QUALITY STATUS REPORT 2010

OSPAR COMMISSION

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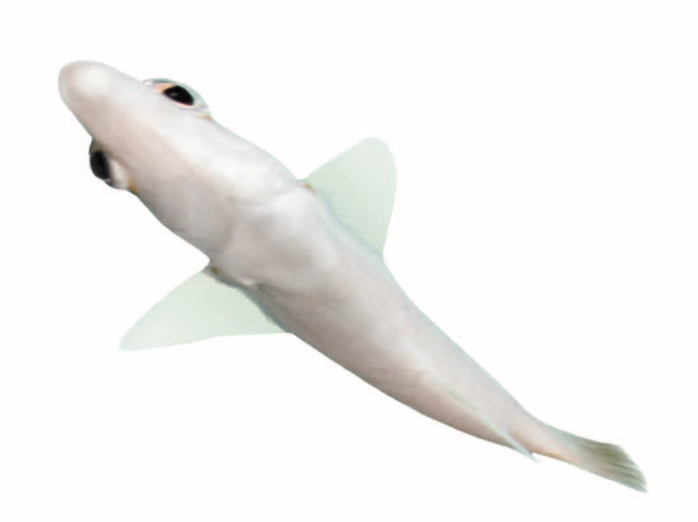

OSPAR COMMISSION

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OSPAR Convention
The Convention for the Protection of the Marine Environment of the North-East Atlantic (the 'OSPAR Convention') was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Community and Spain.

More information is available via the OSPAR website:
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PREFACE

Scientific knowledge is indispensable as the basis for our management of the marine environment. The OSPAR Convention rightly requires, through the Joint Assessment and Monitoring Programme, Contracting Parties to cooperate in both monitoring and assessment of our seas. This increases our knowledge and understanding of the marine environment and enables us to undertake periodic holistic assessments in order to take stock of achievements and provide directions for the future. The Quality Status Report (QSR) 2010 is such a holistic assessment. It presents a clear picture of the status of the North-East Atlantic at the end of the first decade of the 21st century and shows how the status has changed since the QSR 2000 was published.

Preparing the QSR 2010 has been a huge collective achievement of the OSPAR Governments. OSPAR has used the expertise of the many specialists that provide input to OSPAR Committees and Working Groups. Without their strong personal commitment this summary report, and its wealth of supporting assessments, would not have been possible. The contributions of OSPAR observers from industry, environmental non-governmental organisations and international partner organisations in the process have clearly helped to close gaps in information and to shape recommendations for future actions. The peer review by a group of international scientists, facilitated by the International Council for the Exploration of the Sea, and the e-consultation on the QSR 2010 have both helped to critically review the gathered evidence and the conclusions we have drawn, as well as adding an important step in quality assurance.

The QSR process has resulted in the development of new assessment criteria, original research and fundamentally new approaches to considering cumulative effects. In so doing, OSPAR has courted controversy, has at times been provocative and has caused some unease amongst its community. I would like to extend my personal thanks to the members of the Management Group for the Quality Status Report and the Environmental Assessment and Monitoring Committee, who had the main responsibility for the QSR 2010, as well as to the OSPAR Secretariat. All have remained resolute throughout and ensured the delivery of this fundamental report.

It is evident that there remain gaps in our knowledge and challenges in making integrated assessments. Yet, it is equally clear that our management of the North-East Atlantic is reaping benefits in terms of reducing concentrations of contaminants, delivering improvements in fisheries and affording greater protection for vulnerable species and habitats. We do, however, face further challenges as we seek to develop marine renewable energy, understand the possible implications of an increase in the acidity of our seas and comprehend better anthropogenic influences against a background of natural fluctuations. The QSR 2010 provides OSPAR Ministers at their meeting in Bergen in September 2010 with the evidence, conclusions and recommendations needed to tackle the future challenges and to ensure OSPAR's vital role in the protection of the North-East Atlantic. I am convinced that OSPAR's contribution to a scientifically robust approach to ocean governance will remain essential for the future use of the many resources of the North-East Atlantic while ensuring a clean, healthy and biologically diverse sea for future generations.

Professor Colin Moffat
Chairman of the Environmental Assessment and Monitoring Committee

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KEY FINDINGS

CLIMATE CHANGE

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Climate change effects and ocean acidification are now evident, especially in the northern OSPAR Regions.

- → Surface water temperatures have risen since 1999. Water in the *North Sea* has warmed 1 to 2 °C since 1985.
- → Warm-water plankton and some fish species are shifting northward. This could affect entire ecosystems.
- → Ocean acidification could have significant impacts on calcareous organisms. There are likely to be ecosystem-wide effects by 2050, perhaps even in the coming decade in the *Arctic*.
- → Winter Arctic sea-ice extent has fallen 2.5 % per decade since 1979, reducing ice-associated habitat and opening new areas of ocean to human uses.
- → Sea level is rising, making low-lying coasts vulnerable to flooding and coastal erosion.

The QSR recommends that OSPAR cooperates internationally to monitor the effects of climate change and ocean acidification, and to help develop marine policies that encourage mitigation of climate change and acidification. Where possible, policies should also facilitate adaptation.

EUTROPHICATION

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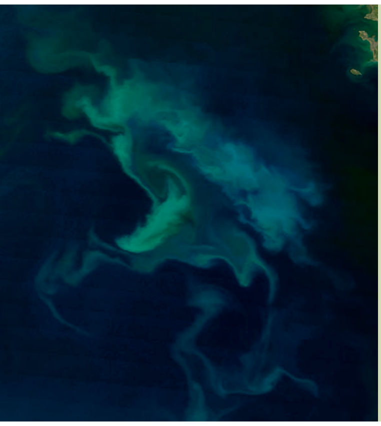

Nutrient inputs have generally decreased, but the OSPAR objective of no eutrophication will not be reached by 2010.

- → Large areas of the *North Sea* coast, and some estuaries and bays in the *Celtic Seas*, *Northern Brittany* and *Bay of Biscay* remain eutrophication problem areas.
- → Nutrient discharges to eutrophication problem areas have substantially reduced compared to 1985 for phosphorus (up to 85 % lower), but less so for nitrogen (up to 50 % lower).
- → Farming contributes almost two-thirds of waterborne nitrogen reaching problem areas in the *North Sea* and *Celtic Seas*. Progress in controlling this source has been slow.
- → Nitrogen inputs from the atmosphere remain high and air emissions from shipping are increasing.
- → It can take decades for ecosystems to respond to the reduction of nutrient releases.

The QSR recommends setting targets to reduce nutrient inputs to individual problem areas and urgently implementing existing measures to reduce them.

HAZARDOUS SUBSTANCES

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Concentrations of some substances have decreased, but problems remain in many coastal areas.

- → A third of OSPAR's 26 priority (groups of) chemicals are expected to have been phased out by 2020. More effort is needed to move towards the cessation target for releases of the remaining priority chemicals.
- → Adverse effects of the anti-fouling agent tributyltin (TBT) are still seen in four of the five OSPAR Regions, but are decreasing everywhere in response to the global ban.
- → Levels of cadmium, mercury, lead, polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) are unacceptable in fish, shellfish and sediment in many coastal areas.
- → Persistent organic pollutants (POPs), such as brominated flame retardants, are widespread and accumulating in marine life, partly as a result of atmospheric transport.
- → Biological effects of hazardous substances, such as endocrine disruption, are not well understood.

The QSR recommends continued abatement at source, further promotion of global controls on POPs and mercury emissions, and improving knowledge of hazardous substances and their biological effects.

RADIOACTIVE SUBSTANCES

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Discharges of radionuclides from nuclear installations have fallen, and radiation doses to humans and marine life from this pollution are low in all OSPAR Regions.

- → On average, β-activity discharges from nuclear installations are down by 38 % since 1995.
- → Levels of radioactive substances in the marine environment have dropped in the *Celtic Seas* and some areas of the *North Sea*.
- → Releases of technetium-99 from the Sellafield reprocessing plant (UK) have been drastically reduced.
- → Produced water from offshore oil and gas extraction is a substantial source of α-activity discharges, but their trends and impacts have not yet been assessed.

The QSR recommends continued effort to reduce radioactive discharges from the nuclear sector, and further assessment of radioactive discharges and impacts from the oil and gas industry in order to identify and implement appropriate management measures.

OFFSHORE OIL AND GAS INDUSTRY

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Pollution from oil and gas production has fallen, but continued monitoring is essential as the industry changes and develops.

- → The oil and gas industry is important in the *North Sea* and is expected to increase in *Arctic Waters*.
- → Oil discharges to water have fallen by 20 % on average in the OSPAR area since 2000, with most countries meeting OSPAR's reduction target of 15 %.
- → The number of small oil spills (<1 tonne) has decreased.
- → The discharge of organic-based drilling fluids has largely ceased since 2005.
- → Environmental impacts around some installations have improved, but the evidence is limited.

The QSR recommends a risk-based approach to managing discharges of produced water, improved environmental assessment, and consideration of how existing measures can be applied in the Arctic.

FISHING

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Fishing has large impacts on marine ecosystems despite improvements in management.

- → Exploitation of many stocks continues to be beyond sustainable levels, while the status of a large number of stocks still cannot be fully assessed due to lack of data.
- → Depletion of key predator and prey species and disruption of food webs are worrying ecosystem effects of fishing. Discards need to be addressed as a priority.
- → The by-catch of non-target fish, seabirds and marine mammals in OSPAR Regions II, III and IV is a concern.
- → International cooperation has reduced illegal, unreported and unregulated fishing in several areas.
- → Damage to seabed habitats is extensive but protection of deep-sea cold-water coral reefs has improved.

The QSR recommends cooperation to promote sustainable fishing, as well as improved monitoring and assessment of fisheries, by-catch and vulnerable habitats, particularly in the *Wider Atlantic* where knowledge is poor.

OTHER HUMAN USES AND IMPACTS

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There are multiple pressures on the marine environment, and many are increasing.

- → Offshore renewable energy, mineral extraction, shipping, mariculture and coastal defence reinforcement are making increasing demands on marine space and resources, especially in the *North Sea* and *Celtic Seas*.
- → The broadscale environmental impacts of individual activities such as offshore wind farms are unclear.
- → A better understanding is needed of the combined pressures from all these activities, which should be managed in an integrated manner as is already done in some OSPAR countries, such as Norway.
- → Many activities increase the amounts of noise, litter and non-indigenous species affecting the marine environment. The cumulative impacts on marine ecosystems, especially of noise and litter, are still unclear.

The QSR recommends implementing regionally coordinated management plans, backed up by research on the impacts of different activities. New and existing uses of the sea must be continually monitored and their impacts assessed. Where necessary, management measures should be applied.

BIODIVERSITY AND ECOSYSTEMS

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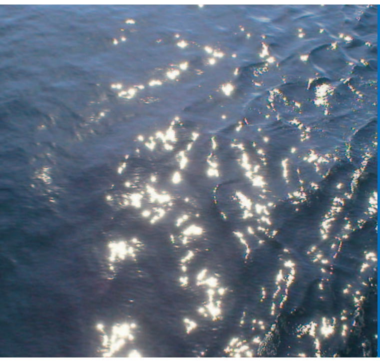
The decline in biodiversity is a long way from being halted.

- → All OSPAR Regions have threatened and/or declining species. These include sharks, skates and rays, turtles, seabirds, whales, seahorses, invertebrates, and diadromous and commercial fish species.
- → Human activities threaten the extent and condition of several seabed habitats, with fishing a key pressure.
- → Climate change will increase the challenge of protecting and conserving biodiversity.
- → 159 marine protected areas cover 13 % of territorial waters, but just over 1 % of the whole OSPAR area.
- → Better monitoring of marine biodiversity both in the wider environment and in protected areas is needed.

The QSR recommends extending the OSPAR network of marine protected areas, especially in key areas away from coasts, to complete an ecologically coherent network. Targeted measures are needed to improve the protection of threatened and/or declining species and habitats.

1 THE QUALITY STATUS REPORT 2010



Ten years of managing, monitoring and assessing the marine environment

The vast sea area covered by the OSPAR Convention is the home of a wide range of ecosystems which vary in diversity and sensitivity. It hosts an ever-growing number of human activities, each with impacts on the marine environment, and there are emerging threats from climate change. How is the North-East Atlantic responding to these pressures? What are we doing about it? Is it working? These are the questions being posed by scientists, politicians, and the public alike. OSPAR's monitoring and assessment activities provide a solid basis for answering such questions and for the necessary political action to resolve them.

The Quality Status Report 2010 – the QSR 2010 – is a milestone for evaluating the quality status of the North-East Atlantic and for taking forward OSPAR's vision of a clean, healthy and biologically diverse sea. It follows up on the previous quality status report – the QSR 2000 – as well as earlier QSRs specific to the North Sea. The QSR 2010 reflects the collective effort made by Contracting Parties over the period 1998 to 2008 to manage, monitor and assess the many pressures on the diverse ecosystems of the North-East Atlantic and the impacts that they bring.

The assessment process

This summary report provides policy makers and the wider public with a condensed overview of current knowledge on trends in pressures and impacts and the quality status of the North-East Atlantic and its Regions → **FIGURE 1.1**. It is backed up by a series of thematic assessment reports → **BIBLIOGRAPHY** prepared under the OSPAR Joint Assessment and Monitoring Programme. These set out the scientific evidence for this summary report and provide more detailed information for the interested reader. The assessment reports were prepared in order to deliver regional assessments, based, where possible, on collective monitoring and data collection undertaken by OSPAR countries, and on scientific literature relevant to the development of conclusions at the regional scale. This summary report also draws on information from other sources including the International Council for the Exploration of the Sea (ICES) and its expert groups, and organisations within the European Union, for example Eurostat and the European Environment Agency. Together, this summary report and the thematic assessments form the QSR 2010. All levels of information are interactively accessible to the reader through an electronic version of the QSR (the e-QSR) on the OSPAR website and the DVD at the back of this book.

The QSR 2010 summary report is structured such that Chapters 4 to 10 report progress on OSPAR's five thematic Strategies for addressing the main threats within the North-East Atlantic (the Eutrophication Strategy, the Hazardous Substances Strategy, the Radioactive Substances Strategy, the Offshore Oil and Gas Industry Strategy and the Biodiversity and Ecosystems Strategy). This information is set within the context of the socio-economic, physical and biological features of the North-East Atlantic (Chapter 2) and a changing ocean climate (Chapter 3). Chapter 11 reports on the progress made in applying tools to support the ecosystem approach to management of the North-East Atlantic, including ecological quality objectives and methodologies to assess ecosystem health. Chapter 12 brings together the findings of the preceding chapters in a qualitative summary for each OSPAR Region. These summaries describe the quality status and the delivery of OSPAR Strategies as well as the main pressures within these Regions and how these are expected to develop over the next decade. This provides the basis for the priorities for action identified for each Region. The Key Findings presented at the beginning of this summary report are intended to provide policy makers with a concise overview of the progress made, the main issues of concern and the need for action identified by the QSR 2010.

OSPAR's role within the wider community

The OSPAR Convention is firmly rooted in global obligations and commitments on the protection and management of the sea. The United Nations Convention on the Law of the Sea which came into force in 1994 sets the global jurisdictional framework → **FIGURE 1.2**. The 1992 Rio de Janeiro United Nations Conference on Environment and Development and the 1992 Convention on Biological Diversity are the first major international agreements putting the ecosystem approach at the heart of environmental policy.

At a regional level, OSPAR cooperates with many other international organisations and has formal agreements with the North East Atlantic Fisheries Commission (NEAFC), the International Maritime Organization (IMO), the UN Economic Commission for Europe (UNECE) and ICES. Following the EU Water Framework Directive, the EU Marine Strategy Framework Directive is now an important driver for OSPAR's future work → **FIGURE 1.2**. It is also a common platform for continued cooperation between OSPAR and other organisations concerned with protection of the European seas. For example, in 2003 OSPAR and the Helsinki Commission (HELCOM – responsible for protecting the marine environment of the Baltic Sea) agreed to work together on a range of activities including marine nature conservation, impacts of fisheries and shipping, and the implementation of the ecosystem approach.

QSR 2010 supports the EU Marine Strategy Framework Directive

The Marine Strategy Framework Directive complements OSPAR's existing work on protection of the North-East Atlantic. It requires 11 OSPAR countries to take the necessary measures to achieve or maintain 'good environmental status' of the EU's marine waters by 2020, and to protect the natural resources upon which marine-related economic and social activities depend. To date, the Directive does not apply to Iceland and Norway.

The QSR 2010 forms an important regional contribution to the initial assessments of national marine waters that most OSPAR countries will submit in 2012 under the Marine Strategy Framework Directive. It will provide a regional reference point and contribute toward delivering the ecosystem approach → BOX 1.1. In so doing it will support OSPAR's role as a platform for the relevant OSPAR countries to coordinate their actions on the implementation of the Marine Strategy Framework Directive within the OSPAR area.

The way forward

It is essential that the biodiversity, resources and environmental quality of the North-East Atlantic ecosystems are conserved, protected and sustainably managed. OSPAR has had a number of successes in working to achieve this goal, but there is still much to do and cumulative impacts from past activities as well as a range of emerging pressures are now providing the focus for future work. An ecosystem-based approach is the way forward and this QSR 2010 summary report, together with the underlying assessments, provides a comprehensive baseline against which the effectiveness of future efforts can be measured.

