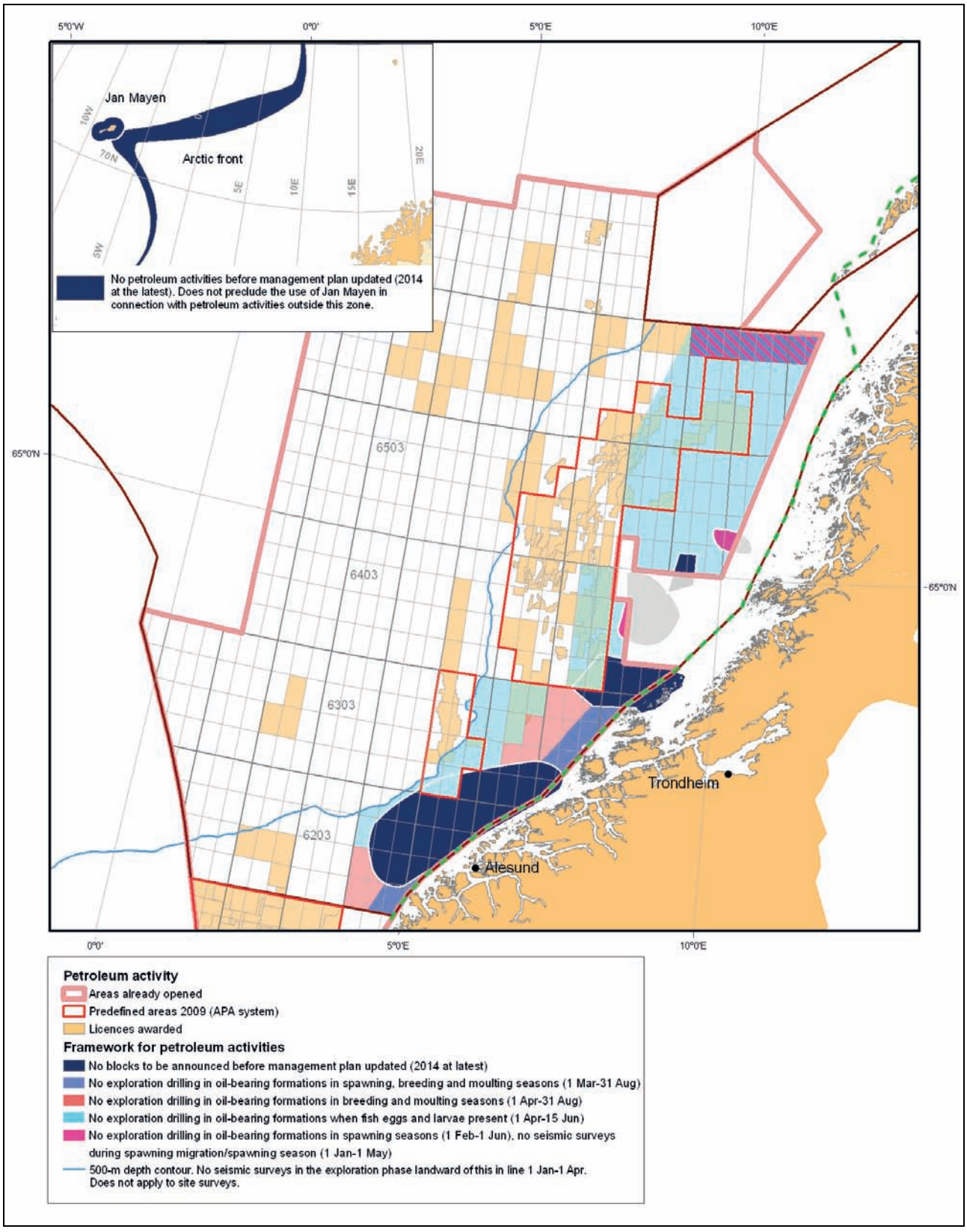

Figure 10.1 Framework for petroleum activities (announcement of blocks, exploration drilling, seismic surveying)

Source: Ministry of the Environment

Jan Mayen/the West Ice

- The Government intends to initiate opening of the Norwegian part of the shelf around Jan Mayen with a view to awarding licences. The first step is to further investigate the petroleum resources and ecological goods and services of the area and to carry out an environmental impact assessment of opening the area for petroleum activities. The Government will use the conclusions of this impact assessment as a basis for determining the framework for petroleum activities.
- However, before the first update of the management plan, in 2014 at the latest, no petroleum activities will be permitted in a zone stretching 30 km outwards from Jan Mayen. This does not preclude the use of Jan Mayen in connection with petroleum activities outside this zone. In connection with the first update of the management plan, the Government will reconsider the question of petroleum activities close to Jan Mayen. In its evaluation, the Government will attach importance to new knowledge that has been gained about the area.
- There may also be mineral resources other than petroleum in this area. This management plan does not involve any restrictions on exploration and extraction of such resources.

The arctic front

- The Government does not propose to open any areas within the arctic front for petroleum activities at present. The Government will consider this issue again in connection with the first update of the management plan, in 2014 at the latest.

Other areas that have been opened for petroleum activities in the Norwegian Sea

The environmental and fisheries-related requirements in licences for parts of the Norwegian Sea not discussed above have also been reviewed. In these areas, the current requirements will generally continue to apply, including those laid down in the 20th licensing round. Until the first update of the management plan, in 2014 at the latest, the following environmental and fisheries-related requirements will apply to new licences in these areas:

- No seismic surveys in the exploration phase to be carried out landward of the 500-metre depth contour in the period 1 January–1 April. This restriction does not apply to site surveys;
- No exploration drilling in oil-bearing formations when fish eggs and larvae are present (1 April–15 June) in the blocks 6204/*1,2,3,4,5,*7,*8* and 6304/*12* landward of the 500-metre depth contour; quadrant 6305 landward of the 500-metre depth contour, quadrants 6306, 6307, 6407/2,3,5,6,8,9,11,12; 6408/*4,7*; 6508, 6509, 6510, 6608/*3,5,6,7,8,*9,*10,*11,12; 6609, 6610 and 6611;
- No exploration drilling in oil-bearing formations in the breeding and moulting seasons (1 April–31 August) in the blocks 6204/*7,8,*10,*11;*6306/6,*8,9;*6307/1,*2,3,4,5,7*.