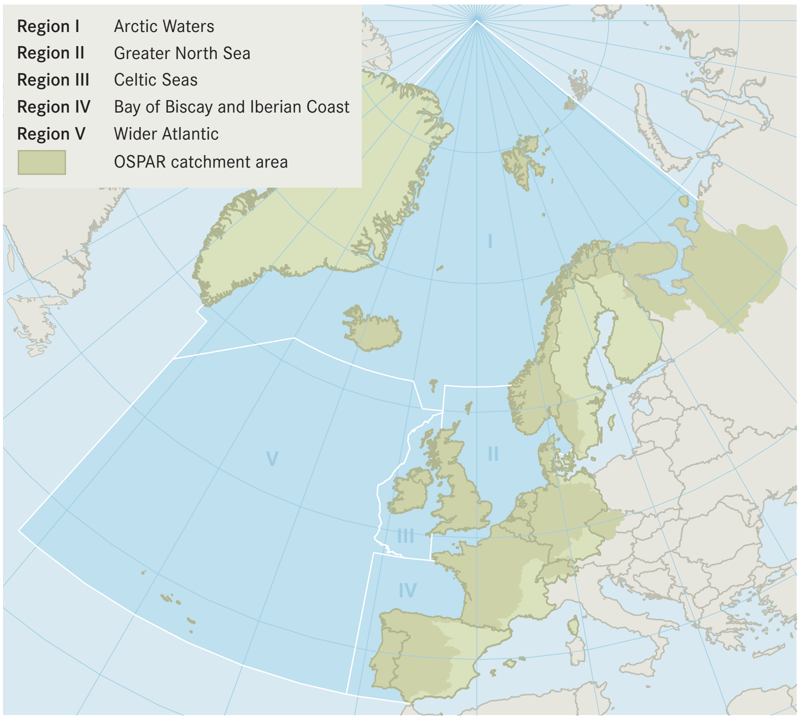


FIGURE 1.1 *The OSPAR area and its catchment. For the purposes of assessment, the OSPAR maritime area is divided into five Regions.*

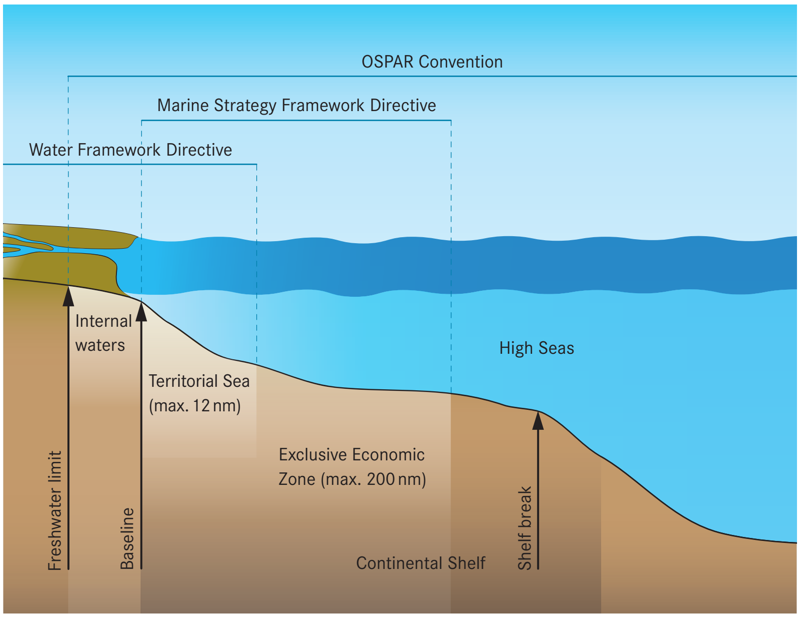


FIGURE 1.2 *Jurisdictional zones of the United Nations Convention on the Law of the Sea, the OSPAR Convention, the EU Water Framework Directive and the EU Marine Strategy Framework Directive. The jurisdictional rights of coastal states over the water column extend up to 200 nautical miles (nm) from the baseline. Their jurisdictional rights over the Continental Shelf, relating to the seabed and subsoil, can extend beyond 200 nm.*

BOX 1.1 The challenge of delivering the ecosystem approach

OSPAR's work has been guided since 2003 by the ecosystem approach. This is also a main element of the EU's Water Framework Directive and Marine Strategy Framework Directive. The essence of the ecosystem approach is to allow sustainable exploitation of natural resources while maintaining the quality, structure and functioning of the marine ecosystems. It has at its centre the integrated management of human activities and nature conservation needs. It involves consideration of the combined effects of all human activities on the ecosystem and the assessment of specified ecosystem components against defined quality objectives. The implementation of the ecosystem approach requires a good understanding of the ecosystem and its dynamics and the development of appropriate indicators and scientific methodologies to enable evaluation of the quality status of the ecosystem in response to pressures from human activities. The development of tools for defining the desired quality of the ecosystem has been a key field of OSPAR's work. The Ecological Quality Objectives (EcoQOs) developed for the North Sea provide an initial set of objectives for selected components of the ecosystem and function as indicators for human pressures. OSPAR's progress towards assessing the ecosystem health of the five OSPAR Regions of the North-East Atlantic, in support of the ecosystem approach to their management, is reported in Chapter 11.

2 THE NORTH-EAST ATLANTIC

A common sea with varied ecosystems and management challenges

The OSPAR Convention covers most of the North-East Atlantic and its adjacent seas. This is a vast area of about 13.5 million km^2 which includes a diverse range of environmental conditions and different ecosystems. These play a key role in the types and patterns of human activity in the North-East Atlantic and associated impacts on the marine environment. Knowledge about the biodiversity of the marine ecosystems of the OSPAR area and its interactions with ocean dynamics and human activities is still limited.

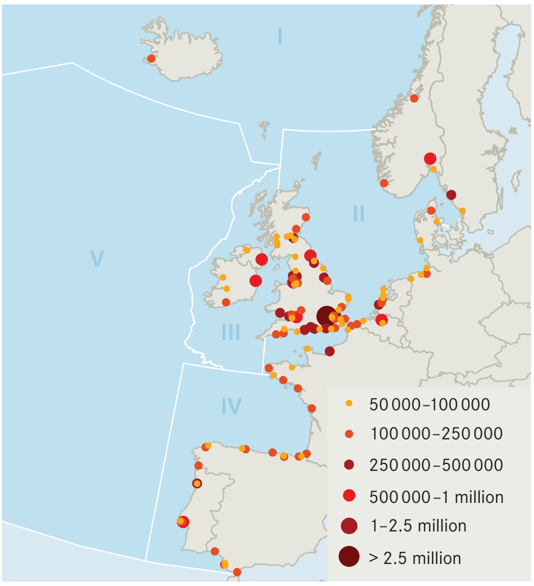
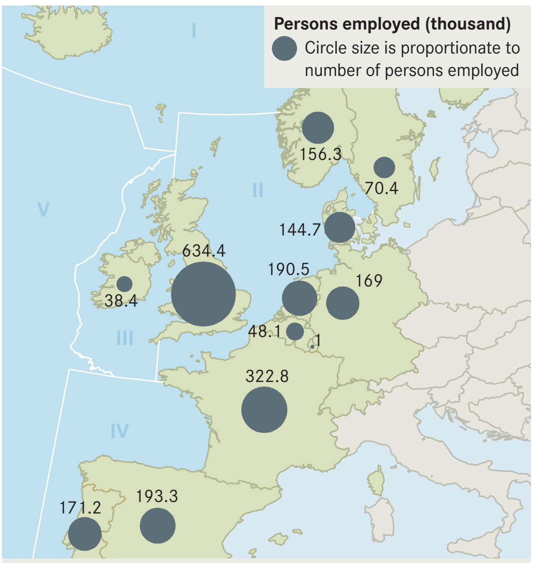


FIGURE 2.1 *Population in coastal urban areas in 2001. Data source: EEA (2006).*



Percentage of sea-related employment in national employment

Belgium	1.08	Ireland	1.82	Spain	0.94
Denmark	4.96	Luxembourg	0.30	Sweden	1.54
France	1.25	Netherlands	2.17	UK	2.19
Germany	0.42	Norway	5.97		
Iceland	n.d.	Portugal	3.33		

FIGURE 2.2 *Employment in all sea-related sectors in OSPAR countries. Data for Iceland are not available. Data source: Policy Research Corporation (2008).*

Much of the coastal area in the North-East Atlantic is densely populated, highly industrialised or used intensively for agriculture. Population density is much higher on the coasts than inland, with most of the population in some areas of Northern Europe being concentrated in coastal settlements. Population density is highest on the Iberian and North Sea coasts (with over 500 inhabitants per km^2) and lowest in Region I (with fewer than 10 inhabitants per km^2 in some remote areas) and Region V, which covers more than half of the OSPAR maritime area, dominated by High Seas. Even in areas with low population density, large coastal settlements can exert pressures on the sea → **FIGURE 2.1**.

Marine and coastal ecosystems provide a range of goods and services

The OSPAR maritime area provides the basis for a wide range of goods and services including food, transport, energy and amenities for millions of people. Marine-related industries and services contribute roughly 1.8 % to the Gross Domestic Product and 2.1 % to employment opportunities in the OSPAR area → **FIGURE 2.2**. More than a third of the value of the maritime sector in the North-East Atlantic is generated by coastal tourism and shipping, with tourism and the fishing industry being the largest employers. Fishing is a key industry for some of the economies in Region I (Iceland, Norway, Faroe Islands, Greenland) and is also highly significant in certain parts of other OSPAR countries. Norway's offshore oil and gas industry ranks among the largest in the world. Economically, oil and gas production in the North Sea is also important for Denmark, the Netherlands and the UK. Some of the main European seaports are situated along the eastern coast of the North Sea with world-leading shipbuilding and shipping related industries. The maritime transport and seafood sectors are important for Ireland (Region III), and in France, Portugal and Spain (Region IV) coastal tourism is the largest employer of the maritime industries. The low-lying areas of the southern North Sea maintain an important coastal engineering industry, especially in the Netherlands. Across the OSPAR area new industries are also developing, with marine renewable energy (wind, wave and tidal energy production) the fastest growing activity in coastal and offshore waters. The intense human activities in the OSPAR area place considerable pressure on the marine environment.

Variations in the physical system affect the biology

The bathymetry of the seabed → **FIGURE 2.3** and the ocean circulation → **FIGURE 2.4** exert a strong control on the ecosystems of the OSPAR area, including the occurrence of species and habitats and their interactions. The distinction between waters that are mixed (where most conditions are the same from the surface to the seabed) and waters that are stratified (where conditions vary stepwise with depth) is important biologically, influencing the distribution of habitats as well as the structure of pelagic and benthic ecosystems. The areas where these water types meet ('fronts') are regions of intense biological activity and often provide productive fishing grounds.

Most of the North-East Atlantic is well-mixed to depths of up to 600 m during winter with a deep, permanent thermocline in deep oceanic waters. In spring, a strong vertical temperature gradient develops that separates warm surface water from cold deeper water. In shallow shelf areas strong tidal currents keep the water mixed throughout the year.

Local variations in temperature and circulation can be important in terms of the ecology of an area. The known range of these naturally occurring variations is now being exceeded, and this is a key factor in understanding how human-induced climate change is affecting marine ecosystems. For example, in the North Sea the monthly average sea surface temperature has exceeded the long-term average since the late 1980s. The rising temperatures have already affected the plankton and allowed new species to colonise → **CHAPTER 3**.

Detailed information on the physical environment of the North-East Atlantic may be found in the previous quality status assessment, the QSR 2000.

Regional ecology varies widely

The ecology of the OSPAR area includes a wide range of species and habitats, from the ice-bound and fjord coastlines of Region I, to the estuaries, sea lochs, rias and open bays of Regions II, III and IV, and to the deep-ocean ecosystems of Region V → **BOX 2.1**.

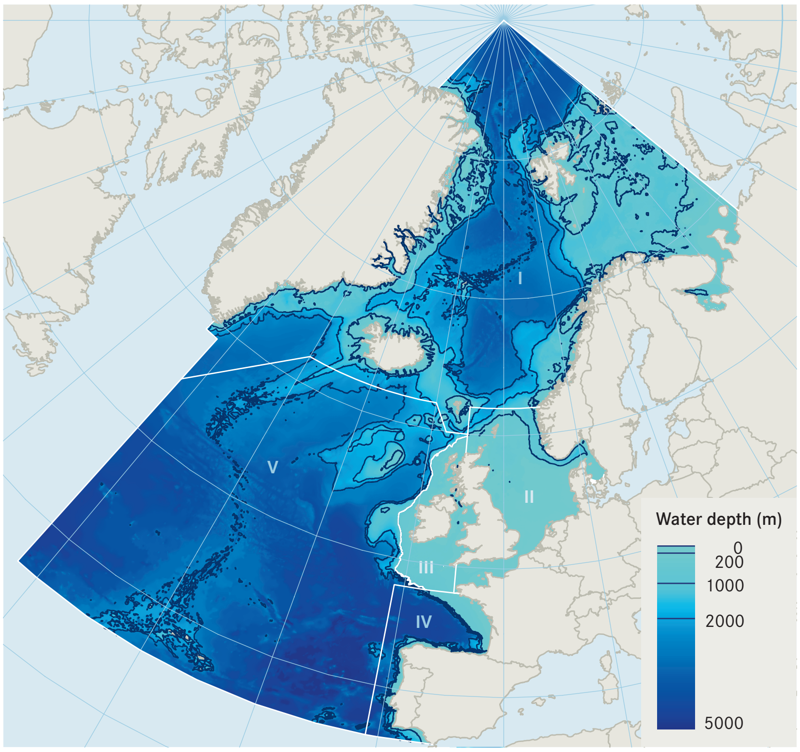


FIGURE 2.3 *The seabed can be divided into three distinct zones: the shallow continental shelf region to 200 m depth, the zone of rapidly increasing depth known as the continental slope, and the deep ocean basin. The main features of the deep ocean basins are the Mid-Atlantic Ridge (the Azores and Iceland are its highest points), and the Greenland-Scotland Ridge (which separates the Atlantic Basin from the Nordic Seas). Seamounts (underwater mountains) are also present, individually and in chains. The abyssal plain, the deep flat ocean floor extending beyond these features, is about 5000 m deep.*

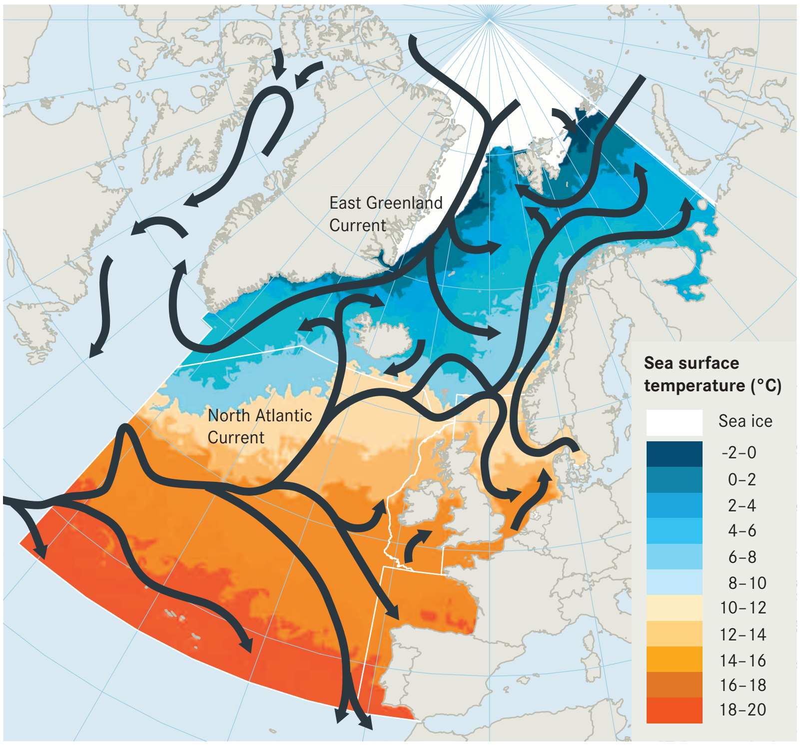


FIGURE 2.4 *Sea surface temperature within the North-East Atlantic from global high resolution Mercator ocean forecasting system for 13 October 2009 (source: Mercator Océan) and circulation patterns. The general ocean circulation in the North-East Atlantic is dominated by the north-eastward extension of the Gulf Stream, known as the North Atlantic Current. This is a part of the global ocean circulation – the 'Great Ocean Conveyor' – which transports relatively warm, nutrient-rich and oxygen-rich water from the north-western Atlantic towards the European coasts. One of the factors driving this flow in the North-East Atlantic is the cooling and sinking of this water in the polar region, from where it flows southward at depth. This general pattern of northward flow at the surface and southward flow at depth can be affected by freshwater inputs from the European landmass. Inter-annual variations in the North Atlantic Current control the temperature and salinity regimes in the OSPAR Regions.*

Region I – Arctic Waters

Tasiilaq, East Greenland (upper); Walrus (lower)

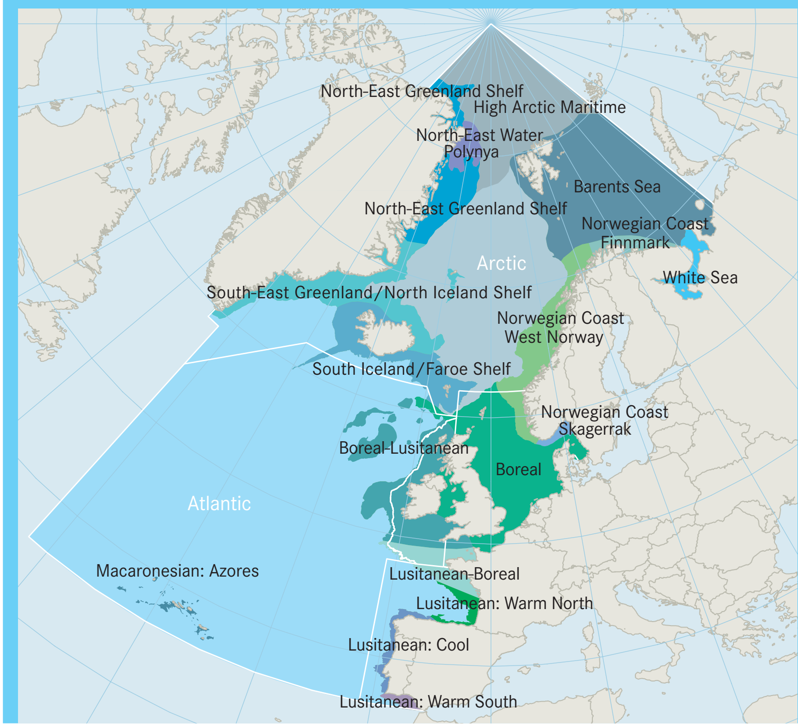
Large parts of Region I are permanently ice-bound, but the Region is warmed by the North Atlantic Current and there is a large area of sea which is ice-free in summer. To the east, Atlantic water is diluted by mixing with the northward-flowing Norwegian Coastal Current, which carries fresher water flowing out from the Baltic Sea and the North Sea. In the Greenland Sea and Iceland Sea, winter cooling of the surface water and the release of water vapour to the atmosphere both increase the density of the surface water which then sinks to the bottom.

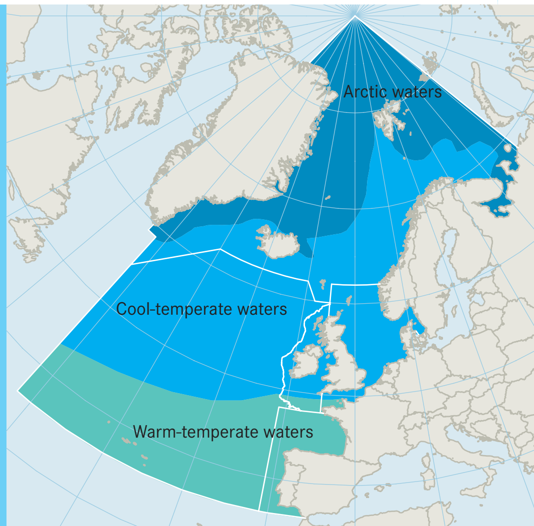
Melting of the seasonal sea ice in spring has an enormous impact on the ecology of the Region. Immediately after the ice melts there is a burst of primary productivity which is conveyed, often through short food chains, to the higher trophic levels that in turn support large stocks of fish, marine mammals and seabirds. The ecosystems are characterised by high natural variability due to a highly variable recruitment of fish stocks, strong biological interactions within simple food webs, and many species being near the edge of their distribution range.

Region I includes the transition between the Boreal and the true Arctic biogeographic zones, which in some areas is very sharp with a distinct polar front. The southern part of Region I supports some of the world's most important fisheries (herring, capelin, cod) as well as substantial populations of marine mammals (whales and seals) and seabirds, notably auks and guillemots. The Arctic supports many endemic species and Region I also contains Europe's entire population of polar bear, narwhal, walrus and beluga. Other notable features include cold seeps (areas of the ocean floor where the release of hydrogen sulphide, methane and other hydrocarbons from the seabed supports endemic species), as well as a large number of extensive cold-water coral reefs and numerous cold-water sponge aggregations. To the south, the Greenland-Scotland Ridge is a major biogeographical boundary for deep-sea benthos, acting as a barrier between warm-water and cold-water species.

BOX 2.1 The Dinter Biogeographic Classification

The Dinter Biogeographic Classification divides the seafloor, the deep sea and open oceanic waters into a series of representative biogeographic zones, each having a specific oceanography which supports characteristic biological communities. Source: Dinter, W.P. (2001).





Top: The water column less than 1000 m depth is divided into three characteristic biogeographic zones for the pelagic environment.

Left: Biogeographic zones for the benthic and deep-sea environments. The deep-sea benthos and deep-sea environments (>1000 m) are separated into two broad zones: Arctic and Atlantic, separated by the Iceland-Faroe Shelf. The benthic environment less than 100 m depth is separated into a series of characteristic zones.

Region II – Greater North Sea

Wadden Sea, Germany

In Region II, North Atlantic water mixes with freshwater run-off and river discharges within a roughly anti-clockwise circulation. Residual currents move southward along the east coast of the UK and northward along the continental west European coast. In the Kattegat, salty oxygenated water flows into the Baltic Sea at depth and brackish water enters the North Sea in a surface counter-flow. Shallower areas of the North Sea (<30 m) are normally fully mixed by tidal action. In deeper areas, the upper 30 m are usually mixed by wind action.

With the exception of the deeper waters along the Norwegian coast, Region II corresponds to the cool-temperate Boreal biogeographic zone. The Channel forms the border with the Boreal-Lusitanean zone. Shallow rocky areas are colonised by extensive forests of kelp. Most of the seabed is covered in sandy sediment habitats which support large populations of flatfish. The Fladen Ground in the northern North Sea is a large area of muddy seabed with abundant Nephrops. The extensive estuaries with mudflats and salt marshes are globally important areas for migrating waterfowl and waders. The south-east of Region II comprises the Wadden Sea, the largest area of intertidal mudflat in the world with abundant shellfish, including mussel beds, and patches of sea grass. It is a crucial stopover for millions of migrating birds. In the north-west of the North Sea, offshore islands support major colonies of seabirds. Benthic and pelagic processes in the North Sea are strongly coupled and work together to make the Region highly productive. Region II has supported large commercial fish stocks, as well as substantial populations of key prey species such as sandeels that are the main food item for many seabirds. Region II contains a great number of habitats considered to be threatened or in decline, including most of the North-East Atlantic's littoral chalk communities.

Bird colonies on Farne Island, north-east England

The Seven Sisters cliffs in southern England

Region III – Celtic Seas

Isle of Harris, Scotland

Region III ranges from being fully oceanic at the shelf break to the west of Ireland, through the relatively shallow semi-enclosed Irish Sea, to the brackish estuarine systems along the west coast of the UK. The overall movement of water is from south to north, continuing the North Atlantic Current flow into the North Sea and Norwegian Sea.

Region III mainly corresponds to the Boreal-Lusitanean biogeographic zone, but with the Irish Sea more closely aligned to the Boreal zone. This is reflected by the spring bloom in the Irish Sea taking place about a month earlier than in the open shelf waters to the north and south, although there is strong variability between years. The Region has a wide range of coastal and seabed habitats, including sea lochs and estuaries, with diverse biological communities that include many commercially important species. The Region is at the southern limit of the distribution range for some cold-water species, such as herring and cod, while some warm-water species, such as sea bass and sardine, come up from the south. There are also important seabird areas and the waters to the south and west of Ireland support a variety of cetaceans, including common dolphins and a resident population of bottlenose dolphins in the Shannon Estuary. Region III, and with the northern part of Region II, supports a high proportion of the North-East Atlantic's sea-pen and burrowing megafauna communities, where soft coral sea-pens coexist with large shrimps burrowing in muddy sediments. These occur in sheltered areas such as sea lochs or on the deeper parts of the shelf.

Short-beaked common dolphin

Cliffs of Moher, western Ireland

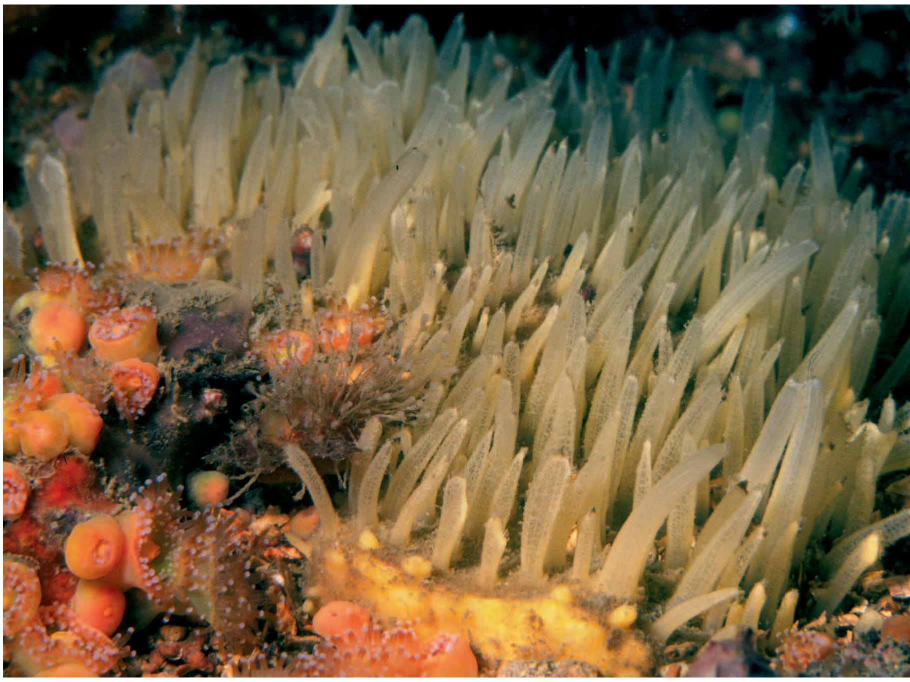
Region IV – Bay of Biscay and Iberian Coast

Cabo Vidio, Asturias, Spain

In Region IV, branches of the North Atlantic Current bend round towards the south. Beyond the shelf break, Atlantic water interacts with salty Mediterranean water, which then moves northward along the continental slope. Off the Iberian Peninsula, northerly winds cause an upwelling of cold and nutrient-rich deeper water to the surface during summer.

Ria Ferrol, Galicia, Spain

Region IV corresponds to the Lusitanean zone and is highly diverse with many different types of coastal habitat, such as rocky cliffs, shingle, sandy and muddy shores, rias, coastal lagoons, open bays and estuaries. The waters of the shelf host maerl beds and sea-pen and burrowing megafauna communities. Many northern species reach the southern limit of their distribution in Region IV and many southern species reach their northern limit of distribution. Mediterranean species occur in the south. Areas of upwelling off the Iberian coast are responsible for the spring bloom occurring earlier than in the other Regions. These areas are highly productive and have supported large populations of pelagic fish such as sardine. The continental shelf hosts cold-water corals and deep-sea sponge aggregations and is dissected by large submarine canyon systems which provide a pathway to the deep sea for sediment and nutrients and contain diverse biological communities with many endemic species.



Sponges, Rade de Brest, France

Region V – Wider Atlantic

Azorean barnacles

Cory's shearwater (left); Punta Delgada, Azores (right)

Region V is dominated by the North Atlantic Current. The northern sections divert into the North Sea and Norwegian Sea, while a more southerly branch forms the easterly Azores Current that coincides with the southern boundary of the OSPAR area.

Region V is sub-divided into two biogeographic regions. To the north of 40° N, the deep mixing of the water column during winter and its stratification in summer results in a strong seasonal cycle of primary production. To the south, the upper water column is stratified throughout the year and so the annual productivity is both lower and less variable seasonally. This causes major differences in the pelagic and benthic ecology, with biological activity almost totally dependent on production in the upper layers of the ocean that receive enough sunlight for photosynthesis. The benthic communities are too deep to be directly supported by photosynthesis, except within the coastal fringes of the Azores, and depend on organic matter sinking or being transported downward.

Biodiversity in Region V is less well-quantified than in the other Regions, particularly in the deep waters. Many deep-sea species have an extensive geographical range due to the small environmental variations in their habitat. Top predators such as sharks probably play an important role in maintaining the structure and diversity of fish communities, which include several long-lived and slow-growing species. Large pelagic predators (tuna and marlin) are highly migratory, ranging far beyond the boundaries of Region V. Region V is also important for Europe's threatened sea turtles and some oceanic seabirds such as Cory's shearwater. The main benthic habitats are the flat, featureless abyssal plains, but rising out of these the Mid-Atlantic Ridge, the continental slope and seamounts support vulnerable deep-sea habitats, such as cold-water coral reefs and deep-sea sponge aggregations. These have highly diverse biological communities with many endemic species. Hydrothermal vents along the Mid-Atlantic Ridge support particularly specialised and largely endemic communities.

Many challenges but common pressures

Although the vast waters of the OSPAR area and its diverse ecosystems present many challenges for management and environmental protection, there are many commonalities within each of the Regions, including common oceanic and open sea characteristics that are strongly influenced by the dynamics of the North Atlantic Current. The degree of pressure from the different human activities varies between and within Regions. The much greater concentrations of human population in catchments draining into Region II produce a significantly different level of pressure to that affecting Region V, where the only human populations are associated with the Azores archipelago. Nevertheless, important pressures, such as fishing and climate change, are of concern in all Regions. Other common types of pressure also exist, particularly from intensive (and sometimes conflicting) uses of the coastal zone. OSPAR provides a common framework for managing the impact of these pressures on the North-East Atlantic.

3 CLIMATE CHANGE

Impacts of climate change are now becoming evident, especially in the northern Regions (I and II). While the nature and rate of these impacts are uncertain, rising sea temperature and increasing acidification represent major threats to marine ecosystems in the OSPAR area. Mitigation and adaptation are a necessity and will alter human activities and their pressures on the sea.

OSPAR Contracting Parties should cooperate

→ to reduce existing pressures under OSPAR's Strategies and thereby increase ecosystem resilience;
→ to manage and regulate increasing demand for sea-based renewable energy production and carbon capture and storage through OSPAR so as to minimise their impacts on marine ecosystems;
→ to adapt OSPAR's policies and objectives for the protection of the marine environment to account for changing pressures and increasing vulnerability of marine ecosystems;
→ to enhance OSPAR's knowledge about the vulnerability of species, habitats and ecological processes to climate change and acidification and their interaction with human pressures;
→ to monitor and assess within OSPAR and in cooperation with partner organisations (e.g. ICES, IOC) ocean acidification and climate change, and to develop impact scenarios and indicators to track progression of impacts at regional scales.

Key OSPAR assessments

→ Impacts of climate change on the North-East Atlantic ecosystem
→ Climate change mitigation and adaptation

Atmospheric and ocean climate are closely coupled, with the ocean playing a significant role in regulating global and regional climate and weather patterns. Increased concentrations of anthropogenic greenhouse gases are recognised to have contributed to the rise in globally-averaged atmospheric temperatures since the mid-20th century. Increased concentrations of atmospheric carbon dioxide (CO_2) also make the oceans more acidic. Climate change and ocean acidification are significant threats to marine ecosystems within the OSPAR area and ultimately will affect human well-being, for example, through threats from sea-level rise and changes in biodiversity and fish stocks.

What are the problems?

Climate change is widely recognised but its rates and impacts are uncertain

The UN Intergovernmental Panel on Climate Change (IPCC) has warned that continued emissions of greenhouse gases at or above current rates will cause further warming and will lead to many changes in the global climate system during the 21st century which can be expected to be greater than those observed during the 20th century → FIGURE 3.1. The changes may exceed natural multi-decadal variability and lead to permanent changes in ecosystems.

The changing climate has been linked to a wide range of impacts on marine ecosystems → FIGURE 3.2, either directly (through changes in sea temperature) or indirectly through impacts on the seasonality, distribution and abundance of species. The impacts of future climate trends on marine ecosystems are difficult to predict due to a number of uncertainties, including those in the scenarios for future greenhouse gas emissions. There is also a need for a better understanding of how marine ecosystems will respond to change.

The range of climate change impacts projected for various components of the marine ecosystem are listed in → TABLE 3.1 (physical and chemical environment) and → TABLE 3.2 (biological environment), together with a summary of what has been observed to date.

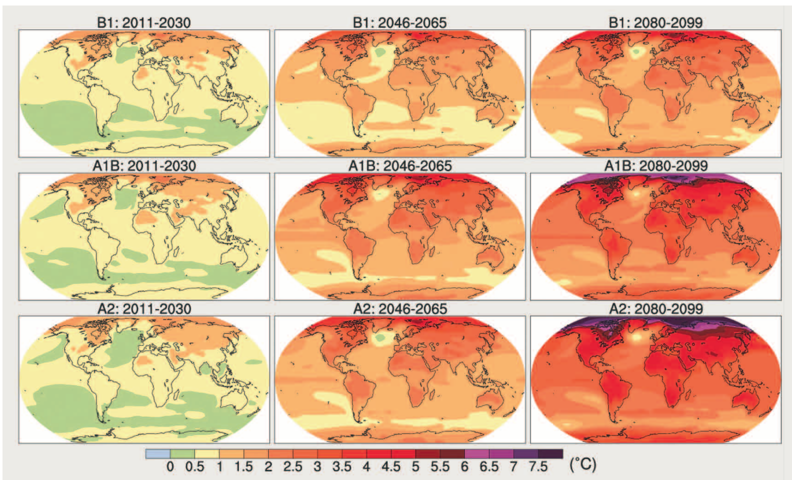


FIGURE 3.1 *IPCC projections of the range of possible changes in surface air temperature for the period to 2100 based on three greenhouse gas emissions scenarios (source: IPCC, 2007 – AR4 WG1, Figure 10.8). The scenarios shown are as follows: B1 – more integrated, and more ecologically friendly growth aimed at global environmental sustainability; A1B – rapid economic development with a balanced emphasis on all energy sources; A2 – a divided world, self reliant nations, continuously increasing population.*

TABLE 3.1 *Projected and observed climate change impacts on the physical and chemical environment.*

Impact	What might happen	What has been observed
Increased sea temperatures	Warming in all OSPAR areas, with strongest warming in Region I	Regions I–IV have warmed since 1994 at a greater rate than the global mean. Warming is most evident in Region II → FIGURE 3.3
Reduced sea ice	Region I: Sea ice may disappear in the summer in coming decades	Region I: Extent of sea ice has decreased in recent decades
Increased freshwater input	Region I: 10% to 30% increase in annual riverine inputs by 2100 with additional inputs from the melting of land-based ice Regional precipitation is difficult to project, but Region IV and the southern part of Region V may experience decreases in precipitation	Region I: The supply of freshwater to the Arctic appears to have increased between the 1960s and the 1990s
Changed salinity	Regions I and V: The Atlantic Ocean north of 60° N might freshen during the 21st century	Freshening in the deep waters of Regions I and V over the last four decades of the 20th century
Slowed Atlantic meridional overturning circulation	Slowdown of circulation in 21st century is very likely	No observations, but monitoring is now in place that will be able to observe long-term change in the Atlantic meridional overturning circulation
Shelf sea stratification	Regions II and III: Shelf seas may thermally stratify for longer and more strongly, but in the same locations	Regions II and III: Some evidence for earlier stratification in recent years and onset of the associated bloom
Increased storms	Projections of storms in future climate are of very low confidence	Regions I to V: Severe winds and mean wave heights increased over the past 50 years, but similar strong winds were also present in earlier decades
Increased sea level	Between 0.18 and 0.59 m by 2100 mostly through thermal expansion. There is high uncertainty at the upper range of these projections due to ice sheet processes. A rise of 2 m in a century cannot be discounted as a possibility based upon past change	Global sea level rose on average at 1.7 mm/yr through the 20th century. A faster rate of sea-level rise was evident in the 1990s
Reduced uptake of CO_2	Dependent on water temperature, stratification and circulation	North Atlantic: Reduced flux of CO_2 into surface waters in 2002–2005 compared with 1994–1995
Acidification	In the 21st century, ocean acidity could reach levels unprecedented over the last few million years with potentially severe effects on calcareous organisms	Global: Average decrease in pH of 0.1 units since the start of the industrial revolution
Coastal erosion	Projections are very uncertain and highly location specific	In many areas the combined effects of coastal erosion, infrastructure and sea defence development have led to a narrow coastal zone
Nutrient enrichment	Projections are uncertain and linked to impacts on various factors, such as rainfall patterns on freshwater input and run-off, storminess on turbidity, sea temperature on stratification	Regions I to IV: Drier summers may already be contributing to a decrease in nutrient inputs. Higher nutrient inputs in wet years have caused harmful algal blooms

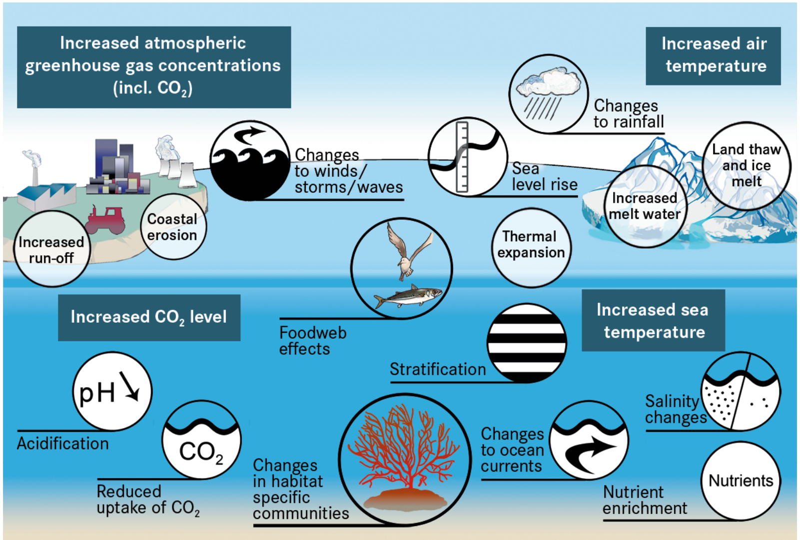


FIGURE 3.2 *Summary of impacts arising from climate change and ocean acidification.*

Many of the observed physical and chemical changes are consistent with increasing atmospheric CO_2 and a warming climate (rising sea temperature, reduced sea ice, acidification), but many of the causative links to climate change are still not well understood. It is difficult to predict the precise rate, magnitude and direction of change, for example for ocean uptake of CO_2, salinity, storminess and nutrient enrichment, and to map impacts at the local level. Physical and chemical changes have been directly linked to impacts on marine organisms (range shifts in plankton, fish and intertidal species communities) and are suggested to have important secondary effects such as on prey availability for seabirds. Uncertainties about physical changes make it difficult, for example, to predict the effects of changes in stratification on primary production, storminess on seabird nesting sites and nutrient enrichment on harmful algal blooms.