No further environmental and fisheries-related requirements for petroleum activities in these areas will be included in licensing rounds (including APA rounds) before the first update of the management plan, in 2014 at the latest.

The authorities will take a flexible approach to the environmental and fisheries-related requirements.

On application, the environmental and fisheries-related requirements that are included in new licences may also be made applicable to existing licences for these areas.

Updating and revision of the management plan

The management plan will be a rolling plan and will be updated at regular intervals. The first update will be made at the latest in 2014. At this point, the Government will also conduct a new assessment of the spatial framework for petroleum activities in the Norwegian Sea. On the basis of the overall needs that have been identified, a process will be started well before 2025 with a view to an overall revision of the management plan in 2025 with a time frame up to 2040.

10.1.4 Surveys of the seabed in connection with petroleum activities

The petroleum industry already collects large amounts of data in connection with activities such as pipeline route surveys, the siting of wells and installations on the seabed, and environmental surveys of the seabed. Such data should be made more readily available to the public administration and for use in the MAREANO programme and by the Norwegian Mapping Authority.

The Government will:
- when issuing new petroleum production licences, require licensees to survey the relevant areas with a view to identifying any coral reefs and other valuable benthic communities and habitats that could be affected by petroleum activities and ensure that they are not damaged by such activities. This condition will apply to all surrounding areas that could be affected as well as the area covered by the licence. Special requirements may be imposed to avoid damage caused by petroleum activities;
- when issuing new petroleum production licences, require licensees to survey and report on finds of shipwrecks and other underwater cultural heritage that could be affected by petroleum activities in the areas concerned and, in cooperation with the cultural heritage authorities, ensure that they are not damaged by such activities;
- require licensees to ensure that data collected on topography, benthic fauna, etc. are made available to the Norwegian Mapping Authority and for use in the MAREANO programme.

10.1.5 Seismic surveys in connection with petroleum activities and coexistence between the fisheries and petroleum industries

As an extra safety precaution to avoid damage to fish resources, and to reduce conflicts of interest between the fisheries industry and the petroleum industry in its role as the client commissioning seismic surveys, rules have been established for where and when such surveys are permitted.

A working group with representatives from the Directorate of Fisheries and the Norwegian Petroleum Directorate was appointed in September 2007 to review the legislation for seismic surveys in order to identify possible conflicts of interest and make proposals for measures to reduce conflict. A second working group, in which the Ministry of Fisheries and Coastal Affairs, the Norwegian Petroleum Directorate and business interests also participated, reviewed existing compensation rules. The two groups presented their final reports on 1 April 2008, with proposals for measures in the following areas:
- administrative procedures – notification of seismic surveys, pipeline route surveys and other baseline studies, consultations;
- announcements;
- fisheries experts – role, number, organisation, competence/training, approval, contact with the authorities, reporting;
- conflicts of interest related to different uses of the same areas;
- tracking of seismic vessels;
- potential for rationalisation.

The working groups' proposals have been or will be incorporated in the legislation and implemented. For example, as from 1 January 2009, time limits for dealing with demands for compensation and a new, simplified electronic form for applications for compensation have been introduced. Furthermore, a steering group has been established consisting of representatives from the Norwegian Petroleum Directorate, the Directorate of Fisheries and the Norwegian Pollution Control Authority. The group was asked to review acoustic disturbance and other negative impacts on fish and marine mammals caused by seismic activity, with a view to establishing a recommended minimum distance from fishing activities, fish farming, and whaling and sealing. The steering group was also asked to assess the need for legislative amendments and make proposals based on their conclusions concerning negative impacts. The group will also propose measures to regulate other testing activities. The group presented its report on 30 April 2009.

The Government will:
- follow up the efforts to establish legislation regulating seismic activity that will reduce the potential for conflict between such activity and fisheries;
- seek to reduce uncertainty as regards acoustic disturbance and other possible negative impacts of seismic surveys on marine life.

10.2 Species management

10.2.1 Sustainable harvesting

The objective of Norwegian fisheries management is that all fisheries should be sustainable. However, some fish stocks are currently not in a very healthy condition. Special management strategies are proposed for these stocks to in order to rebuild them and ensure that sustainable fishing will be possible in the future. In some cases, particularly for socio-economic reasons, it will be necessary to permit harvesting on a scale that will prolong the time needed to rebuild a particular stock.

Fisheries have an impact on marine ecosystems. Satisfactory knowledge of individual stocks and their interactions with other species in the food chains is essential to ensure sustainable harvesting of living marine resources. The most important fish stocks in the Norwegian Sea are shared between several nations, and annual quotas for each country are negotiated on the basis of advice from the International Council for the Exploration of the Sea (ICES). The principle for management of wild living marine resources set out in the Marine Resources Act applies to all harvesting of such resources, and means that the authorities must assess each stock regularly. Application of this principle will require an enhanced research effort to build up the knowledge base that will be needed.

It is only possible to harvest sustainably from healthy ecosystems, and these in turn are dependent on biodiversity. Sustainable harvesting of living marine resources is a vital step in achieving the Government's target of halting the loss of biodiversity by 2010. It will therefore be important to increase the proportion of commercially exploited stocks that are surveyed, monitored and harvested in accordance with sustainable management strategies. This approach must be reflected in Norway's efforts to ensure that the International Council for the Exploration of the Sea (ICES) can set precautionary reference points for the spawning stocks of all harvested species and stocks.

The pressure on fisheries resources is influenced by many factors, and the Government considers it important for management purposes to register all types of pressure on fish stocks. This includes efforts to quantify and reduce «ghost fishing», the term used for lost or abandoned fishing gear that continues to catch fish. Directed fisheries for endangered species must be stopped, a principle that must also be applied in international management cooperation. The Government also considers it important to build up knowledge of marine species that are harvested but for which there is an inadequate scientific basis for regulation. Precautionary management regimes must also be established for harvested marine species for which no such regime currently exists.