TABLE 3.2 *Projected and observed climate change impacts on the biological environment. In all cases, projections are limited by uncertainties in ocean climate projections and species and community responses.*

Impact	What might happen	What has been observed
Plankton	Northward shift of species in shelf and open ocean. Region I: Increased productivity with loss of sea ice	1000 km northward shift of many plankton species over the past 50 years → **FIGURE 3.4**. Changes in timing of seasonal plankton blooms
Harmful algal blooms	Potentially increasing incidence of harmful algal blooms as a result of changes in sea temperature, salinity and stratification	Anomalous phytoplankton blooms (often harmful) in specific habitats affected by lower salinities (e.g. Norwegian trench) or higher temperatures (German Bight)
Fish	Northward shifts in population, but lack of knowledge of the underlying mechanisms make projections uncertain Increased temperature could increase the incidence of disease for farmed species of fish and shellfish	Northward shifts of both bottom-dwelling and pelagic fish species, most pronounced in Regions I and II
Marine mammals	Loss of habitat for mammals dependent on sea ice. Changes in availability of prey species are likely, especially in Region I, due to mismatches in production	Data on distribution, abundance and condition of marine mammals are limited Ringed seals and polar bear may already be affected by loss of sea ice
Seabirds	Impacts on seabirds are likely to be more influenced by changes in their food supply than through loss of nests due to changed weather	Seabird breeding failure in the North Sea has been linked to variations in food availability as a result of increased sea temperatures
Non-indigenous species	Increased invasions and establishment may be facilitated by climate change and pose a high risk to existing ecosystems	Establishment of Pacific oyster and the barnacle *Elminius modestus* has been linked to climate change
Intertidal communities	Continued extension and retraction of the ranges of different intertidal species	Some warm-water invertebrates and algae have increased in abundance and extended their ranges around the UK over the past 20 years
Benthic ecology	Benthic sessile organisms are largely tolerant of moderate environmental change over reasonable, adaptive time-scales but are very vulnerable to abrupt and extreme events	Anomalously cold winter conditions have seen outbreaks of cold-water species and die-offs of warm-water species. Species composition changes have occurred, but not major shifts or changes in gross productivity

Understanding of the links between climate change and impacts on marine ecosystems is also limited due to insufficient data (e.g. relating to marine mammals, benthic ecology, and intertidal communities) and to difficulties in establishing local effects. Synergies and trade-offs between impacts and feedback mechanisms add further to uncertainties in projections.

Clear evidence of physical changes

Annual sea surface temperatures for the period 1999–2008 were warmer than in the period 1971–2000 across the whole OSPAR area → **FIGURE 3.3**. Region II has warmed the most, with temperatures increasing by 1 to 2 °C over the past 25 years. Temperatures in 2002 were the warmest since sea surface temperature records for the North Sea began in 1968. Summers in Region II have generally become longer and warmer while winters have become shorter and less cold. Regional patterns in weather and water circulation reduce the global warming signal in some areas. For example, in Region IV the temperature increase in the south is lower than expected, due to the upwelling of colder water. In the Arctic, both the maximum (March) and minimum (September) sea-ice extent decreased by around 2.5 % and 8.9 % per decade respectively in the period 1979–2009 → **BOX 3.1**.

The observed decrease in salinity in the deep North Atlantic and the Nordic Seas is likely to reflect higher levels of precipitation in the northern regions as well as higher river run-off, ice melt, advection and an overall speeding up of the global water cycle.

BOX 3.1 Reduction in Arctic sea ice

The Arctic may be ice-free in summer within the next few decades. In September 2009, sea ice in the Arctic reached the third lowest minimum extent recorded since 1979. This follows the lowest minimum extent recorded in September 2007 with ice extent about half the mean minimum observed in the 1950s. The IPCC stated with high confidence in its Fourth Assessment report that continued changes in sea-ice extent are likely to have major impacts on marine organisms and human activities in the Arctic. On the one hand, the increase in open water may increase biological production south of the ice edge, with benefits to important North-East Atlantic fish species such as cod and herring. On the other hand, species such as ringed seals and polar bears that depend on sea ice for feeding and breeding are likely to be adversely affected. Early summer sea-ice melt could exacerbate these impacts by causing a mismatch between the timing of marine mammal breeding and the availability of prey.

Increased accessibility in ice-free periods is likely to allow more shipping and offshore oil and gas production in the Arctic waters. More commercial activity in the open ocean and along the Arctic coasts will inevitably increase the risk of pollution and the risk of introducing non-indigenous species through ships' ballast water. Coastal erosion affects most the soft and historically eroded Arctic coastlines and is more likely as rising seas allow higher waves and storm surges to reach a shore no longer protected by ice. The risk of flooding in coastal wetlands is likely to increase, affecting coastal ecosystems and human settlements. Melting ice and snow may also release stored contaminants and increase their run-off to the sea in melt water.

Data source: NSIDC.

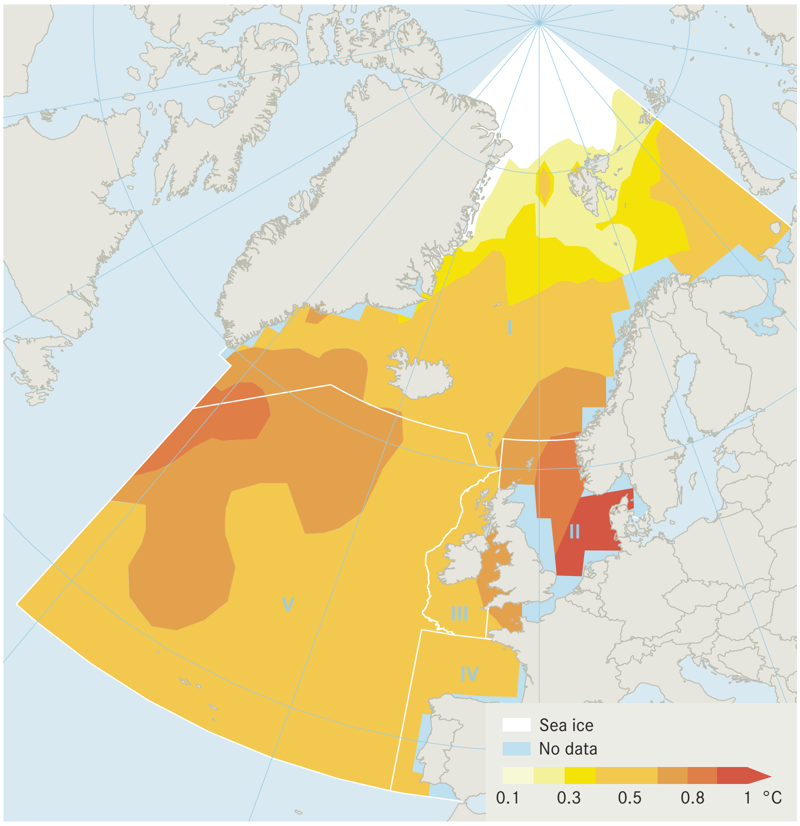


FIGURE 3.3 *Annual mean sea surface temperature anomaly for 1999–2008 relative to 1971–2000. Data source: NOAA.*

These changes have been linked to a possible slowing down of the large-scale circulation in the North-East Atlantic. It is unclear whether the observed increase in storm frequencies and higher sea levels are due to natural variability or whether there is some link with climate change. Rates of relative sea-level rise may be partly compensated in areas where the land rises in response to the loss of ice cover.

Evidence of biological impacts is growing

Climate is an important factor driving changes in the distribution, abundance and seasonality of marine biota → **BOX 3.2**. Evidence suggests that species are expanding their ranges under a warming climate in marine systems. The changes in distribution and abundance, which are expected to continue in the near future, have been sufficiently abrupt and permanent to be termed 'regime shifts' with ecosystems reorganising rapidly in terms of changes in predator-prey relationships and the spread of non-indigenous species.

The seasonal timing of phytoplankton and zooplankton production has altered in response to recent climate change with some species present up to four to six weeks earlier than twenty years ago, which affects predators such as fish. Changes in the timing of planktonic production and the distribution and composition of planktonic communities → **FIGURE 3.4** have been linked to changes in the distribution of many fish species. For example, the earlier occurrence,

BOX 3.2 Changes in the distribution and abundance of marine species in the OSPAR area

Changes in the distribution and abundance of marine biota in a number of long-term datasets (mainly from Region II) are consistent with expected climate effects. While this does not mean that climate is the only cause of the changes observed, it is an important factor in about 75 % of assessed area/taxon groups ('cases'). These include zooplankton (83 cases), benthos (85 cases), fish (100 cases), and seabirds (20 cases). Changes in the distribution and abundance of seabirds showed the weakest link to climate change. For other species, particularly zooplankton and fish, the relationship was much stronger.

Percentage of assessed area/taxon groups for which the observed change matches the change projected to result from climate change (source: ICES, 2008).

Changes in area/taxon groups:	Zooplankton			Benthos		Fish		Seabirds	Change matching projection
	Distribution	Abundance	Other (e.g. seasonality, phenology)	Distribution	Abundance	Distribution	Abundance	Distribution/ abundance	
Region I	4	1				2	13	7	74 %
Region II	3	9	61	40	32	42	15	10	77 %
Region III						9	12	3	83 %
Region IV	1	4		13		2	5		76 %
Change matching projection	100 %	64 %	100 %	66 %	66 %	82 %	71 %	60 %	

■ > 75 % ■ 50–75 % ■ < 50 % ■ No assessment

reduced abundance and increasing dominance of smaller species in zooplankton communities have been linked to the decline in cod in the North Sea. Loss of summer sea ice will have profound implications for ice-associated plankton and the organisms that rely on them.

All OSPAR Regions have experienced range shifts and changes in fish distribution and abundance consistent with what is expected as a result of climate change, with northward shifts in distribution and lower levels of abundance in the southern part of the range. The rate at which cod stocks in the North Sea have decreased cannot be explained by over-fishing alone. Southern species such as the silvery John dory, sea bass, red mullet and European anchovy have all become more common further north. In the UK, expansions in the range of intertidal species have been observed towards previously cooler areas (i.e. eastward and northward).

Climate change is likely to encourage species to spread into and establish in new areas. Several non-indigenous species are now established in the OSPAR area; two of these (the Pacific oyster and the barnacle *Elminius modestus*) as a direct result of regional warming. As Arctic sea ice decreases, organisms may spread into the North Atlantic from the Pacific. The Pacific diatom *Neodenticula seminae* was discovered in the North Atlantic in 1999 and may provide the first evidence of trans-Arctic migration. There is also a risk that loss of sea ice will lead to loss of ice-dependent Arctic species.

Stormy sea on Arranmore Island, North-West Ireland

Ocean acidification is a key threat

With increasing amounts of anthropogenic atmospheric CO_2 dissolving into the sea, the pH of seawater is decreasing and the ocean is becoming more acidic. Decreasing pH reduces the ability of the ocean to take up CO_2 and provides a potential feedback effect on climate change.

There has been an average global fall in ocean surface water pH of 0.1 units since the start of the industrial revolution which reflects a 30 % increase in acidity. The trend is also reflected in the OSPAR area, for

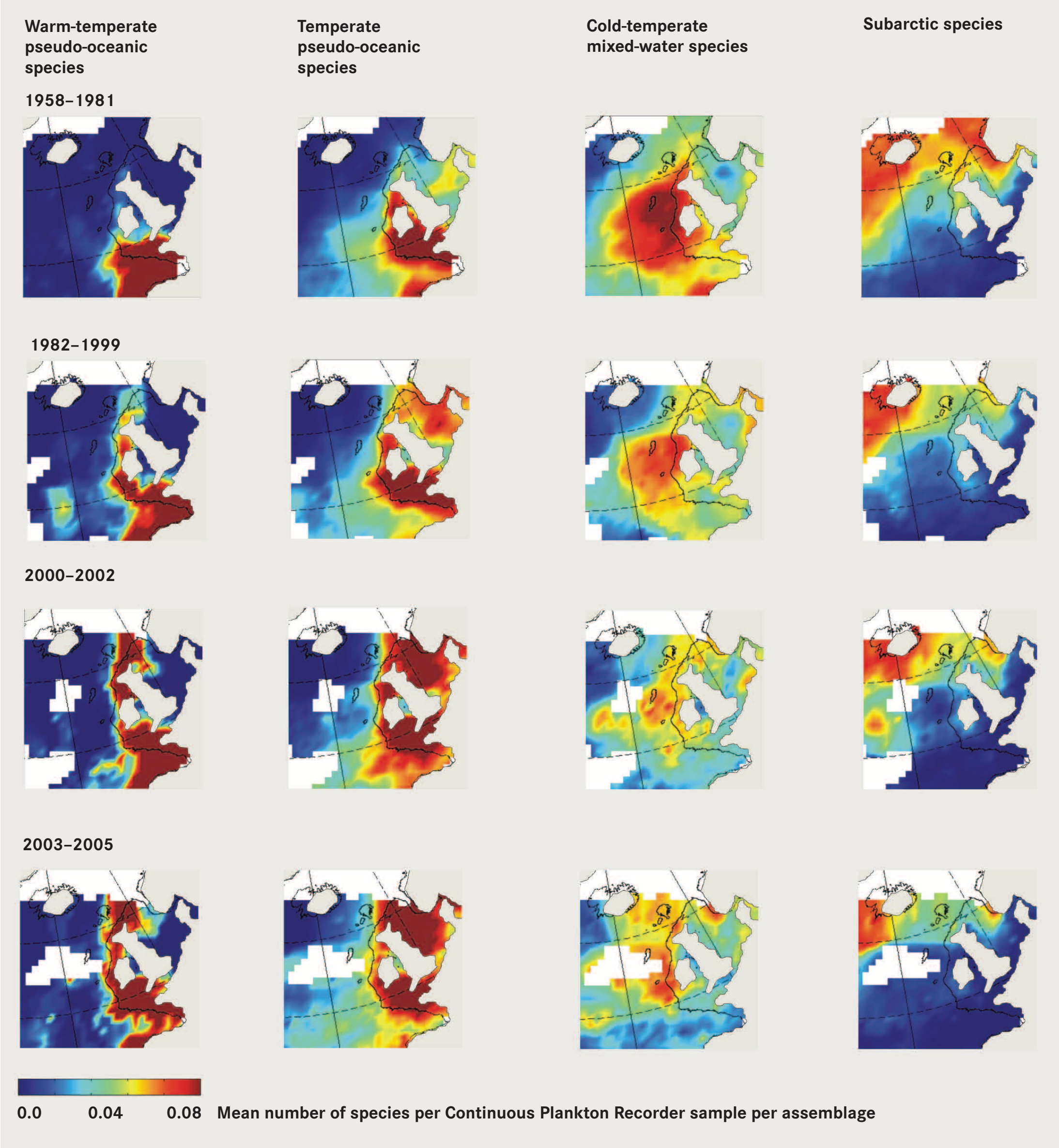


FIGURE 3.4 *Changes in the biodiversity of Calanus copepod zooplankton species in relation to the rise in sea temperatures since the late 1950s. Source: Edwards et al. (2008). Over the past five decades there has been a progressive increase in the presence of warm-water/sub-tropical species into the more temperate areas of the North-East Atlantic and a decline of colder-water species. In the North Sea the warm-temperate species C. helgolandicus has progressively replaced the cool-temperate C. finmarchicus. Overall Calanus abundance in the North Sea has declined. Between 2000–2002 and 2003–2005, subarctic species have declined south-east of Iceland.*

example in the Kattegat and Norwegian Sea → **BOX 3.3**. Current changes in ocean carbon chemistry are at least 100 times more rapid than any over the last 100 000 years. Little is known about the ecological and economic impacts of marine acidification but they could be severe, affecting the many biologically mediated processes that transport carbon from the ocean surface to the depths. Experimental data indicate that lower pH (at the levels predicted) is expected to have a range of effects on marine organisms, including dissolution of calcium carbonate (aragonite or calcite) shells and skeletons (decalcification) in calcareous plankton and corals, and acidification of body fluids in fish and invertebrates. Many species with critical ecological roles in pelagic and benthic systems will be affected. Ecosystem-wide effects are expected within 50 to 100 years, including the undersaturation of calcium carbonate in seawater – a condition where there is a risk of decalcification occurring. There have been some recent projections that undersaturation of surface water with aragonite may happen in parts of the Arctic by as early as 2016 in winter and 2026 throughout the year. More than 150 scientists under the umbrella of UNESCO's Intergovernmental Oceanographic Commission (IOC) support projections that most regions of the ocean will be inhospitable for coral reefs by 2050 if atmospheric CO_2 concentrations continue to increase. They urged policymakers through the 2009 Monaco Declaration to develop plans to drastically cut CO_2 emissions.

BOX 3.3 Marine acidification in the Kattegat and Norwegian Sea

The trend towards lower pH in the world's oceans is also reflected around Sweden (Region II) and off the Norwegian coast (Region I). Decreases in pH are statistically significant in both surface waters and deeper waters in the Kattegat and projections suggest a decrease in surface pH of 0.2 units by 2050 and 0.4 units by 2100. However, time series are short and geographic coverage limited, making improved measurement of acidification parameters an imperative for the future. Based on current trends, rates of decline in depths over 30 m are projected to be double those for surface water. Given the experimental results obtained to date and the observed trends of declining pH in Swedish coastal waters, it is likely that ecosystem-wide effects will be observed within 50 to 100 years. Similar findings apply for the Norwegian Sea where a statistically significant decrease in pH of 0.03 units was observed in the mixed layer between 2002 and 2007 and projections suggest a further decrease of 0.3 units by 2070 to 7.8.

Observed and projected pH change in the Kattegat

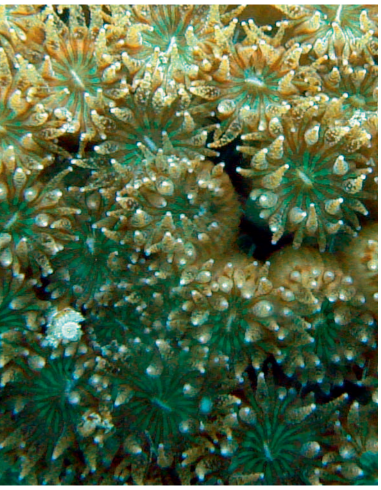
Depth	pH 2007	pH change 1993–2007	pH change per year	Projected pH 2050	Projected pH 2100
0–25 m	8.15	–0.06	–0.0044	7.96	7.74
30 m	8.00	–0.11	–0.0079	7.66	7.24

What has been done?

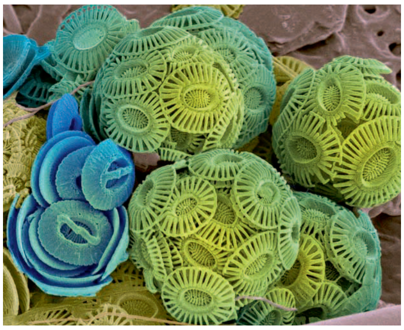
Drastic reductions in greenhouse gas emissions are key to mitigating impacts

The UN Framework Convention on Climate Change leads work at the global level towards stabilising greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. In this context the Kyoto Treaty has committed most industrialised nations to legally binding reductions in greenhouse gas emissions by 2008–2012. Negotiation of a post-2012 framework was initiated by the Copenhagen Conference of the Parties in December 2009.

More than 5000 million tonnes CO_2 equivalent of greenhouse gases were emitted in Europe in 2007. This is 9.3% less than in 1990. Global greenhouse gas emissions must be reduced to less than 50% of 1990 levels by 2050 if the rise in average global temperature is to be kept below 2 °C compared to pre-industrial levels, and specifically, reductions in CO_2 are required to mitigate consequences of ocean acidification. The EU has set a binding unilateral interim target to cut greenhouse gas emissions by 20% over the period 2012–2020 and aims to increase the share of renewable energies in Europe to 20% over this period. Urgent action is needed to achieve these targets, employing a wide range of solutions. Options include improving energy efficiency, reducing energy demand, shifting to renewable energies and carbon capture and storage. All options, whether on land or at sea, can be expected to change the distribution and intensity of pressures on the marine environment.



Impacts of acidification on calcareous organisms. Cladocora caespitosa is a Mediterranean coral, at normal pH (8.1) (left) and with dissolving skeleton in acidified water near CO_2 vents (pH 7.4) (right)



Coccolithophores (coloured scanning electron micrograph) are calcareous microphytoplankton with a major role in the global carbon cycle

Demand for energy from wind, waves and tides is increasing

Most of the existing and planned offshore renewable energy projects are wind farms concentrated in Regions II and III. The number of offshore wind farms in the OSPAR area has grown substantially over the past ten years and if all farms authorised and applied for in 2009 are developed, the number of offshore turbines in the OSPAR area will increase almost ten-fold → CHAPTER 9. More applications have been made and more are expected. In some areas there is potential for harnessing energy from waves, tidal streams and salinity gradients. Commercial-scale development is currently limited.