The Government will:
- further develop systematic monitoring and management of living marine resources in accordance with the Marine Resources Act;
- in accordance with the target of halting the loss of biodiversity by 2010, continue the development of an ecosystem-based management regime for living marine resources;
- take part in international efforts to build up knowledge of individual fish stocks so that the overall harvest from the Norwegian Sea is sustainable;
- build up knowledge about marine species that are harvested.

10.2.2 Illegal, unreported and unregulated fishing (IUU fishing) in the Norwegian Sea

Good management of fish stocks depends on reliable information on catches. Illegal, unreported and unregulated fishing (IUU fishing) is a threat to sound, sustainable management because it increases the harvest to unacceptable levels.

The Government will:
- work to make Norwegian controls at sea and control of the quantities of fish landed and sold more effective;
- continue its close cooperation with relevant coastal states to facilitate bilateral and regional arrangements for coastal and port state control that make IUU fishing more difficult;
- continue efforts within FAO to develop a legally binding international regime for port state control in the fisheries;
- in the UN and all relevant regional fisheries management organisations, work towards closer cross-sectoral cooperation to combat IUU fishing;
- improve transparency and traceability in the value chain for fish and fish products, in the first instance by introducing a catch certification scheme, which from 1 January 2010 must be in place for all exports of fish and fish products to the EU.

10.2.3 Protection of seabird populations

Seabirds are an important element of biodiversity in their own right, and their populations are also very good indicators of the state of and trends in marine ecosystems. In recent years, a serious decline has been registered for a number of seabird populations. Good surveys and long-term monitoring of seabird populations are an important source of knowledge about seabird populations and the pressures on them. The Government will take steps to protect seabird populations, in accordance with the target of halting the loss of biodiversity by 2010.

The Government will:
- improve knowledge about seabirds through the SEAPOP mapping and monitoring programme;
- continue the SEAPOP programme in all Norwegian sea areas, along the entire Norwegian coast and in Svalbard;
- ensure that resource management is based on ecosystem considerations, including the food supplies needed by seabirds;
- give priority to efforts to find the causes of the decline in seabird populations in the western part of the Nordic region;
- continue the development of an action plan for seabirds;
- review experience of cleaning and rehabilitating oil-contaminated seabirds and consider whether further work is needed on the implications for populations and animal welfare.

The steep decline in seabird populations in the Norwegian Sea in recent years has made it necessary to improve knowledge of the environmental pressures affecting seabirds. These include long-range transboundary pollution, climate change, food shortages, oil spills and human activities on land. In addition, seabirds are taken as unintended bycatches during fisheries activities, and there has been uncertainty about the scale of this problem.

Bycatches of seabirds are therefore being registered on a daily basis by a reference fleet of gill net vessels that cover the entire coastline, and a second reference fleet of seagoing fishing vessels. The data collected will be scaled up to provide an estimate of the total bycatches.

The Government will:
- on the basis of the results of these studies and monitoring activities, evaluate the need for further measures to reduce bycatches of seabirds.

10.2.4 Alien species

The introduction and spread of alien species is a threat to marine biodiversity, and may have serious ecological and economic impacts. Ballast water exchange by ships is one important route of introduction. The International Maritime Organization (IMO) has adopted international rules on ballast water exchange in the Ballast Water Convention. Norway has ratified the convention, and a public consultation has been held on proposed national legislation, including the designation of ballast water exchange zones (see Chapter 7).

The Government will:
- adopt regulations on ballast water in summer 2009;
- act as a driving force in efforts to persuade more countries to ratify the Ballast Water Convention so that it can enter into force.

10.3 Measures to reduce pollution and pollution risk

10.3.1 Preventive measures for safety at sea and oil spill response

In general, maritime transport is a safe, environmentally friendly form of transport. However it does pose environmental risks, and the consequences of accidents can be serious. The Government therefore gives high priority to measures for preventing accidents and reducing the risk of acute oil pollution along the coast. Key tools include the maintenance, operation and development of maritime infrastructure and services, and standards and controls for vessel construction and equipment and crew qualifications. Special routeing measures, such as moving maritime transport further away from the coast, are also an important tool for reducing the risk of accidents. Updated plans to include an overview of ports of refuge may also be of crucial importance in managing the risk of accidents along the coast.

The volume of traffic in the Norwegian Sea is expected to increase up to 2025 as a result of increased traffic from Russia, and the expected growth will pose a greater risk of oil spills unless risk-reduction measures are implemented. The environmental risks are influenced by the growth in maritime transport, the amount and type of petroleum products being shipped, and the amount and type of bunker fuel on board. There is dense traffic in the coastal areas of the Norwegian Sea, especially in the area off Stad at around 62° N, which is a meeting point for several different traffic streams. Oil spills in coastal areas have a short expected drift time to shore, which means that there is a high probability that the oil will reach the coast. The oil spill response system must therefore have a rapid response capacity and adequate resources for preventing any spills from having a negative impact on vulnerable resources along the coast. The rapid response system for acute pollution in the management plan area must therefore be dimensioned to take account of the risk of oil spills.

As part of its efforts to enhance safety at sea through preventive measures and to reduce the

consequences of oil spills through the government oil spill response system, the Government will:

- consider cooperating with other countries to establish a cross-border regional or international Vessel Traffic Management Information System (VTMIS). The first step will consist of exchanging automatic identification system (AIS) data;
- play an active role in the international cooperation on the development and implementation of e-navigation;
- continue the efforts to follow up the report on governmental oil spill response equipment – current status and recommendations for renewal and upgrade up to 2010;
- provide a revised overview of suitable ports of refuge in close cooperation with stakeholders, including municipalities;
- strengthen the system of courses, exercises and training for oil spill response teams;
- facilitate the development of oil spill response technology to deal with challenging conditions in the management plan area, for example large waves.