Tidal turbine, Orkney, Scotland

Wave and tidal power test sites have been operating off Ireland and Scotland for several years, with 0.3 GW total installed capacity in 2008. It will probably be some years before there is large-scale marine energy generation in the OSPAR area, although some countries have set targets for tidal stream and wave energy production. For example, Scotland plans to install 1.3 GW of capacity by 2020. The environmental impacts of these techniques and the necessary mitigating measures are likely to vary depending on the technology and location. Increasing demand for renewable energy from the marine environment suggests that regional cooperation and marine spatial planning could be important tools for managing the competition for space in coastal and offshore areas and for minimising their impacts on the marine environment.

Carbon sequestration can help the transition to a lower carbon economy

Capturing carbon from combustion at source and transporting this to sub-seabed geological reservoirs could help mitigate climate change over century-long time scales and thus help with the transition to a lower carbon economy. Eligible reservoirs include depleted oil and gas fields in the North Sea (Region II) and the Norwegian Sea (Region I). OSPAR and the EU have developed frameworks for managing the risks from carbon sequestration. The main risks to the environment and human health include a risk of re-emitting stored CO_2 to the atmosphere, and local risks from possible releases of CO_2 and other substances in the CO_2 stream to the marine environment. Three projects are currently operating in the OSPAR area, of these the *Sleipner* project provides the longest experience → BOX 3.4. Good site selection,

BOX 3.4 CO_2 capture and storage at the *Sleipner Vest* gas-condensate field

The *Sleipner* CO_2 injection project in the North Sea off the Norwegian coast was the first industrial-scale activity of its kind in the world and has been operating since 1996. Around 1 million tonnes of CO_2 are removed each year from natural gas produced at the *Sleipner Vest* gas-condensate field before it is transported onshore. By 2008, almost 10 million tonnes of excess CO_2 had been injected into a sandy geological layer, called the Utsira formation, which lies 800 to 1000 m below the seabed. The formation is overlain by a thick layer of shales which act as an effective barrier to CO_2 leakage. Selection of an appropriate reservoir and injection location was essential for the success of the storage. Seismic surveys and other monitoring techniques record the spread of the CO_2 and show that the injected CO_2 has remained in place without leaking.

The recent amendment of the OSPAR Convention and the adoption of a package of OSPAR measures make it possible to permanently dispose of CO_2 in sub-seabed reservoirs remote from the source of its capture, subject to agreed standards for risk assessment and management being applied. Placing CO_2 in the water column and on the seabed is banned because it is likely to result in harm to living organisms and marine ecosystems.

Coastal erosion at Happisburgh, eastern England

project design based on risk assessments, and monitoring are essential for avoiding CO_2 leakage and reducing environmental impacts.

Fertilising the oceans with iron to encourage the natural sequestration of carbon has been proposed as a mitigation strategy, but this is unlikely to be feasible within the OSPAR area because the ocean chemistry is unsuitable.

The importance of coastal habitats, such as salt marshes, seagrass meadows and kelp forests, as natural carbon sinks is becoming recognised (Laffoley and Grimsditch, 2009). These habitats may provide a significant contribution to carbon sequestration and this might justify renewed attention to their management and conservation.

Increased risk of floods and coastal erosion requires early response

Whatever level of mitigation can be achieved, it will take years for the ocean to respond and some impacts will inevitably arise even though the precise nature and rate of future climate change are still uncertain. Adaptation strategies for the marine environment will be more challenging than those for land as fewer tools are available.

Sea-level rise and increased storm frequencies will increase the vulnerability of many parts of the coastline to flooding and coastal erosion, especially in the southern North Sea (Region II) and the Bay of Biscay (Region IV), making adaptation of current coastal defence policies and measures imperative. An increase in the occurrence of severe storm surges is projected for the North Sea.

Some adaptation of coastal defence is already taking place. This includes hard-engineering approaches involving the reinforcement of existing coastal defence structures and construction of storm surge barriers, as well as soft-engineering approaches that make use of natural habitats to dissipate the force of waves and tides, for example, large-scale beach nourishment and the conversion of farmland into salt marshes. The effects of these measures, individually and cumulatively, on the marine environment still need to be quantified.

What happens next?

Climate change and ocean acidification add urgency to OSPAR's work

Impacts of climate change are now becoming evident. While the nature and rate of these impacts are uncertain, rising sea temperature and increasing acidification represent major threats to marine ecosystems in the OSPAR area. Even projections based on the more moderate emissions scenarios imply major environmental, economic and social impacts. This adds urgency to OSPAR's work to reduce existing pressures and so increase the capacity of ecosystems to cope under a changing climate. The OSPAR network of marine protected areas (MPAs) will have an important role to play in helping to maintain and restore the capacity of ecosystems to resist and recover from the impacts of ocean climate change.

OSPAR will need to recognise opportunities to mitigate and adapt to climate change. Mitigation and adaptation on land and at sea will alter the distribution and intensity of human pressures on marine ecosystems. OSPAR offers a framework for managing and regulating the increasing demands for new uses of the sea, such as the generation of renewable energy and carbon capture and sequestration. Marine spatial planning and integrated coastal zone management provide additional tools. Attention should be given to conservation and restoration of natural coastal carbon sinks.

To account for the changing pressures on the marine environment and its increased vulnerability, OSPAR will need to adapt its current policies and objectives for the protection of the marine environment and to strengthen its cooperation with other international organisations on the management of uses of the sea (e.g. the North East Atlantic Fisheries Commission and the International Maritime Organization).

Monitoring and assessment are a priority

The nature, rate and impacts of climate change differ across the OSPAR area. The increase in temperature and acidification will be higher in northern areas (Regions I and II) than southern areas (Regions IV and V). Threats to Arctic biodiversity are particularly imminent with sea-ice loss profoundly affecting ice-associated marine life, and projected rates of acidification suggesting adverse ecosystem impacts within the next decade. The differences between the Regions imply a need to understand better the potential climate change impacts at both the regional and local level, as well as the risk of so-called 'tipping points' being reached. These thresholds represent the point at which a change is no longer linear and reversible, but abrupt, large and potentially irreversible over time-scales relevant for the well-being of contemporary generations. Better links between science and the development of local policy on risk assessment are essential. OSPAR will need to undertake the following actions:

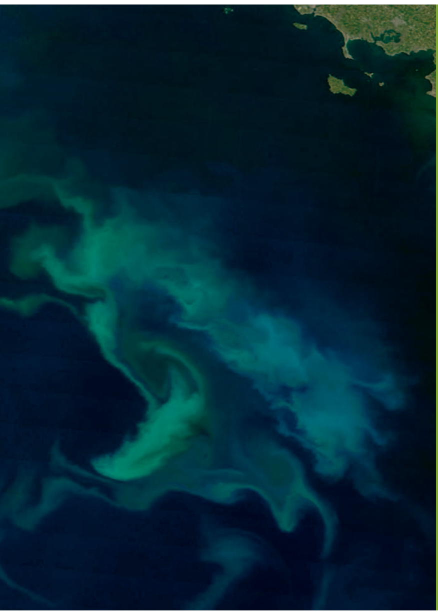
- Enhance knowledge about the vulnerability of species, habitats and ecological processes and their interaction with pressures from human activities.
- Work with partner organisations (e.g. the International Council for the Exploration of the Sea and the Intergovernmental Oceanographic Commission) to put in place systems for assessing climate change. This should include scenarios of potential impacts and methods and indicators to monitor and assess the progression of climate change impacts particularly at regional scales.
- Give priority to monitoring and assessment of ocean acidification and its effects on marine ecosystems.

Selected climate driven changes in the OSPAR Regions

→ LEGEND: BACK-COVER FOLD-OUT

OSPAR Region	Observed physical and biological changes	Key observed changes	Outlook for key changes
Region I	Strong changes ***	Sea-ice loss Sea temperature rise Acidification	↑
		Range shifts of fish species Plankton/food web changes	?
Region II	Strong changes ***	Sea temperature rise Acidification	↑
		Range shifts of fish species Plankton/food web changes	?
Region III	Changes ***	Sea temperature rise Acidification	↑
		Range shifts of fish species Plankton/food web changes	?
Region IV	Changes ***	Sea temperature rise Acidification	↑
		Range shifts of fish species Plankton/food web changes	?
Region V	Changes ***	Sea temperature rise Acidification	↑
		No information on species distribution and abundance	?

4 EUTROPHICATION



Eutrophication is still a problem in Regions II, III and IV and the objective of no eutrophication will only be partly achieved by 2010. Reductions in phosphorus discharges exceed the OSPAR target of 50 % compared to 1985, but nitrogen discharges are still the main problem, especially those from agriculture. Concern about atmospheric nitrogen inputs is increasing. It can take decades for reduction measures to have positive effects in the sea because nutrients are released from soils and sediments.

OSPAR Contracting Parties should cooperate

→ to implement with urgency OSPAR and EU measures to reduce nutrient inputs to eutrophication problem areas and take additional action if needed to eliminate eutrophication problems;
→ to set within OSPAR appropriate reduction targets for nutrient inputs to individual problem areas;
→ to promote consideration of marine eutrophication when implementing the EU Nitrates Directive and in the revision of international nitrogen air emission targets and standards, for example, those set by the EU, UNECE and IMO;
→ to refine OSPAR's assessment methodologies, including modelling of nutrient transports;
→ to improve OSPAR's monitoring framework through coordinated use of novel observation tools and coordination of data collection on sources, inputs and environmental status.

Key OSPAR assessments

→ Eutrophication status of the OSPAR maritime area
→ Towards the 50 % reduction target for nutrients
→ Trends in atmospheric concentrations and deposition
→ Trends in waterborne inputs

Nutrients, especially nitrogen and phosphorus, are essential for the growth of aquatic plants which form the basis of marine food webs. Natural processes regulate the balance between nutrient availability and the growth of marine plants and animals in ecosystems. Excess nutrients introduced into the sea by human activities can disturb this balance and may result in accelerated algal growth, leading to adverse effects on water quality and marine ecology. This process is known as eutrophication. OSPAR works under its Eutrophication Strategy to combat eutrophication and to achieve a healthy marine environment.

OSPAR Strategy objectives for eutrophication

→ Combat eutrophication in the OSPAR maritime area in order to achieve and maintain, by 2010, a healthy marine environment where eutrophication does not occur.
→ Reduce inputs of nitrogen and phosphorus to areas affected by or likely to be affected by eutrophication in the order of 50 % compared to 1985.

What are the problems?

Eutrophication affects marine ecosystems in many ways

Eutrophication is mainly a problem in coastal areas and in areas with restricted water exchange, such as enclosed estuaries and embayments. Eutrophication causes changes in the composition of plant and animal communities and generally favours growth of rapidly reproducing opportunistic algal and animal species → FIGURE 4.1. Opportunistic algal species do not always pose a threat but some species can adversely affect ecosystems. Mass occurrence of phytoplankton also reduces the depth at which light is available for long-lived seagrass species. Once the nutrients have been depleted, the algal blooms associated with nutrient enrichment decay, leading to oxygen deficiency and possibly kills of fish and benthic invertebrates, and to the formation of toxic hydrogen sulphide (H_2S).

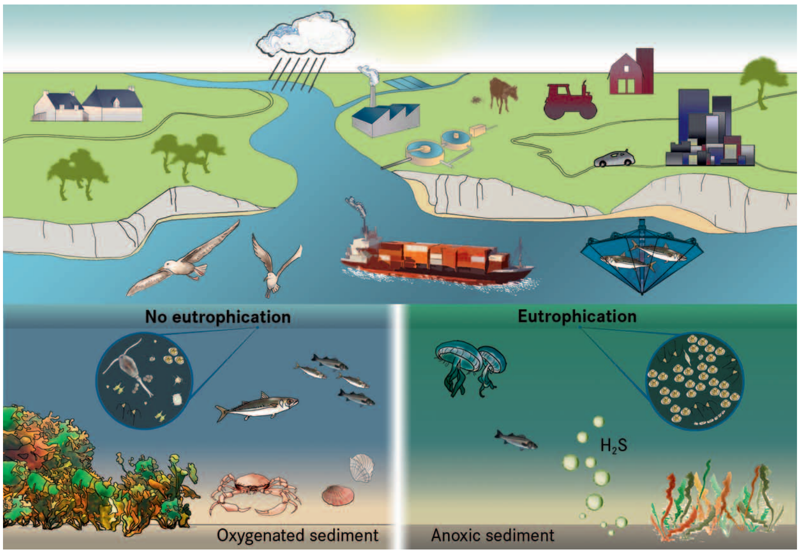


FIGURE 4.1 *Sources of nutrient input to the marine environment and simplified schemes showing eutrophication effects arising from nutrient enrichment.*

As well as causing impacts on the ecosystem, eutrophication can affect human activities. For example, algal blooms can clog fishing nets. Decaying blooms of some algae can create unsightly foam masses on beaches and unpleasant smells that interfere with tourism and recreation. Although some algae produce toxins that can harm humans through consumption of contaminated shellfish, the link to nutrient enrichment is uncertain.

Excess nutrients result from sources on land and at sea

Rivers are the main pathway for excess nutrients to Regions II, III and IV, collecting direct discharges from point sources, such as sewage treatment plants and industry, and inputs from land run-off and leaching, mainly as a result of agriculture. The amounts of nutrients released from land-based sources vary according to land use and population density. Point sources generally dominate in urban areas, while diffuse sources dominate in farming areas. Farmland covers about half the total land area in many OSPAR countries, reaching 60 % to 70 % for some countries bordering Regions II and III. The rate of turnover of nutrients in soils and sediments means they can be released to the marine environment for decades after releases from the original sources have been reduced. A further potential confounding factor is hazardous substances, some of which (e.g. certain anti-fouling agents) have the potential to influence algal growth and in turn eutrophication effects. Transboundary transport of nutrients by ocean currents is particularly important in Region II.

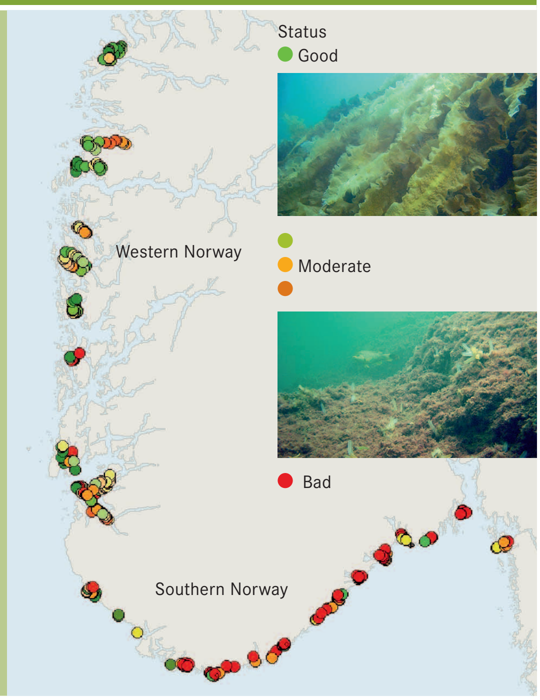
Atmospheric deposition is an important pathway for nitrogen to the sea and is usually greatest close to the source. Nitrogen is emitted to the atmosphere from agriculture and from combustion processes associated with industry and transport, including maritime shipping, and can be carried by winds to places far from the emission sources, where it is deposited. In Regions I and V, far from most point sources of pollution, atmospheric deposition is the main pathway for anthropogenic inputs of nitrogen.

BOX 4.1 Declining sugar kelp forests on the Norwegian coast

Surveys of sugar kelp forests between 1996 and 2006 by the Norwegian Institute for Water Research uncovered a dramatic decline in their abundance along the Norwegian coasts. Abundance of sugar kelp reduced by 40 % on the western coast and 80 % on the southern (Skagerrak) coast. The decline was most pronounced in sheltered waters, where the sugar kelp forests have been replaced over large areas by a silty turf community dominated by filamentous algae.

The shift in vegetation probably reflects a combination of long-term eutrophication (transboundary inputs as well as local nutrient inputs) and recent climatic events resulting in higher sea temperatures. The decline in sugar kelp followed exceptionally warm summers. Eutrophication may also have negatively affected recruitment of new plants on the Skagerrak coast.

The kelp forests are highly productive and diverse communities, providing habitat for many organisms, and are important feeding and nursery areas for many species of fish. In contrast, the turf communities provide much less food and shelter. The ecological and economic consequences of these changes within the coastal zone are uncertain. Estimates suggest that the lost sugar kelp forests mean a shortfall of 50 000 tonnes of fish biomass and CO_2 capture capacity worth 11 million Euro (based on 18 Euro per tonne CO_2).



BOX 4.2 A Common Procedure to assess eutrophication

The Common Procedure for the Identification of the Eutrophication Status of the Maritime Area ('Common Procedure') provides the framework for a comprehensive, harmonised characterisation of marine areas by OSPAR countries in terms of 'problem areas', 'potential problem areas' and 'non-problem areas' with regard to eutrophication. Its second application, relating to the period 2001–2005, was restricted to areas that had previously shown eutrophication problems or non-problem areas which gave concern that their quality status may have deteriorated.

The Common Procedure links ten indicators for nutrient enrichment and direct and indirect eutrophication effects in an integrated cause-effect scheme. Applications of the Common Procedure have so far focused on assessing eutrophication status and change in area status over time. Assessments of regional trends in individual indicators will need to receive more attention in future to make it possible to track improvements.

The indicators cover excessive nuisance algal blooms, loss and changes in biodiversity (for macrophytes, zoobenthos, fish) and oxygen deficiency. Differences in environmental characteristics, such as salinity, mean that not all parameters are relevant or robust indicators for eutrophication in each area. Indicators are elevated if they exceed the acceptable deviation from area-specific background conditions which OSPAR countries determine through regionally agreed methodologies, taking into account natural variability. As a result they are not applied in the same way across the OSPAR area. Data availability also contributes to differences in their use. An area is generally classified as a problem area if an indicator for nutrient enrichment and an indicator for eutrophication effect are elevated. Monitoring of the indicators is coordinated across the OSPAR area through agreed methodological standards covering sampling, analysis, reporting and quality assurance. The work supports judgement about the quality of coastal and marine waters under the EU Water Framework Directive and the EU Marine Strategy Framework Directive.

Climate change may alter impacts

More rain and increased flooding as a result of climate change are expected to enhance nutrient enrichment through increased freshwater input and run-off from land → CHAPTER 3. Rising sea temperature and prolonged stratification are likely to lead to increased incidence of harmful algal blooms and changing phytoplankton composition. Ocean acidification may also promote changes in the plankton. Recent observations of the decline in sugar kelp along the southern coast of Norway indicate possible interactions between climate change and eutrophication → BOX 4.1. Improved understanding of this interaction will be important in OSPAR's future work on eutrophication.

What has been done?

Reduction targets set to tackle eutrophication

The presence of serious eutrophication effects in parts of the maritime area during the 1970s led North Sea countries to agree on the need for a reduction of nitrogen and phosphorus inputs to areas affected, or likely to be affected, by eutrophication. Agreement was reached on a target for reduction of the order of 50% between 1985 and 1995. This was endorsed by OSPAR in 1988 for its entire maritime area and has since formed an integral part of its Eutrophication Strategy.