Traffic separation schemes and other routeing measures

At present much of the traffic stream in the Norwegian Sea sails along the coast, and releases of pollutants may therefore have serious consequences for valuable and vulnerable areas along the coast. The high probability of collisions or stranding and the potentially short drive time to shore for oil spills and for vessels with operational or manoeuvring problems make emergency management a challenging task. The area off Stad at around 62° N is particularly vulnerable (dense traffic, beaches, seabirds, herring eggs and larvae at certain times of the year). Moving traffic further out to sea would considerably reduce the risk of accidents, allow more time for response in the event of an accident and reduce the environmental risks to resources in the coastal areas. There is a great deal of commercial activity, involving a number of different industries, in the sea areas concerned and this must be taken into account in the establishment of new traffic separation schemes lanes or other routeing measures. The Government has started work on the evaluation of traffic separation schemes and other routeing measures from Røst and southwards along the Norwegian coast. The establishment of routeing measures outside Norway's territorial waters, such as the Vardø–Røst shipping lane, requires the approval of the IMO.

The Government will:

- continue the efforts to divert maritime transport further away from the coast southwards from Røst, and plans to hold a consultation in the course of 2009 on a proposal for routeing measures to reduce risk, which will then be presented to the IMO. The routeing measures will provide the same level of protection for this part of the coast as the routeing and traffic separation scheme Vardø–Røst.

10.3.2 Other measures to reduce pollution

Discharges to the sea from petroleum activities

At present the environmental impacts of ordinary petroleum operations in the Norwegian Sea are limited and local. However, we do not know enough about the long-term effects of releases of pollutants with produced water. Such releases are strictly regulated, see Chapter 5.3. Discharges of produced water will more than double in the period up to 2014, but are then expected to decrease to about half the current level by 2025. The current strict rules must be maintained to ensure that the environmental impacts of such discharges continue to be small.

The Norwegian Pollution Control Authority, the Petroleum Directorate and the Norwegian Radiation Protection Authority drew up a report in December 2008 evaluating the environmental and social costs and benefits of zero discharges, see Chapter 5.3.

On the basis of the recommendations in the report, the Government will:

- include technologically enhanced naturally occurring radioactive materials (TENORM) in the zero-discharge targets;
- not introduce general requirements for zero discharges of produced water and/or drill cuttings and drilling mud;
- conduct socioeconomic cost-benefit analyses for new and old fields that will include overall environmental assessments of measures to prevent discharges of produced water and/or drill cuttings and drilling mud;
- in areas where the benthic fauna is vulnerable or that are key spawning areas for bottom-spawning fish, require the use of technology for dealing with drill cuttings and drilling mud to prevent sediment deposition.

Requirements concerning discharges may be revised as new information and more advanced technology become available. Comments from the

ongoing consultations on the above-mentioned report will be included in the assessment of whether to make such revisions. If new information is presented during the consultation that will make it necessary to revise such requirements at a later date, the Government will return to the matter.

Sellafield

An accident involving releases of radioactivity could significantly increase inputs of radioactive substances. The large stocks of liquid high-level waste at Sellafield are considered to pose the highest risk of radioactive contamination of the Norwegian Sea. A worst-case scenario has been developed for the impacts of a large-scale release of waste from Sellafield on the Barents Sea. This study, which is also relevant to the Norwegian Sea, showed that releases on this scale could result in substantial inputs of Cs-137 and Sr-90 with ocean currents, and a rise in activity concentrations of these substances. However, we do not know enough about the impacts of low-dose radiation on the environment and it is therefore difficult to assess the consequences. Given the high potential for releases to water and air from the liquid high-level waste at Sellafield, and the risk to Norwegian sea and land areas posed by such releases, the Government attaches great importance to the efforts to bring about the closure of the nuclear facilities that are the source of this waste.

The Government will:
- give high priority to reducing the risk of releases of radioactivity from Sellafield that could affect Norwegian sea areas.

10.4 Strengthening the knowledge base – surveys, research and monitoring

We know a good deal about many of the most important components of the ecosystems in the Norwegian Sea, but there are considerable gaps in our knowledge about others, and especially in our knowledge of the pressures on ecosystem components and of the interdependence between them.

There have been relatively few studies of the benthic fauna in the Norwegian Sea given the size of the area and the great variations in temperature, depth and conditions on the seabed. General surveys of depth, topography, sediment quality, pollution levels and habitats and biodiversity in the Norwegian Sea are needed. Surveys and research should be relevant to the practical management of sea areas.

The Government will:
- take the initiative to improve knowledge of ecosystem-based management;
- improve knowledge of the structure and functioning of marine ecosystems;
- improve knowledge of the seabed and seabirds by continuing the MAREANO programme for the seabed and the SEAPOP programme for seabirds;
- improve knowledge on the prevention of accidents that may result in pollution;
- improve knowledge about the socioeconomic issues related to management of the marine environment.

10.4.1 Climate and ocean acidification

Climate change and ocean acidification may have far-reaching impacts on ecosystems in the Norwegian Sea. However, the interactions between these factors are so complex, and the level of knowledge is still so low, that it is impossible to say with any certainty what these impacts will be. We therefore need to survey the current status, further develop the necessary long-term monitoring programmes, and give priority to research in cooperation with international research programmes. The focus should be on climate and acidification trends and the combined effects on ecosystems and the resource base. Long time series obtained from monitoring and research are the most important basis for all climate research.

The Government will:
- ensure that knowledge is developed on the separate and combined impacts of climate change and ocean acidification on marine ecosystems, so that management of the Norwegian Sea area can be adapted to the changes that are taking place;
- ensure systematic long-term monitoring of acidification and climate trends and the impacts on vulnerable fish stocks and species and habitats, including coral reefs, in the Norwegian Sea and the Barents Sea, as part of the monitoring programmes under the management plans for these sea areas;
- ensure that possible adaptation measures for the relevant sectors are reviewed;
- seek to ensure that the significance of climate change and ocean acidification for the marine

environment are given sufficient priority in international cooperation on climate and the marine environment.

10.4.2 Monitoring the state of the environment in the management plan area

Chapters 2 and 9 set out the goals for management of the Norwegian Sea. Ecosystem-based management of human activity in the area must be based on continuous assessment of ecosystem trends in relation to these goals. A system for monitoring ecological quality must be established so that the management authorities can be warned of changes that require action.

The Government will:
- further develop an integrated monitoring system for the marine ecosystems in the Norwegian Sea:
- intensify the efforts to develop representative indicators, reference values and action thresholds that will enable the monitoring programmes to reveal changes in ecosystems in relation to the goals for biodiversity, pollution control and safe seafood.

10.4.3 Offshore wind power

In general, the establishment and operation of offshore wind turbines is expected to have impacts on natural resources locally and at the individual level. However, there is considerable uncertainty about the scale of such impacts, especially as regards seabirds. Little is known about the collision risk and barrier effects on resident and migratory birds. We also know little about the effects of offshore wind turbines on marine biodiversity.

The Government's goal is to promote the development of environmentally friendly wind power. Building wind turbines offshore is technically more complicated than it is on land. In other countries offshore wind turbines are built in shallow water, at depths of down to 45 metres, but the establishment of large-scale offshore wind farms in Norway will require fixed installations for deeper water and/or floating offshore installations, both of which are currently still at the development stage. Currently, specific plans for development of large-scale fixed installations are being considered for the coastal zone off Møre og Romsdal in an area adjacent to and partly overlapping the management plan area (Havsul I has been licensed by the Norwegian Water Resources and Energy Directorate, whereas the application for Havsul II has been rejected. Both decisions have been appealed to the Ministry of Petroleum and Energy). A project for the development of floating installations off Stad, at the southern border of the management plan area, has also been submitted. However, this project is based on untested technology. The construction of offshore wind power installations will have impacts on other users, for example the fisheries and shipping industries. Together with the cables and other infrastructure for electricity transmission to shore, these installations may also have impacts on the marine and coastal environments.

The Ministry of Petroleum and Energy is drawing up a national strategy for offshore wind power to facilitate the development of the industry and at the same time ensure that this takes place in a way that minimises conflict with other user interests and takes account of the particularly valuable and vulnerable areas. As part of the strategy, the Ministry is holding a public consultation on a draft act relating to renewable energy outside the baseline. According to the draft act, the authorities will identify areas that will be opened for applications for the establishment of wind power installations.

The Government will:
- take the initiative for a strategic impact assessment of suitable areas for offshore wind power development with a view to identifying those that may be opened for applications for development;
- present a proposal in 2009 for an act relating to renewable energy outside the baseline;
- in areas where ecological goods and services are of particular value, impose special requirements for assessments of pressures and impacts, particularly for benthic habitats, spawning areas for herring, and migration routes for seabirds, when planning future operations.

10.5 Organisation and implementation

Integrated, ecosystem-based management of the Norwegian Sea will require close coordination between sectors and between the public institutions responsible for management of the Norwegian Sea area. At ministerial level, the Ministry of the Environment will coordinate the work and head the interministerial Steering Committee.

10.5.1 Advisory groups

Close coordination between directorates and institutions will be necessary to ensure a sound basis for the implementation of the management plan for the Norwegian Sea.

The Government will:
- appoint an expert group to follow up the management plan for the Norwegian Sea.

The group will be called the Forum for Integrated Management of the Norwegian Sea and will be headed by the Directorate for Nature Management. The group will consist of representatives from public institutions with management responsibilities for sea areas.

The Government will:
- expand the terms of reference of the Advisory Group on Monitoring of the Barents Sea and the Forum on Environmental Risk Management to include the Norwegian Sea and the North Sea.

The Management Forum responsible for the coordination and overall implementation of the scientific aspects of ecosystem-based management of the Barents–Lofoten area will continue its work under the leadership of the Norwegian Polar Institute. The Norwegian Pollution Control Authority is heading a similar expert group that is preparing the scientific basis for a management plan for the North Sea.

In line with this, the Government will:
- draw up more detailed terms of reference for the Advisory Group on Monitoring and the Forum on Environmental Risk Management for the Barents Sea–Lofoten area, the Norwegian Sea and the North Sea to include specific time limits for reporting.

10.5.2 Closer integration of interest groups

Under the integrated management plan for the Barents–Lofoten area, a Reference Group has been appointed for the work on the ecosystem-based management regime that represents the various interests involved, including business and industry, environmental organisations and Sami interest groups. Through its meetings, the Reference Group promotes transparency in the implementation of the management plan and ensures that stakeholders are able to voice their comments and views to the authorities. The group normally holds one meeting a year, and discussions are based on the reports from the Advisory Group on Monitoring and the Forum on Environmental Risk Management. The Management Forum for the Barents–Lofoten area reports the views of the Reference Group to the Steering Committee.

The Government will:
- expand the terms of reference of the existing Reference Group for the Barents–Lofoten area to include the Norwegian Sea and the North Sea. The group will hold meetings with the bodies responsible for implementing the management plans to give them the opportunity to present their views.

10.5.3 Exchange of information and experience

The Government will:
- coordinate the publication of information about the scientific work and environmental information related to this management plan, for example through the website www.environment.no;
- strengthen knowledge-sharing by all the institutions involved in integrated marine management, especially the Directorate for Nature Management, the Norwegian Polar Institute, the Norwegian Pollution Control Authority, the Directorate of Fisheries, the Norwegian Petroleum Directorate, the Institute of Marine Research, the National Institute of Nutrition and Seafood Research, the Norwegian Institute for Nature Research and the Norwegian Institute for Water Research.