Regular national reporting, supported by harmonised procedures for quantifying and reporting discharges and losses of nutrients, makes it possible to judge progress on reducing nutrient releases and achieving the 50% reduction target.

Agreed methodologies track eutrophication problems

In response to the need for a collective approach for evaluating the eutrophication status of the maritime area, OSPAR developed the Common Procedure for use by all OSPAR countries → BOX 4.2. This was applied in 2002 for the period 1990–2000 and again in 2007 for the period 2001–2005 and has proved a good means for assessing the extent of marine eutrophication and for identifying problem areas, where the 50% nutrient reduction target applies. Joint modelling exercises have been used to test the effectiveness of current and projected nutrient reduction scenarios and to estimate transboundary nutrient transport in the North Sea.

The Common Procedure also supports the application of the eutrophication-related Ecological Quality Objective (EcoQO) for the North Sea → CHAPTER 11.

Continued cooperation with other international bodies

To achieve OSPAR's targets, OSPAR countries have agreed to implement a coordinated programme for the reduction of nutrient inputs from point sources and agriculture where eutrophication problems are identified. This is mainly being delivered through implementing measures adopted in the EU, the European Economic Area and other international forums. A wide range of European and international instruments aim at combating nutrient releases to surface waters and air through controlling discharges, emissions and losses at source and by setting environmental targets → TABLE 4.1. Under EU legislation, stricter requirements apply to agriculture and urban

TABLE 4.1 *European and international instruments to combat eutrophication and their respective tools that have supported progress towards the OSPAR objective.*

EU Urban Waste Water Treatment Directive (91/271/EEC)
Connection of industry and households to waste water treatment Higher level treatment of waste water Designation of water areas sensitive to nutrient inputs
EU Nitrates Directive (91/676/EEC)
Good agricultural practice Designation of water zones vulnerable to nitrogen losses
EU Integrated Pollution Prevention and Control (IPPC) Directive (2008/1/EC)
Industrial and agricultural point sources Best Available Techniques Emission and discharge limits
EU Water Framework Directive (2000/60/EC)
Normative definitions describing good ecological status of a water body River basin management plans
EU National Emissions Ceiling Directive (2001/81/EC)
Ceilings for air emissions of nitrogen
MARPOL Annex VI
Emission control standards for ships Emission control sea areas with stricter ship standards
UNECE Convention on Long-range Transboundary Air Pollution (Gothenburg Protocol)
Industrial and agricultural point sources Emission targets for nitrogen Transboundary air transport of nitrogen

waste water treatment plants discharging into areas designated as sensitive or vulnerable to nutrient inputs. These broadly coincide with OSPAR problem areas. EU legislation and OSPAR measures mutually support objectives to combat eutrophication.

Did it work?

The 50 % reduction target has mostly been met for phosphorus but not for nitrogen

Nutrient discharges and losses to water from point and diffuse sources to eutrophication problem areas have steadily decreased in Regions II and III over the past 20 to 25 years → FIGURE 4.2. By 1995, the initial timeframe agreed, most Region II countries had achieved a reduction of 50 % in phosphorus discharges compared to 1985. This was not the case for nitrogen and OSPAR countries committed themselves to the 50 % reduction target beyond 1995. Continued efforts have now resulted in further substantial decreases in phosphorus discharges in several countries of up to 85 % compared to 1985. By 2005, some progress had also been made on reducing nitrogen discharges and losses to the North Sea, with Denmark having achieved the 50 % reduction target and Germany and the Netherlands approaching it. More efforts are needed by OSPAR countries, especially to reduce nitrogen inputs to areas where eutrophication problems still exist. Differential reductions in nitrogen and phosphorus inputs can alter nitrogen/phosphorus ratios in seawater and this may cause shifts in algal species composition, for example from diatoms to flagellates.

Point source discharges are falling, but sewage is still a problem

Four countries have reported reductions in nitrogen and phosphorus discharges to eutrophication problem areas from industry of more than 80 % for the period 1985–2005, with Germany (nitrogen and phosphorus) and the Netherlands (phosphorus) reporting reductions of more than 90 %. Urban

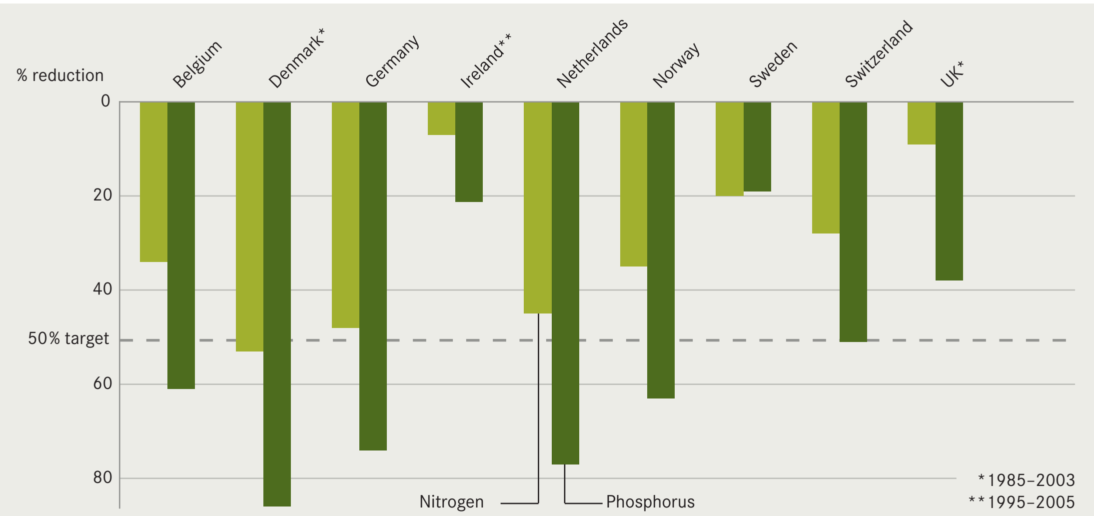


FIGURE 4.2 *Reduction of discharges and losses of nitrogen and phosphorus to problem areas reported for 2005 relative to 1985. Most countries in Regions II and III have met the target reduction of 50 % for phosphorus, but not for nitrogen. For France data on source-related discharges and losses to problem areas are not available. France reported, however, a 50 % reduction in riverine inputs of phosphorus to its coastal waters in the period 1990–2007, but no significant trend in nitrogen inputs. It is not possible to compare directly the reductions achieved by OSPAR countries owing to differences in the periods over which the reduction measures were applied and the different methods used to calculate reductions.*

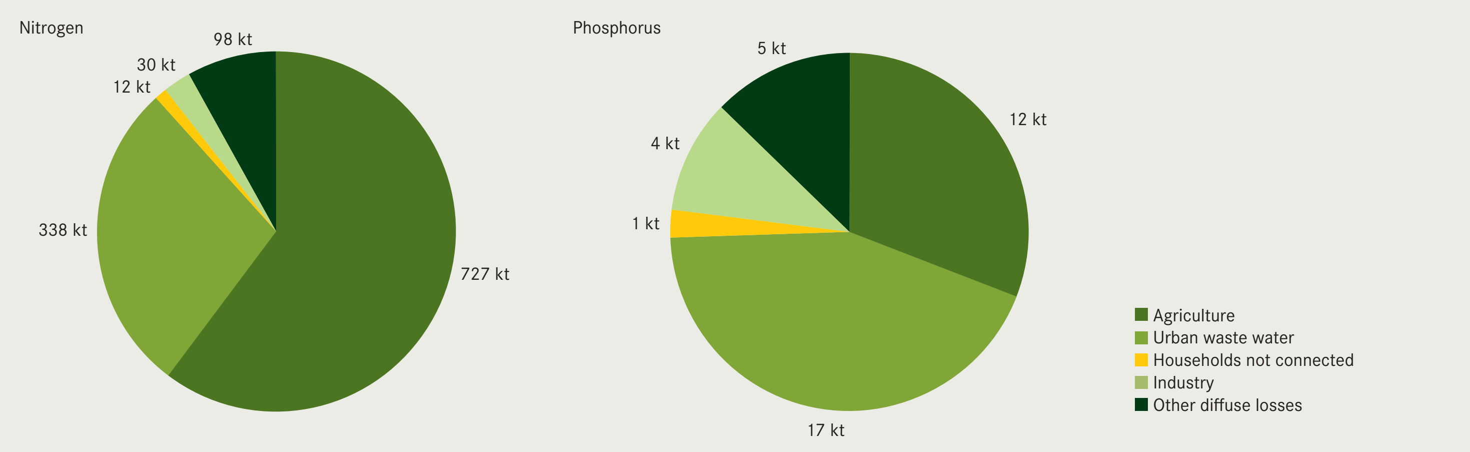


FIGURE 4.3 *Relative contribution of sources of discharges and losses of nitrogen and phosphorus to eutrophication problem areas in Regions II and III in 2005. Eight OSPAR countries reported combined totals of around 1200 kt nitrogen and 40 kt phosphorus for discharges and losses. Data on discharges to problem areas in Region IV are not available. The category 'other diffuse losses' includes background losses, atmospheric deposition on freshwater and some losses from agriculture. Releases from coastal and freshwater aquaculture are not shown in the chart as they are substantially smaller than those from other sources, amounting to around 260 t of nitrogen and 45 t of phosphorus.*

waste water is another major source of nutrient discharge and efforts to collect and treat waste water from households and industry are continuing. Most households in OSPAR countries are now connected to waste water treatment plants and many of these use biological and chemical treatment to remove nitrogen and phosphorus. Nevertheless, sewage effluents are still the main source of phosphorus to the marine environment and contribute a quarter of all nitrogen discharged to problem areas in Regions II and III → **FIGURE 4.3**. Full implementation of the EU Urban Waste Water Treatment Directive is key to achieving further reductions.

Nitrogen losses from agriculture must be tackled

Nearly two-thirds of the nitrogen and a third of the phosphorus discharged to eutrophication problem areas in Regions II and III in 2005 came from agricultural sources → **FIGURE 4.3**. The progress made since 1985 in reducing losses from agriculture varies between OSPAR countries and is more marked for phosphorus. Some countries have reduced nitrogen losses by roughly a quarter, while others have reported only minor progress or even small increases. While it is difficult to predict the future trend in fertiliser use and associated nitrogen releases from agriculture, the expansion in biofuel production to meet EU targets for renewable energy and the expected intensification of food crop production should be kept under review with regard to possible impacts on the eutrophication status of coastal areas. The reform of the Common Agricultural Policy provides an opportunity to promote agro-ecological schemes aimed at reducing nutrient losses to surface water. To reduce agricultural inputs to eutrophication problem areas it is essential for countries to fully implement the reduction measures under the EU Nitrates Directive, taking into account marine eutrophication, and the EU Water Framework Directive. OSPAR should assess, through modelling and in cooperation with the EU, whether these measures are sufficient to support the achievement of non-problem area status.

Trends in riverine and direct inputs are mostly downward

Rivers collect the nutrients discharged and lost from all land-based point and diffuse sources in the catchment and account for most of the waterborne inputs of nitrogen and phosphorus to Regions II, III and IV. Monitoring shows that nitrogen inputs from rivers and direct discharges to the sea have decreased to varying degrees since 1990 → **FIGURE 4.4**. Phosphorus inputs show similar regional patterns, although reductions are generally more pronounced than for nitrogen.

Large decreases in the nitrogen loads carried by the rivers Elbe and Rhine and the phosphorus loads carried by the rivers Seine, Elbe, Rhine and Meuse underlie the clear fall in river inputs to Region II since 1990. Direct discharges of phosphorus for this period were significantly reduced but discharges of nitrogen were not.

There is no clear trend for river inputs to Regions III and IV in the period 1990–2006, but there has been a significant downward trend in direct discharges for Region III, reaching 50 % for phosphorus. In Region I, total nutrient loads are small compared to the other Regions and remained unchanged in the period 2000–2006 because increasing discharges from mariculture offset reductions in riverine inputs.

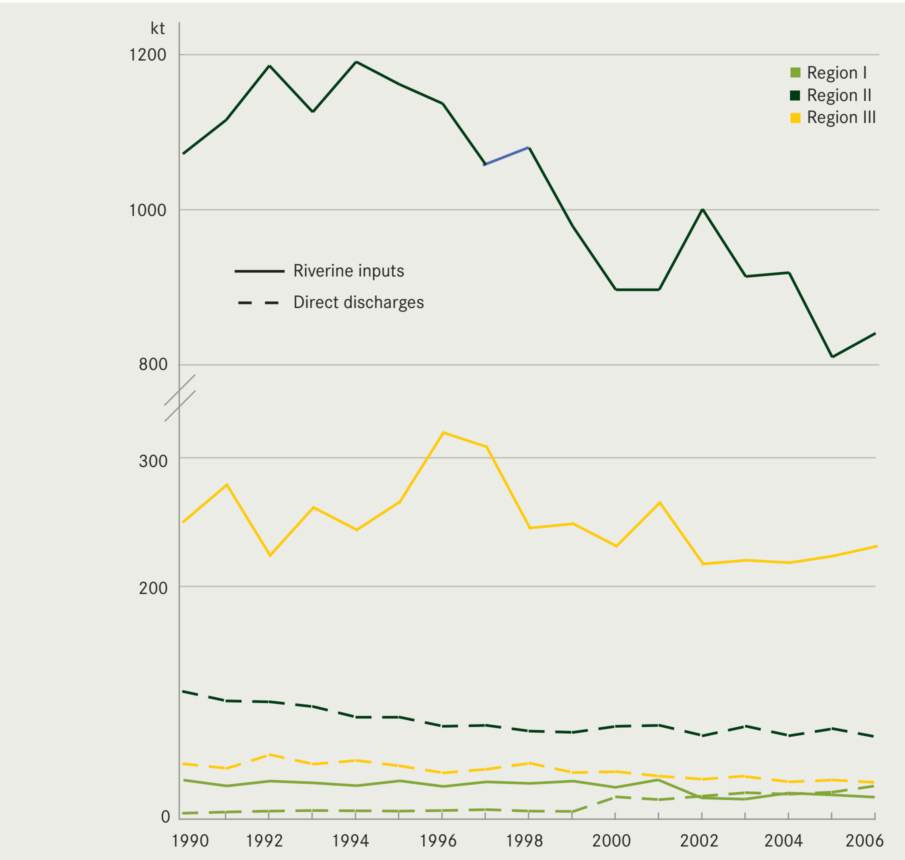


FIGURE 4.4 *Annual riverine inputs and direct discharges of nitrogen in the period 1990–2006. Statistical analysis of the monitoring data, taking into account annual changes in water flow, shows significant downward trends in riverine inputs in Region I (−50 %) and Region II (−25 %). There is no trend in riverine inputs in Region III. Direct discharges decreased in Region II (−35 %) and Region III (−30 %) over this period. In Region I, Norway first reported direct discharges from mariculture in 2000. Direct discharges have since increased and now account for the greater fraction of waterborne inputs in Region I. Data for Region IV are not included in this figure as they are incomplete and not fit for trend assessment.*

Reductions in nitrogen emissions to air are limited and atmospheric inputs remain high

More than 4600 kt of nitrogen were emitted to air across the OSPAR Convention area as a whole in 2006, with combustion in power plants, industry and industrial processes, agriculture and transport, including international shipping, the main contributing sectors → **FIGURE 4.5**. While emissions of oxidised nitrogen decreased by 20 % in the period 1998–2006, mainly as a result of pollution control in industry and stricter emission standards for motor vehicles, emissions of reduced nitrogen, which are almost entirely attributable to agriculture, decreased only by 10 %. Agriculture and combustion are estimated to have contributed most to atmospheric nitrogen deposition in the OSPAR area in 2006 → **TABLE 4.2**. Nitrogen emissions from growing international ship traffic on the North Sea and the Atlantic have increased by more than 20 % since 1998, to 560 kt in 2006, and accounted for 10 % of total atmospheric nitrogen deposition to the OSPAR area.

Models estimate that Region II receives most atmospheric nitrogen, as would be expected from the high levels of industry and agriculture in its coastal areas and its intense ship traffic → **FIGURE 4.6**. Models show no significant trends in atmospheric inputs between 1998 and 2006 in the OSPAR area. This is supported by coastal observations of nitrogen in precipitation in Region II which show little change in this period. Monitoring also shows an increase in ammonium and nitrate concentrations in air in Regions I and II and nitrate in rain in Region IV. Efforts are required to reduce emissions from agriculture, combustion processes and transport, and to tackle emissions from increasing levels of ship traffic.

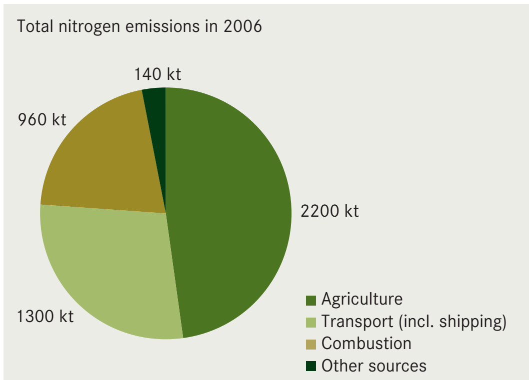


FIGURE 4.5 *Relative contributions of the main sectors in OSPAR countries to emissions of nitrogen to air in 2006. Data source: EMEP.*

TABLE 4.2 *Relative percentage contribution of emission sectors to modelled atmospheric nitrogen deposition to OSPAR Regions in 2006. Data source: EMEP.*

Percentage (%)	Region I	Region II	Region III	Region IV	Region V
Agriculture	26	42	44	37	28
Combustion	28	23	22	24	26
Transport	21	15	14	14	15
International shipping	7	7	8	10	14
Other sectors	18	13	12	15	17

How does this affect the quality status?

Eutrophication is still a problem in Regions II, III and IV

A healthy marine environment where no eutrophication occurs was not achieved over the assessment period (2001–2005) and will only be partially achieved by 2010. Anthropogenic nutrient enrichment of marine waters is still causing eutrophication in areas of Region II, and in some coastal embayments and estuaries within Regions III and IV. Regions I and V are not affected by eutrophication → **FIGURE 4.7**.

Many of the indicators taken into account when assessing eutrophication are above the acceptable deviation from background conditions. Nutrient, chlorophyll and oxygen concentrations are the most widely used indicators across the OSPAR area. Eutrophication problems are more apparent in coastal areas, that is, closer to the main nutrient sources and where environmental conditions (e.g. restricted circulation, resuspension of nutrients in shallow waters) make them susceptible to eutrophication. In offshore areas, dilution generally ensures lower nutrient concentrations, but the origin of the nutrients is less clear owing to transport by ocean currents.

Region II is most widely affected

The eutrophication status of Region II over the assessment period (2001–2005) was not significantly different to that during the first assessment period (1990–2000) under the Common Procedure. Region II is the most widely affected Region with large areas along the continental coast from France to Norway and Sweden and a number of estuarine areas on the UK North Sea coast still adversely affected by eutrophication → **FIGURE 4.7**.

In the period 2001–2005 severe eutrophication effects have occurred in various coastal areas with adverse impacts on ecosystems and society:

- In some estuaries in the Netherlands a die-off of cultured mussels and benthic animals has been linked to the decay of massive algal blooms.