10.5.4 Strengthening international cooperation

The Government will:
- share experience gained through the present management plan in the work on integrated management of the marine environment within the framework of the OSPAR Commission and the EU;
- consider the management plan in the context of the EU Marine Strategy Framework Directive;
- strengthen the cooperation on management measures in the North East Atlantic Fisheries Commission, including the work on protection of vulnerable areas against fisheries activities;

- seek to ensure that knowledge about the rising CO_2 levels in the sea is included in the international climate negotiations;
- promote knowledge-sharing about the bioaccumulation of hazardous substances in marine ecosystems in the High North in international chemicals negotiations;
- play an active role in the Nordic work on management of the marine environment.

10.5.5 Updating and revision of the management plan

The management plan will be a rolling plan and will be updated at regular intervals.

The Government will:

- regularly assess the need to follow up and update this management plan;
- update the plan for the first time by 2014. The Government will at this point also conduct a new assessment of the spatial framework for petroleum activities in the Norwegian Sea;
- on the basis of the overall needs that have been identified, start a process well before 2025 with a view to an overall revision of the management plan in 2025, with a time frame up to 2040;
- on the basis of status reports from the Advisory Group on Monitoring of the Barents Sea and the Forum on Environmental Risk Management, assess the overall need for new measures to achieve the goals of the plan.

11 Economic and administrative consequences

The present white paper contains proposals for new working methods, processes for reviewing the current use of instruments in the various sectors, and specific measures. It also indicates topics to be reviewed at a later date. The economic and administrative consequences of the various proposals can be predicted with varying degrees of accuracy, but as the proposals are implemented the consequences for public and private actors will be assessed in the usual way as set out in the Instructions for official studies and reports and the preparation of legislation. The measures outlined in the management plan that will require increased budgets or allocations will be considered by the Government in the ordinary budgetary processes and presented in the budget propositions of the ministries concerned. The Government will evaluate the measures in the management plan in relation to other priorities. Follow-up and implementation of measures in the years to come will therefore depend on economic developments and the budget situation. The following is a preliminary assessment of the economic and administrative consequences of the proposals put forward in this white paper.

11.1 Assessment of measures for integrated ecosystem-based management

Implementation of the management plan

An expert group will be appointed to follow up the implementation of the management plan for the Norwegian Sea (the Forum for Integrated Management of the Norwegian Sea). The terms of reference of the Advisory Group on Monitoring of the Barents Sea and the Forum on Environmental Risk Management will be expanded to include the Norwegian Sea and the North Sea. This will improve the coordination and provide a better foundation for management of the Norwegian Sea. It will also involve more work for the directorates and institutes concerned. In addition, the terms of reference of the Reference Group established for the Barents Sea–Lofoten area are to be expanded to include the Norwegian Sea and the North Sea, which will also involve more work. The volume of work for these groups will vary over time, but will always be larger in connection with the scheduled reports. These efforts will be part of the established administrative framework and a continuation of existing activity. Thus the additional work is not expected to have financial consequences of any significance.

Integrated monitoring system for the Norwegian Sea

The costs relating to the development of a system for monitoring the state of the ecosystem in the Norwegian Sea, based on the integrated monitoring system for the Barents Sea–Lofoten area, will be studied in more detail in connection with the annual budget proposals. A great deal of the work of developing the monitoring system will take place within the framework of the research and monitoring already being conducted in the management plan area. Since it will be necessary to monitor a larger number of indicators across a larger geographical area, more funding will be required, and this question will be reviewed in connection with the annual budget proposals.

Surveys

The Government will seek to systematise and improve knowledge about the Norwegian Sea by continuing the MAREANO programme. Areas that provide particularly valuable ecological goods and services, or where such goods and services are particularly vulnerable, will be identified and mapped. Surveys of the seabed will be necessary in order to develop cost-effective tools that will ensure the sustainable use of such areas.

Conducting surveys properly is expensive. The MAREANO programme in the Barents Sea–Lofoten area is costing NOK 51.5 million in 2009. The Government will consider the annual allocations for continuation of the programme in connection with the annual budget proposals.

The Government will continue the SEAPOP programme in the Norwegian Sea, and the costs relating to continuing the programme at the cur-

rent level of activity will be met within the existing budget framework.

Climate change and ocean acidification – knowledge development

More funding will be required to meet the Government's goal of improving knowledge on climate change and ocean acidification. The Government will consider the allocations for knowledge development in connection with the annual budget proposals.

Protection of coral reefs and other habitats

Corals require special protection since they form vulnerable habitats and are important components of ecosystems. This makes it necessary to restrict bottom trawling, which can damage vulnerable habitats on the seabed. Protecting coral reefs will be profitable in the long term because it will protect areas that are important for marine biodiversity and as spawning and nursery areas for commercial fish stocks.

Restricting bottom trawling in areas that have not previously been trawled until seabed surveys have been carried out may have economic consequences for the fisheries, since fishermen will be unable to operate freely in all areas when using trawls and other bottom gear. It is difficult to calculate or estimate the costs of imposing restrictions on bottom trawling in such areas, but it is likely that there will be a temporary loss of income for fisheries using these specific areas. However, such losses could probably be compensated by fishing in other areas.

Framework for petroleum activities

A framework for petroleum activities in particularly valuable and vulnerable areas has been proposed, including spatial restrictions on activities up to 2014, when the management plan will be updated. In some parts of the management plan area, restrictions on when drilling is permitted have been introduced to take account of vulnerable natural resources such as spawning fish or nesting seabirds. The proposal is based on a precautionary approach to protection of areas of particular ecological importance.

The proposed framework could result in loss of revenues from petroleum activities, since any resources present cannot be extracted from areas where no activities are to be started. However, since the resource potential of the areas concerned is not known, it is extremely difficult to estimate the extent of such losses.

Discharges to the sea from petroleum activities

On the basis of a report submitted by the Norwegian Pollution Control Authority, the Petroleum Directorate and the Norwegian Radiation Protection Authority that evaluated the environmental and social costs and benefits of zero discharges, the Government will not introduce general requirements for zero discharges of produced water and/or drill cuttings and drilling mud, but will include technologically enhanced naturally occurring radioactive materials (TENORM) in the zero-discharge targets. In areas where the benthic fauna is vulnerable or that are key spawning areas for bottom-spawning fish, operators will be required to use technology for dealing with drill cuttings and drilling mud that will prevent sediment deposition. Requirements concerning releases may be revised as new information and more advanced technology become available. Adaptations to new requirements will increase costs to an extent that will vary from field to field.

Prevention of acute pollution from maritime transport

Implementing the measures proposed in the management plan will offset the higher risk of acute pollution represented by the increase in maritime traffic in the management plan area. This will reduce environmental risks and on-scene clean-up costs, and will safeguard Norway's reputation as a supplier of safe seafood.

The costs of several of these measures will be mainly related to personnel resources in ministries and subordinate agencies. Training courses, exercises, technological development, international cooperation and following up the report on governmental oil spill response equipment (current status and recommendations for renewal and upgrade up to 2010) will involve additional costs. The Government will consider allocations for this purpose in connection with the annual budget proposals.

Costs will be incurred in connection with the introduction of routeing and traffic separation schemes. Such schemes may also result in higher costs for the shipping and other industries if ships have to follow a longer route along the Norwegian coast.

11.2 Administrative consequences

A number of the measures proposed in this management plan will call for closer cooperation between agencies, but no changes will be made in the formal organisational structure. The measures will also call for closer coordination between research and management.

The remaining measures are not expected to have administrative consequences of any significance.

The Ministry of the Environment

h e r e b y r e c o m m e n d s :

that the Recommendation from the Ministry of the Environment concerning integrated management of the marine environment of the Norwegian Sea dated 8 May 2009 should be submitted to the Storting.

Appendix 1

Abbreviations

AIS	Automatic Identification System
APA	Awards in predefined areas
ACAP	Arctic Contaminants Action Program (Arctic Council working group)
AMAP	Arctic Monitoring and Assessment Programme (Arctic Council working group)
CAFF	Conservation of Arctic Flora and Fauna (Arctic Council working group)
CBD	Convention on Biological Diversity
CLCS	Commission on the Limits of the Continental Shelf
EEA	Agreement on the European Economic Area
EMSA	European Maritime Safety Agency
EPPR	Emergency Prevention, Preparedness, and Response (Arctic Council working group)
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross domestic product
HELCOM	Helsinki Commission
HSE	Health, safety and environment regulations
ICES	International Council for the Exploration of the Sea
IMO	International Maritime Organization
IUU fishing	Illegal, unreported and unregulated fishing
IWC	International Whaling Commission
MARPOL	International Convention for the Prevention of Pollution from Ships
MPA	Marine Protected Area
NAMMCO	North Atlantic Marine Mammal Commission
NEAFC	North East Atlantic Fisheries Commission
NOFO	Norwegian Clean Seas Association for Operating Companies
o.e.	Oil equivalent
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PAME	Protection of the Arctic Marine Environment (Arctic Council working group)
PCBs	Polychlorinated biphenyls
SEAPOP	SEAbird POPulations monitoring programme
SOLAS	International Convention for the Safety of Life at Sea
TBT	Tributyl tin
UNCLOS	United Nations Convention on the Law of the Sea
QSR 2010	Quality Status Report (OSPAR)

Appendix 2

Elements of the monitoring system for environmental quality

Table 2.1 Proposed set of indicators with reference values and action thresholds

Indicator	Reference value	Action threshold
Ocean climate		
Temperature, salinity and nutrients along fixed transects	Summer and winter averages, last 10 years	
Transport of Atlantic water into Norwegian Sea	-»-	
Phytoplankton		
Timing of spring bloom with reference to data from weather observation station M	Average value over last 10 years	
Phytoplankton biomass expressed as quantity of chlorophyll a	-»-	
Zooplankton		
Zooplankton biomass in the Norwegian Sea	Average value over last 10 years	
Species diversity along fixed transects	Historical data	
Population estimate for *Calanus finmarchicus*	Average value over last 10 years	
Fish stocks		
Spawning stock of Norwegian spring-spawning herring	Precautionary reference point	Estimated spawning stock is below precautionary reference point
Spawning stock of blue whiting	-»-	-»-
Spawning stock of North-East Arctic saithe	-»-	-»-
Longline catches of ling and tusk	Average catch per unit effort for each species, 2000–2005	To be developed
Spawning stocks of fish stocks that are being restored to sustainable levels	Precautionary reference point*	Estimated spawning stock is below precautionary reference point

Table 2.1 Proposed set of indicators with reference values and action thresholds

Indicator	Reference value	Action threshold
Marine mammals		
Spatial distribution of whale communities	Average population numbers for last 10 years + historical data	Unexpected decrease of more than 20 % in minke whale population over 5-year period
Population trend for hooded seal	Average for last 10 years	Unexpected decrease of more than 10 % in the population over 5-year period
Bycatch of common porpoise, Vestfjorden	Average for first 5 years of time series	Annual porpoise bycatch exceeds average value for first 5 years of time series (start 2005)
Seabirds		
Spatial distribution of seabird communities	Average for last 10 years + historical data	Population decrease of 20 % or more in 5 years or deviation of more than 10 % from expected distribution
Population trend for kittiwake	Average for last 10 years + historical data	Population decrease of 20 % or more in 5 years, or deviation of more than 10 % from expected adult survival rate, or failed breeding 5 years in a row
Population trend for common guillemot	-»-	-»-
Population trend for puffin	-»-	-»-
Population trend for common eider	-»-	-»-
Population trend for shag	-»-	-»-
Benthic communities and habitats		
Status of selected vulnerable habitats	Status of known habitats	Significant change
Vulnerable and endangered species		
Vulnerable and endangered species and species for which Norway has special responsibility	Viable population level and historical data on population levels	Population of selected species is below the level considered to be viable
Alien species		
Records of alien species	Historical data	Alien species recorded during monitoring or risk of introduction of alien species