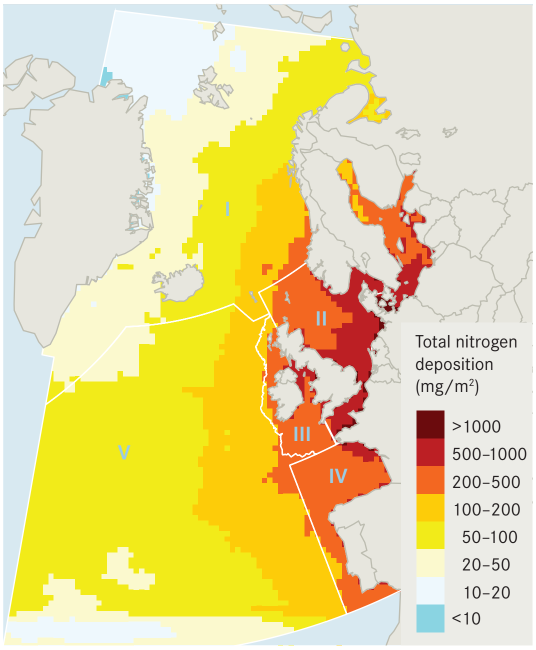


FIGURE 4.6 *Total atmospheric deposition of nitrogen calculated by EMEP models for 2006. Deposition levels are highest in the coastal areas of Region II and decrease towards the open sea. Regions II, III and IV receive high loads of atmospheric nitrogen. For Regions I and V, atmospheric deposition is the main input pathway for nitrogen.*

- Kills of fish and invertebrates due to extreme oxygen deficiency occurred in fjords and estuaries of Sweden and Denmark. Kills of benthic invertebrates also occurred in Norwegian fjords.
- Toxic hydrogen sulphide released from rotting sea lettuce, which is proliferating on Brittany's beaches, has resulted in serious health impacts for locals and tourists.
- Algal foam on beaches in Belgium has been estimated to cause an annual economic loss of around 0.5 % of revenue to the tourism industry.

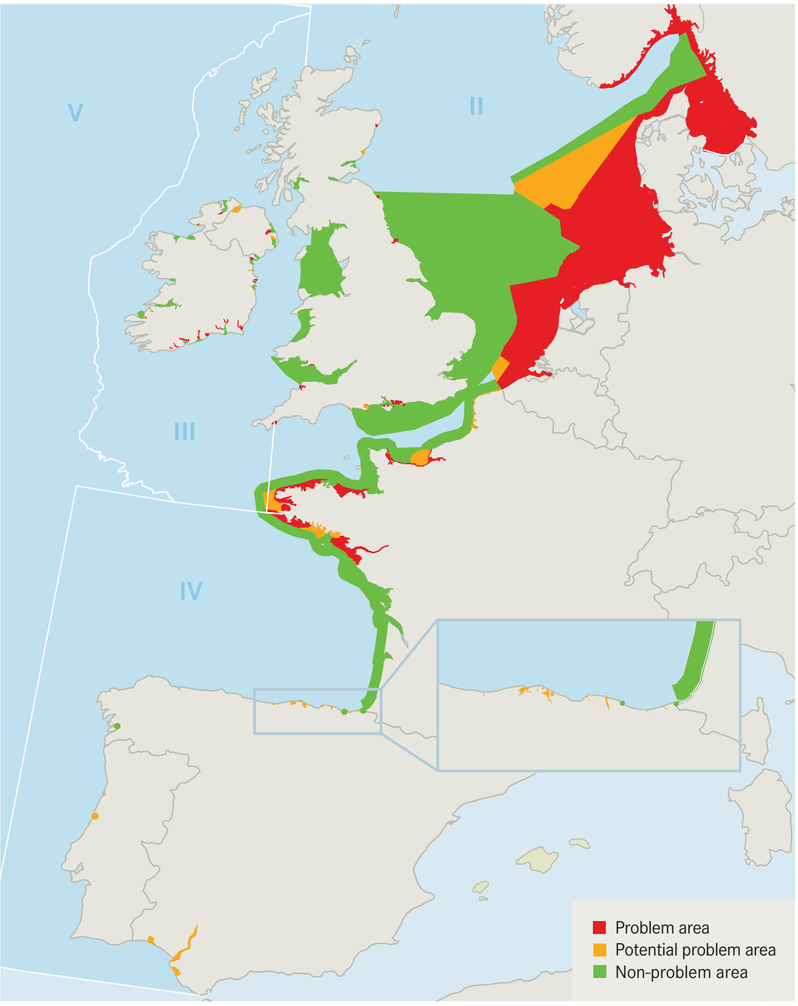


FIGURE 4.7 *Eutrophication status in the period 2001–2005. Large areas of the North-East Atlantic were screened in 2001 for obvious non-problem areas. The latest application of the Common Procedure relating to the period 2001–2005 assessed those areas of the North-East Atlantic which have shown eutrophication problems or which gave rise to concerns that their non-problem status might have changed.*

Although most non-problem areas occur offshore, several coastal areas have also been classified as non-problem areas. Despite high nutrient concentrations in these waters, for example, on the east coast of England, environmental factors, such as high turbidity, prevent the growth of algae and the development of undesirable disturbance to the balance of organisms and water quality.

Some changes in eutrophication status in Region II

The eutrophication status of several areas within Region II changed as a result of the latest classification (relating to the period 2001–2005) compared to their status following the first classification (relating to the period 1990–2000).

Some fjords along the southern Norwegian coast were reclassified in the latest assessment as problem areas, mainly due to the loss of sugar kelp forests → BOX 4.1 and oxygen depletion. In contrast, offshore areas in the Swedish and Danish Skagerrak, and the Netherlands' Oyster Ground are now considered non-problem areas, based on a better understanding of eutrophication induced biological effects and thus refined assessment criteria.

In other areas, indicators show improving trends which are not yet visible in the overall eutrophication status. For example, in coastal waters off the Netherlands, although chlorophyll concentrations decreased over the period 2001–2005, they were still elevated.

The fall in nutrient inputs via rivers since 1990 is now apparent in lower nitrogen and phosphorus concentrations in seawater. This decrease is particularly clear in nearshore waters compared to offshore areas, where the effects of falling inputs via rivers can be masked by the influx of nutrient-rich water from the Atlantic Ocean.

Transboundary transport is significant for Region II

Transport of nutrients between areas can contribute to eutrophication and offset the successful control of local sources. Nutrient-rich water enters the northern North Sea from the Atlantic and is transported with residual currents southward along the east coast of the UK and northward along the continental west European coast. Models have shown that the German Bight receives nutrients via coastal currents that originate in the Atlantic and which become progressively enriched by nutrients from river inputs and atmospheric deposition as they move through the Channel and the North Sea. From the German Bight, the Jutland current transports the nutrients along the west coast of Jutland to the Skagerrak and Kattegat. Together with the outflow from the Baltic Sea and local sources this contributes to the eutrophication apparent along the Swedish west coast and the Norwegian south coast. The onward transport of nitrate from the German Bight may contribute as much as 60% to 80% of the concentration along the southern coast of Norway. Effective assessment of transboundary effects of nutrient loads requires international cooperation.

Chlorophyll levels are still high in Region II

The Common Procedure uses chlorophyll concentration as an indicator of phytoplankton biomass. Overall there have been no significant trends in chlorophyll concentration between 2001 and 2005, despite the reduction in nutrient concentrations observed in coastal waters. The relationship between chlorophyll concentrations and nutrient concentrations is complex, showing natural year to year variability, and depending on factors such as nutrient release from sediments and changes in grazing pressure by zooplankton.

No change in eutrophication status in Region III

There have been no significant changes in the eutrophication status of Region III over the period 2001–2005 compared to the first classification relating to 1990–2000, and most of the coastal and offshore areas are still non-problem areas. Eutrophication resulting from human activities only occurs in semi-enclosed inshore waters such as estuaries, particularly those along the south-eastern coast of Ireland → **FIGURE 4.7**. In general, this reflects the larger coastal settlements and intense agricultural activities in these areas. Three estuaries in western England and Wales, which are variously affected by agricultural run-off and urban drainage, have also been classed as problem areas. While eutrophication problems occur in many locations in Region III, the total spatial extent of the affected areas is small.

Coastal ecosystems are less susceptible to eutrophication in Region IV

There are few eutrophication problems in Region IV and those that do exist are mainly limited to estuaries and bays with restricted circulation. Elevated levels of chlorophyll, nuisance phytoplankton species and algal toxins have been observed in a number of coastal and estuarine areas along the French coast → **FIGURE 4.7**. In Spain, many estuaries have been classified as 'potential problem areas', due to their high nutrient concentrations, but there are no observed biological effects (which is often due to a lack of data).

What happens next?

The OSPAR objective of no eutrophication will not be met by 2010

A healthy marine environment where no human-induced eutrophication occurs was not achieved in the period 2001–2005. While eutrophication is not a problem in Regions I and V, many areas of Region II, including areas in the Channel, Skagerrak and Kattegat, and some small coastal embayments and estuaries within Regions III and IV are still affected by eutrophication. Eutrophication is a more prominent problem in coastal areas than offshore waters.

Progress in improving the status has been slow:
- In many cases, measures targeting nutrient sources have been taken later than envisaged.
- It can take many years for ecosystems to respond to nutrient reductions at source, because nutrients in sediments and soil may contribute to local nutrient budgets over long periods.
- Transboundary transport of nutrients into and within Region II has been shown to contribute to eutrophication problems.

Further actions are needed to improve problem areas

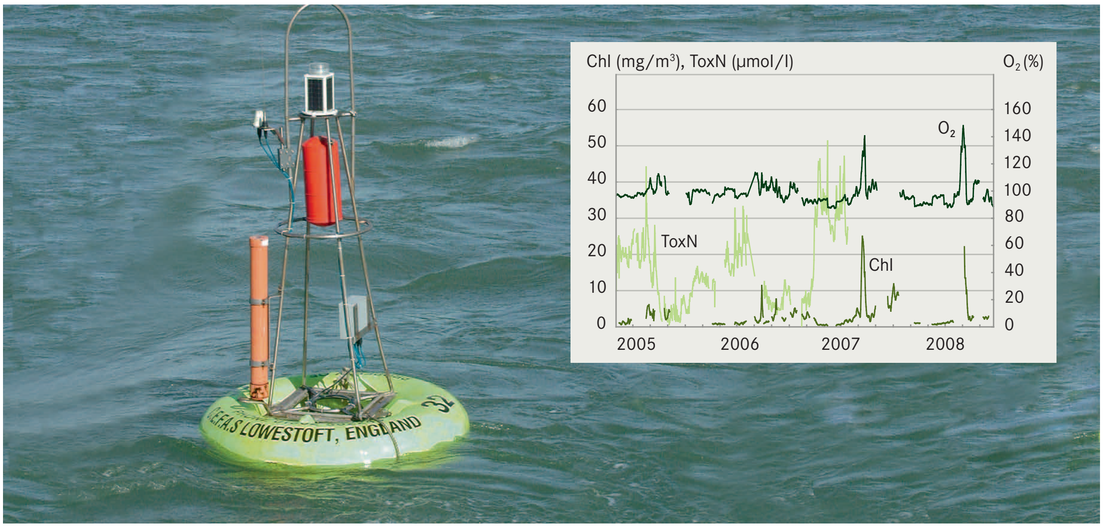
OSPAR countries with problem areas have made substantial progress towards the OSPAR target of 50 % reductions in nutrient discharges and losses compared to 1985. Reductions of up to 85 % have been achieved for phosphorus while progress for nitrogen has been less successful with only few reductions of up to 50 %. Modelling studies suggest that significant further reductions of nutrient inputs, beyond 50 % to some problem areas, will be required to eliminate eutrophication problems. The main contributions of nutrients to problem areas are discharges and losses from agriculture, urban waste water and industry, and from atmospheric deposition.

To achieve a status where eutrophication does not occur, OSPAR countries should take the following actions:
- Fully implement the relevant OSPAR and EU measures as soon as possible → **TABLE 4.1** and promote consideration of marine eutrophication when implementing the EU Nitrates Directive.
- Take, if necessary, additional measures (e.g. via river basin management plans set up under the EU Water Framework Directive) to address sources contributing to problem areas.
- Cooperate to set appropriate reduction targets for nutrient inputs for individual problem areas.
- Improve monitoring and coordinate data collection on sources, inputs and environmental status in order to direct measures.

Atmospheric nutrient loads need to be addressed

There is concern about the level of atmospheric nitrogen deposition to the OSPAR area from agriculture, combustion processes and road transport, and about the increasing absolute and relative contribution from shipping to airborne inputs. Marine eutrophication has yet to be taken into account in international measures setting air emission targets and standards. OSPAR should take the following actions:
- Promote the recognition of marine eutrophication in the revision of air emission targets for nitrogen under the EU National Emission Ceilings Directive and the Gothenburg Protocol to the UNECE Convention on Long-range Transboundary Air Pollution.
- Evaluate the contribution of atmospheric nitrogen emissions, including those from ships, in eutrophication assessments and use these results to promote that marine eutrophication is taken into account in the revision of standards for ship emissions of oxidised nitrogen set by the International Maritime Organization (IMO).

FIGURE 4.8 *The strength of continuous measurement devices such as the Cefas SmartBuoy at Warp Anchorage (outer Thames estuary) is their capacity to detect day-to-day variability and peaks in concentrations of chlorophyll (Chl), total oxidisable nitrogen (ToxN) and oxygen (O_2), and to transmit data in real time.*



Assessment framework to support the EU Marine Strategy Framework Directive

The Common Procedure provides a good tool for a robust assessment of the eutrophication status of the North-East Atlantic. It also provides a good example of how countries can provide a common approach to determining good environmental status under the EU Marine Strategy Framework Directive and good ecological status under the EU Water Framework Directive.

New observational tools such as instrumented buoys → FIGURE 4.8, ferry boxes, airborne surveillance and remote sensing, have the potential to complement traditional sampling and to help in the design of cost-efficient monitoring programmes to enhance the evidence base for future eutrophication assessments through better spatial and temporal coverage. However, they do not yet offer the same guarantee of quality-assured biogeochemical observations as is achieved by monitoring water quality using scientific research vessels.

Future monitoring and assessment should be supported by the following actions:
- Refinement of the methodologies of the Common Procedure, including assessments of individual indicators at regional level.
- Coordinated use of new observational tools to complement the OSPAR eutrophication monitoring programme.
- Continued cooperation on evaluating trans-boundary nutrient transport and improved knowledge through modelling.

There is increasing evidence that climate change may alter eutrophication effects. OSPAR should continue to improve knowledge on the interactions of climate change and eutrophication and should take these interactions into account in future eutrophication-related monitoring and assessment.

Delivering OSPAR Strategy objectives for eutrophication

→ LEGEND: BACK-COVER FOLD-OUT

OSPAR Region	No eutrophication by 2010	Change in status[1]	Key factors and pressures	Outlook for pressures	Action needed
Region I	No problems *	←→ *	Atmospheric nitrogen inputs Aquaculture	↑	OSPAR
Region II	Many problems * * *	←→ * * *	Agriculture Sewage effluents Atmospheric nitrogen inputs	←→	OSPAR EU, UNECE, IMO
Region III	Some problems * * *	←→ * * *	Agriculture Sewage effluents Atmospheric nitrogen inputs	←→	OSPAR EU, UNECE, IMO
Region IV	Some problems * * *	←→ * * *	Agriculture Sewage effluents Atmospheric nitrogen inputs	←→	OSPAR EU, UNECE, IMO
Region V	No problems *	←→ *	Atmospheric nitrogen inputs	↑	OSPAR

[1] *2001–2005 relative to 1990–2000.*

5 HAZARDOUS SUBSTANCES

A third of OSPAR priority chemicals are expected to be phased out in the OSPAR area by 2020 if current efforts continue. Environmental concentrations of monitored chemicals have generally fallen, but are still above acceptable concentrations in many coastal areas of Regions II, III and IV. Contamination with persistent organic pollutants is widespread and their long-range air transport to the OSPAR area, especially Region I, is of concern. Historic pollution in aquatic sediments acts as a continued source for releases of persistent contaminants.

OSPAR Contracting Parties should cooperate

→ to continue and improve abatement of pollution from OSPAR priority chemicals at source, including PAH emissions from combustion of fossil fuels;
→ to use OSPAR to promote further the global ban on use of POPs and worldwide control of mercury emission sources within the UN framework;
→ to use OSPAR to contribute to the identification, selection and prioritisation of hazardous substances of concern for the marine environment in the EU and promote actions under the REACH Regulation and other relevant EU legislation to reduce their releases;
→ to improve OSPAR's understanding of the effects of hazardous substances, particularly cumulative effects and endocrine disruption;
→ to improve and extend OSPAR's monitoring framework and better link it with the understanding of biological effects and ecological impacts.

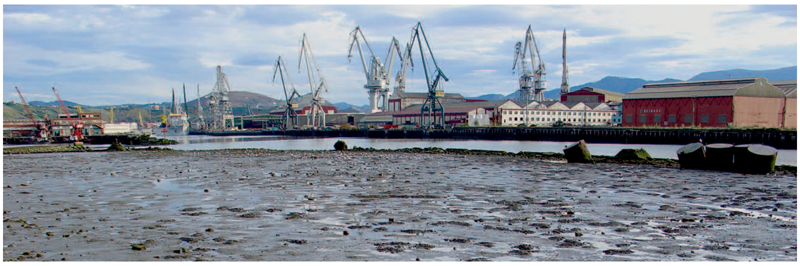
Key OSPAR assessments

→ Status and trend of marine chemical pollution
→ Towards the cessation target for priority chemicals
→ Trends and concentrations in marine sediments and biota
→ Trends in atmospheric concentrations and deposition
→ Trends in waterborne inputs

Chemicals form an essential part of everyday life. They can be naturally occurring, like metals in the Earth's crust, formed as unintended by-products of natural and human-induced chemical processes, or synthesised specifically for use in industrial processes and consumer products. About 100 000 substances are on the European market and around 30 000 of these have an annual production of more than 1 tonne per year. Some of these substances are hazardous because they are persistent, liable to accumulate in living organisms and toxic. They can contaminate the marine environment, with harmful effects on marine life and ultimately human health via the food web. OSPAR works under its Hazardous Substances Strategy to identify which substances are hazardous for the marine environment, to prevent, reduce and ultimately eliminate pollution with these substances, and to monitor the effectiveness of measures to achieve this.

OSPAR Strategy objectives for hazardous substances

→ Move towards the cessation of discharges, emissions and losses of hazardous substances by 2020.
→ The ultimate aim is to achieve concentrations of hazardous substances in the marine environment near background values for naturally occurring substances and close to zero for man-made substances.



Industrial activities in the Nervíon estuary, northern Spain

What are the problems?

A wide range of sources and environmental pathways

Hazardous substances are found in seawater, sediments and marine organisms throughout the North-East Atlantic. Near heavily populated and industrialised areas, concentrations in sediments and marine organisms can threaten marine life and exert various biological effects. Contamination can reach levels at which fish and shellfish are not safe for human consumption and their marketing is prohibited by food safety regulations.

The area covered by the OSPAR Convention includes many of the major centres of industry and population in Western Europe. It is here that most man-made and naturally occurring substances, some of which are hazardous to the marine environment, are released, either as emissions to air, discharges to water or as losses during the lifecycle of products. These substances are transferred to the North-East Atlantic along a range of environmental pathways → FIGURE 5.1. Historic pollution in riverine, estuarine and marine sediments acts as a continued source of release, especially when sediments are moved by currents or disturbed by human activities.