Table 2.1 Proposed set of indicators with reference values and action thresholds

Indicator	Reference value	Action threshold
Pollutants (see Appendix 3)		
Atmospheric inputs	Natural background level	Steady rise in pollutant concentrations continuing for specified number of years, or sudden large rise from one sample to the next in an area
Radioactivity in seawater	Natural background level	-»-
Ocean acidification**	Summer and winter averages, last 10 years	-»-
Pollutants in blue whiting	Natural background level	-»-
Pollutants in coastal cod	-»-	-»-
Pollutants in Norwegian spring-spawning herring	-»-	-»-
Pollutants in Greenland halibut	-»-	-»-
Pollutants in tusk	-»-	-»-
Pollutants in hooded seal	-»-	-»-
Pollutants in shag eggs	-»-	-»-
Pollutants in shrimps	-»-	-»-
Pollutants in mussels	-»-	-»-
Pollutants in sediment	-»-	-»-
Metals and radioactivity in seaweed	-»-	-»-
Pollution from petroleum activities (under development)	-»-	-»-
Pollution from ships (under development)	-»-	Under development
Litter along the shoreline	No litter	Unacceptable amounts of litter on shoreline

* Precautionary reference points must be determined for species for which they are not available at present.
** As shown by measurements of pH, total alkalinity and temperature.

Appendix 3

Current and proposed pollution indicators, showing current and recommended sample types (sediments/biota)

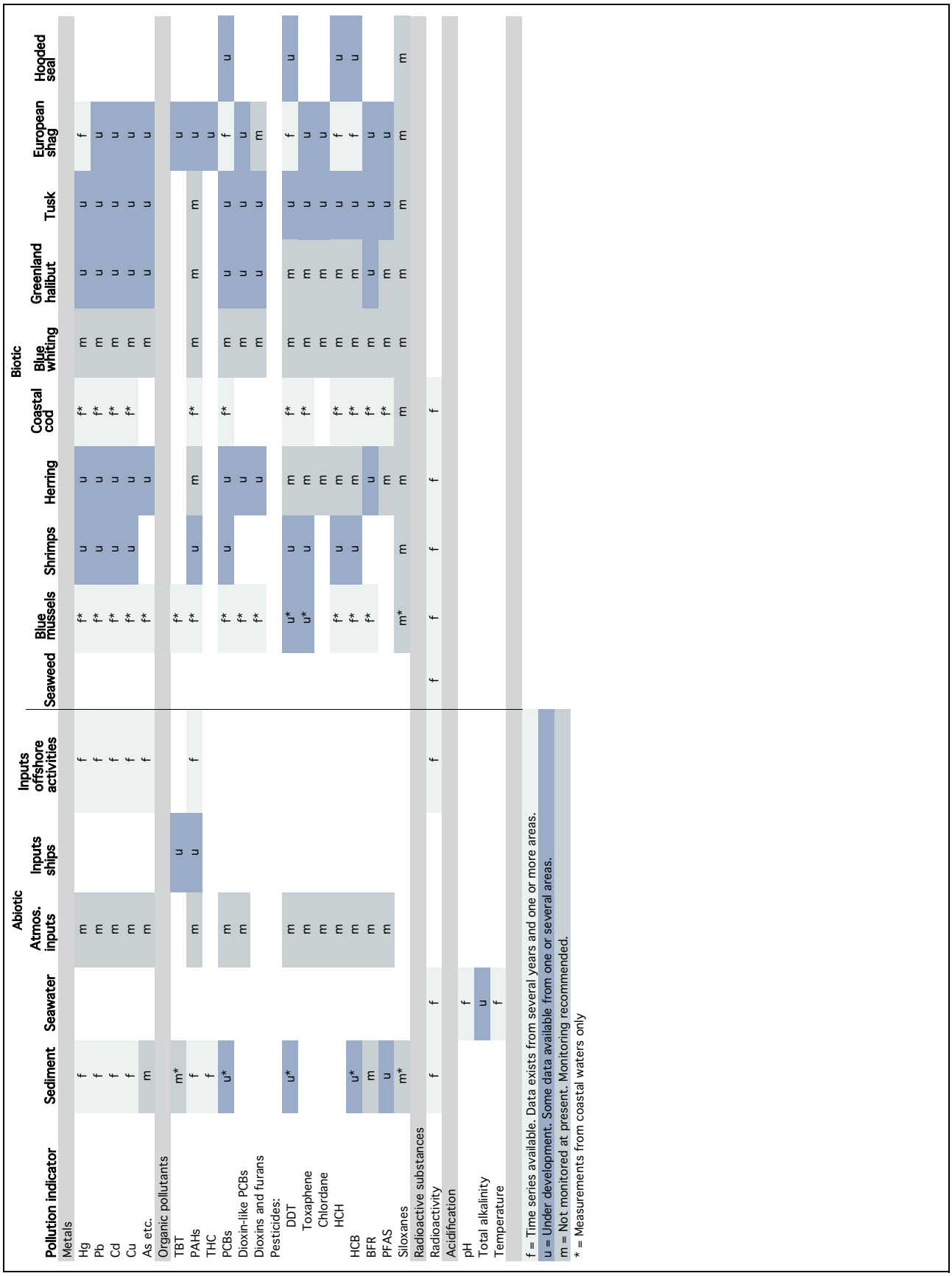
Abiotic
Biotic
Pollution indicator
Sediment
Seawater
Atmos. inputs
Inputs ships
Inputs offshore activities
Seaweed
Blue mussels
Shrimps
Herring
Coastal cod
Blue whiting
Greenland halibut
Tusk
European shag
Hooded seal
Metals
Hg
Pb
Cd
Cu
As etc.
Organic pollutants
TBT
PAHs
THC
PCBs
Dioxin-like PCBs
Dioxins and furans
Pesticides:
DDT
Toxaphene
Chlordane
HCH
HCB
BFR
PFAS
Siloxanes
Radioactive substances
Radioactivity
Acidification
pH
Total alkalinity
Temperature
f = Time series available. Data exists from several years and one or more areas.
u = Under development. Some data available from one or several areas.
m = Not monitored at present. Monitoring recommended.
* = Measurements from coastal waters only

Figure 3.1

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