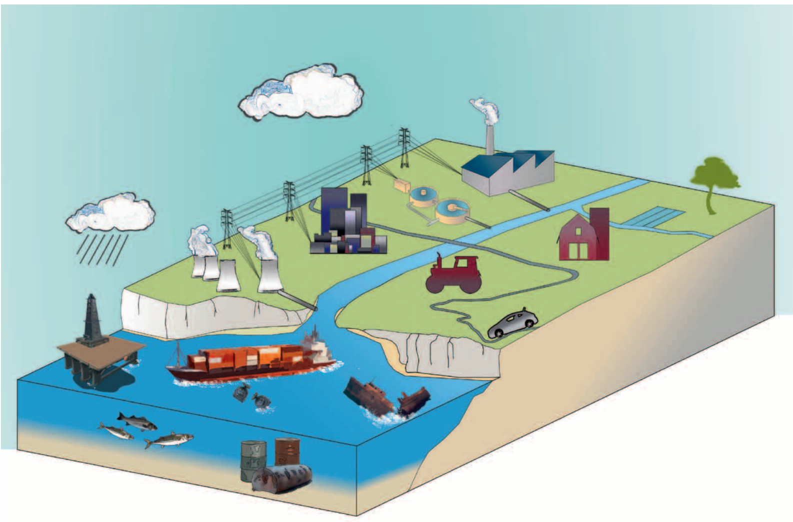


FIGURE 5.1 *Schematic overview of the main sources of hazardous substances and pathways to the marine environment. Waterborne substances enter the sea directly, for example through sewage and industrial discharges, or from offshore activities such as oil and gas extraction* → CHAPTER 7*, mariculture* → CHAPTER 8 *and shipping* → CHAPTER 9*. They are also transported to the sea by rivers which collect inputs from inland sources such as industry and agriculture. Atmospheric transport is an important pathway for volatile substances and substances that attach to particles (e.g. from combustion) which reach the sea mainly through deposition.*

Depending on the physical and chemical properties of the hazardous substances, environmental changes resulting from global warming will alter the pathways of these substances. Warming of the atmosphere may lead to more evaporation and transport of contaminants by air, rainfall may increase and flooding may result in higher run-off from land and more river inputs. Increased storminess may result in additional remobilisation of contaminants from marine sediments. Changes in food web structure may affect contaminant pathways.

What has been done?

More than 30 years of work to control releases

During the 1980s and 1990s, OSPAR adopted more than 60 Recommendations and legally-binding Decisions to regulate the main point sources (e.g. industry) and diffuse sources (e.g. products and wastes) of pollution with hazardous substances in the OSPAR area. OSPAR countries were required to implement best available techniques (BAT) and best environmental practices (BEP) and to achieve specified limit values for emissions and discharges for major industrial sources of heavy metals, organohalogens and polycyclic aromatic hydrocarbons (PAHs). Regulated industries include: large combustion plants; the manufacturing of iron, steel, aluminium, textiles, chlorine, pharmaceuticals, organic chemicals, pulp and paper, and vinyl chloride; and the refining of crude oil. Other measures targeted the uses of particular hazardous substances in industrial processes and consumer products, for example, the phase-out of tributyltin (TBT), PAHs, nonylphenols and short-chain chlorinated paraffins (SCCPs) in main applications. Periodic reporting shows that these measures have been broadly implemented across the OSPAR area. This work has been increasingly supported by implementation of similar EU legislation.

Efforts now focus on specific substances

Since 1998, OSPAR's work on preventing and reducing pollution has moved from targeting industrial and diffuse sources of pollution to a focus on action for specific hazardous substances. OSPAR has taken a systematic approach to identifying which of the steadily increasing number of substances on the market pose a risk for the marine environment and actively cooperates in this work with non-governmental organisations representing both industry and wider society. OSPAR's approach takes into account the hazardous properties of the substances both in terms of their persistence, liability to bioaccumulate and toxicity, and properties giving rise to equivalent levels of concern, for example endocrine disruption caused by substances which mimic hormones and interfere with hormone-controlled processes. More than 300 substances are considered to be of possible concern for the marine environment. Forty substances and groups of substances have been identified by OSPAR as chemicals for priority action, of which 26 pose a risk for the marine environment due to their use patterns → TABLE 5.1. OSPAR has undertaken and published a series of assessments of these priority chemicals to evaluate the extent of their risks and to identify priorities for action.

Ongoing collaboration with other international bodies

The EU has covered the field of OSPAR's work on hazardous substances to an increasing extent over

The phase-out of mercury cells for the production of chlorine (photo) is well underway, but OSPAR's 2010 target for full phase-out is not achieved recent years and is now the main driving force for action by OSPAR countries. Its main instrument in this respect is the Integrated Pollution Prevention and Control (IPPC) Directive and the Marketing and Use Directive → TABLE 5.2. As a result, OSPAR's work has moved towards contributing to and promoting actions within the EU that are complementary to its own objectives. This will ensure that one consistent set of control measures applies in Europe which takes into account concerns for the marine environment. OSPAR has, therefore, given precedence to contributing to the development of BAT under the IPPC Directive over updating its own measures on point sources. Measures that OSPAR has promoted include marketing and use restrictions for mercury (in measuring devices), phthalates (in toys), and most recently the phase-out of the main uses of perfluorooctane sulphonates (PFOS) as water and oil repellents in consumer products such as textiles and carpets, and in fire fighting foams. With similar work taking place under EU chemicals legislation, OSPAR has, since 2004, also paused its systematic work to identify chemicals for priority action. A recent screening of the OSPAR list of substances of possible concern will help OSPAR to focus its efforts on, and raise awareness of, those substances in open use which are presently not covered by EU legislation. The environmental quality standards set for hazardous substances under the EU Water Framework Directive, which concern many OSPAR priority chemicals, are a further driver for regulating pollution sources at river basin level.

OSPAR's work also supports global action to reduce or eliminate use and emission of priority chemicals that can be transported to the North-East Atlantic by atmospheric or oceanic pathways or be imported into the OSPAR area in products.

Monitoring tracks progress towards OSPAR's objectives

For each priority chemical, OSPAR has developed a monitoring strategy that sets out the best way to collect data and information on sources, pathways, concentrations and effects, in order to track progress towards OSPAR's objectives for hazardous substances. This includes long-term data collection under the OSPAR monitoring programmes for atmospheric inputs, riverine inputs and direct discharges, and for the marine environment. These activities provide the basis for coordinated assessments of chemicals in the OSPAR area. However, coverage of priority chemicals by OSPAR monitoring programmes is limited and several chemicals have only recently been included in the Coordinated Environmental Monitoring Programme (CEMP) → BOX 5.1. For other priority chemicals a case for coordinated marine monitoring has not been established, for example where their characteristics and use patterns make their widespread detection in the marine environment unlikely. In these cases, environmental information has been obtained through a range of surveys and national monitoring schemes. Information on the use and production of these substances, and on the implementation of measures to control their release, has also been obtained from other organisations such as the EU, the Organisation for Economic Co-operation and Development (OECD), and from industry.

As part of the Ecological Quality Objectives (EcoQOs) developed for the North Sea, targets and indicators have been set to measure progress towards a clean and healthy sea. These include EcoQOs to reduce the effects of TBT in dogwhelks and other marine snails and to reduce levels of contaminants in seabird eggs.

BOX 5.1 Leading the way on coordinated international environmental monitoring

The Coordinated Environmental Monitoring Programme (CEMP) provides a common framework for the collection of marine monitoring data by OSPAR countries and the results indicate status and trends in pollution. Contamination by cadmium, mercury, lead, PAHs and PCBs is assessed by monitoring concentrations in fish, shellfish and sediments. TBT is assessed by monitoring concentrations in sediments and biological effects on marine snails. The CEMP encourages the monitoring and reporting of a range of biological effects of hazardous substances.

CEMP monitoring is designed to track contaminants which accumulate in the marine environment and through the food chain but which cannot necessarily be detected in seawater. Therefore CEMP assessment results may lead to different conclusions about chemical quality status than water-based monitoring under the EU Water Framework Directive.

CEMP monitoring is mainly focused on coastal areas because, in many cases, the response of the ecosystem to pollution control measures can best be assessed there, close to discharge and emission sources. Increasing attention is being paid to monitoring in offshore areas, where a number of human activities (e.g. oil and gas production, shipping) take place and as awareness of the significance of long-range transport of contaminants has increased. CEMP monitoring does not extend to deeper waters. No data are reported from Region V and this Region has not been assessed.

The CEMP is underpinned by an emphasis on commonly agreed monitoring guidelines and quality assurance procedures and is being extended to include brominated flame retardants, dioxins and PFOS.

Sediment sampling

TABLE 5.1 *Status in relation to the cessation target of the 26 substances (including groups) on the OSPAR List of Chemicals for Priority Action ('priority chemicals') (March 2010).*

	OSPAR priority (groups of) chemicals	Naturally occurring	Key sources	Control measures	WFD	Outlook 2020	Priorities for action
Metals	Cadmium	Yes	Metallurgic processes, fossil fuel	OSPAR, EU, UNECE	●	* *	
	Lead and organic lead compounds	Yes	Mining, petrol	OSPAR, EU, UNECE	●	* *	
	Mercury and organic mercury compounds	Yes	Metallurgic industry, fossil fuel, incineration, chlor-alkali industry, dental amalgam	OSPAR, EU, UNECE, PIC	●	* *	
Organometals	Organotin compounds including:					Group	
	Tributyltin (TBT)		Anti-fouling agent	OSPAR, EU, PIC, IMO	●	*	
	Other organotin compounds (e.g. disubstituted compounds)		Consumer products, polymer industry			*	
Organohalogens	Short-chain chlorinated paraffins (SCCPs)		Rubber working plants, products, waste streams	OSPAR, EU, UNEP-cand., UNECE-cand.	●	*	
	Perfluorooctane sulphonates (PFOS)		Industrial applications, waste streams	EU, UNEP, UNECE-cand.	○	*	
	Polychlorinated dibenzodioxins, dibenzofurans (PCDDs, PCDFs)	Yes	Incineration, forest fire	OSPAR, EU, UNEP, UNECE	○	* *	
	Polychlorinated biphenyls (PCBs)		Industrial products, oils, legacies	OSPAR, EU, UNEP, UNECE, PIC	○	* *	
	Brominated flame retardants including:		Manufacture, products, waste streams			Group	
	PentaBDE and octaBDE			EU, UNEP, UNECE-cand.	⦿	*	
	Other polybrominated diphenyl ethers (PBDEs)			EU	⦿	*	
	Hexabromocyclododecane (HBCD)			EU, UNEP-cand., UNECE-cand.		*	
	Tetrabromobisphenol-A (TBBP-A)		Polymer industry, products, wastes			*	
	Trichlorobenzenes		Industrial processes	EU	●	*	
Pesticides/biocides	Endosulfan		Pesticides, biocides, industrial processes, legacies	EU, UNEP-cand., UNECE-cand.	●	*	
	Hexachlorocyclohexane (HCH) isomers, including lindane			EU, UNEP, UNECE, PIC	●	*	
	Dicofol			EU, UNECE-cand.	○	*	
	Methoxychlor					*	
	Pentachlorophenol (PCP)			EU, UNECE-cand., PIC	●	*	
	Trifluralin			EU, UNECE-cand.	●	*	
Phenols	2,4,6-tri-tert-butylphenol		Industrial processes, oil production				
	Nonylphenol/ Nonylphenol-ethoxylates	Yes	Industrial applications, products, oil production	OSPAR, EU	●	*	
	Octylphenol	Yes	Industrial applications, products, oil production	EU	●	*	
Phthalates	Dibutylphthalate (DBP), diethylhexylphthalate (DEHP)		Polymer industry, products	EU	⦿	*	
Polycyclic aromatics	Polycyclic aromatic hydrocarbons (PAHs)	Yes	Oil production, fossil fuel	OSPAR, EU, UNEP, UNECE	⦿	*	
Pharmaceuticals, personal care and other substances	Clotrimazole		Domestic and hospital waste water			*	
	Musk xylene		Domestic waste water	EU	○	*	
	4-(dimethylbutylamino) diphenylamine (6PPD)		Abrasion from products (tyres)				
	Neodecanoic acid, ethenyl ester		Polymer industry, paints, coatings, adhesives	EU			

Control measures

OSPAR: Abatement and use restriction

EU: Use restriction

UNEP: Stockholm POPs Convention

UNECE: Convention on Long-range Transboundary Air Pollution

PIC: Rotterdam Convention on Prior Informed Consent Procedure

IMO: Convention on Anti-fouling Systems

cand.: Candidate substance for inclusion

EU Water Framework Directive (WFD)

List of WFD priority (hazardous) substances:

- ● (Group of) substance covered
- ⦿ One or more individual substances of group covered
- ○ Group or individual substance under review for inclusion

Outlook

2020 cessation target is likely to be met with existing efforts:

- ■ Yes
- ■ No
- ■ Not known

Confidence

- ★★★ High
- ★★ Moderate
- ★ Low

Priorities for action

- Point sources
- Diffuse sources
- Implement existing measures
- Support global initiatives
- Collect and assess information to direct action
- Continue environmental monitoring
- Keep under review

TABLE 5.2 *Main international and EU instruments and respective tools and objectives, which are complementary to OSPAR's objectives.*

Instrument	Tools and objectives
EC Integrated Pollution Prevention and Control (IPPC) Directive (2008/1/EC)	Permit requirements for installations Best available techniques Emission and discharge limits European Emission Pollution Release and Transfer Register
EU Marketing and Use Directive (76/769/EEC, repealed by Annex XVII REACH Regulation)	Restrictions on the marketing and use of substances Risk assessment
EU Biocides Directive (98/8/EC)	Restrictions on the marketing and use of substances as biocides
EU Pesticides Directive (91/414/EC)	Restrictions on the marketing and use of substances as pesticides
EU REACH Regulation (EC No. 1907/2006)	Registration, evaluation, authorisation and restriction of chemicals
EU Water Framework Directive (2000/60/EC) and Daughter Directive (2008/105/EC)	Normative definitions describing good chemical status River Basin Management Plans Priority (hazardous) substances
UNECE Convention on Long-range Transboundary Air Pollution – POPs and Heavy Metals protocols (both adopted 1998/effective 2003)	Transboundary air transport of contaminants Use restrictions or ban Emission reduction of unintentionally produced POPs Environmentally safe disposal of wastes International Emission Pollution Release and Transfer Register
UNEP Stockholm POPs Convention (adopted 2001/effective 2004)	Transboundary air transport of POPs Use restrictions and elimination of POPs Restrictions on import/export of substances Safe handling of stockpiles Emission reduction of unintentionally produced POPs
Rotterdam Convention on Prior Informed Consent (PIC) procedure for certain hazardous substances and pesticides in international trade (adopted 1998/effective 2004)	Control of international trade in certain hazardous substances Information exchange prior to import of pesticides and industrial chemicals

Did it work?
How does this affect the quality status?

Cessation target is in reach for a third of priority chemicals

The phase-out of a third of the 26 priority (groups of) chemicals which pose a risk to the marine environment is well underway in the OSPAR area. As a result, it is likely that discharges, emissions and losses of these substances will have moved towards cessation by 2020 if current efforts continue. These priority chemicals are: six pesticides (dicofol, endosulfan, lindane, methoxychlor, pentachlorophenol and trifluralin); SCCPs; nonylphenol/ethoxylates; the organotin compound TBT, and two brominated flame retardants, octa- and pentabrominated diphenyl ethers (BDEs) → TABLE 5.1.

For many of the remaining priority chemicals, information is not available to give a complete picture, but it is often possible to judge from measures taken (e.g. use restrictions, BAT) and occurrence in the environment whether releases of those priority chemicals continue and whether further efforts are needed to move closer towards the cessation of their release by 2020. Further efforts include strengthening the implementation of existing measures → TABLE 5.2. Better information is needed about the sources, releases and pathways for several of these priority chemicals. This includes the need for improved tracking of the releases and environmental fate of pharmaceuticals, such as clotrimazole, given that there are concerns that trace concentrations in the sea may pose a risk of disruption to ecological processes.

Heavy metal contamination is decreasing

The phase-out of old technologies and stringent pollution control measures have resulted in substantial reductions in the release of heavy metals from industrial combustion processes, metal production, transport and waste streams. Much of these reductions occurred in the 1990s as a result of technological and regulatory advances. Progress has since slowed as it becomes technically and economically more difficult for industry to reduce releases further. As a result, overall emissions to air of cadmium and mercury have been relatively constant in recent years but lead emissions have continued to fall. Progress on reducing air emissions of cadmium, mercury and lead has varied however across OSPAR countries and industries. In 2007, around 900 tonnes of lead and 40 tonnes each of cadmium and mercury were released by OSPAR countries to the atmosphere. Releases from non-regulated uses need to be further investigated and addressed.

Combustion processes in power plants and industry are major sources for emissions of heavy metals to the atmosphere and account for around two-thirds of the total amount of heavy metals entering the North-East Atlantic from the air. Changes in emission levels between 1998 and 2006 have been small. Measurements of heavy metal concentrations in rain and calculations of atmospheric inputs are consistent with trends in emissions.

Waterborne inputs show a similar pattern to atmospheric inputs, in that heavy metal loads to the sea decreased substantially between 1990 and 2006 with the greatest reductions occurring during the 1990s → BOX 5.2.

Concentrations of cadmium, mercury and lead in fish, shellfish and sediments have generally fallen since 1990, particularly in Region II, where downward trends are clear at both polluted and less polluted sites. As much of the reduction in inputs of metals occurred before 2000, changes in environmental concentrations have been relatively small since 1998 as concentrations approach, but do not reach, background levels in large parts of the OSPAR area → FIGURE 5.2. There are still some locations in Regions II, III and IV where cadmium and mercury concentrations in fish and shellfish have risen (e.g. Dogger Bank, some UK estuaries and in the southern North Sea). In Region I, where concentrations are generally lower than in the other Regions, downward trends are only found close to pollution sources. Many of the OSPAR data series are currently too short to determine trends as – owing to the large amount of natural variation in the marine environment – trends in concentrations can only be determined using data collected systematically over relatively long periods. Continued monitoring is needed in many areas, especially in Regions III and IV, to extend these datasets so that it is possible to detect trends in future.

Concentrations of cadmium, mercury and lead exceed EU food standards in fish and shellfish at various sites, especially in Regions II and III, including on the Danish coast and in some of the heavily populated and industrialised estuaries on the UK and Norwegian coasts → FIGURE 5.2. Concentrations in sediments are at levels that pose a risk of pollution effects for marine life in the southern North Sea, off the Dogger Bank, the German Bight, at a number of other sites around the UK and in industrialised estuaries on the Spanish and Norwegian coasts. High levels of cadmium found in fish and shellfish at

BOX 5.2 Waterborne inputs of heavy metals have fallen

Data collected under the OSPAR Comprehensive Study on Riverine Inputs and Direct Discharges (RID) on cadmium, lead and mercury show in most cases statistically significant decreases in river inputs in Regions I, II and III between 1990 and 2006. Improvements in analytical laboratory techniques over time have caused discontinuities in time series. These add to data uncertainties that result from varying completeness of reporting and monitoring coverage and make it more difficult to detect trends and accurately quantify reductions. For Region II, statistically significant reductions in the main catchments – cadmium in the Elbe (40%), mercury in the Rhine and Meuse (70%) and lead in the Seine (90%) – confirm the overall regional trend. However, progress in reducing waterborne inputs to the marine environment since 1998 has been less marked than in the early 1990s. Direct discharge loads of cadmium, mercury and lead from sewage and industrial effluents are much smaller than riverine inputs in most Regions and their inputs have significantly decreased since 1990, with progress slowing in recent years in many cases. Wide variation in the monitoring undertaken by OSPAR countries for rivers and incomplete data on discharges prevent a trend analysis in Region IV.

Statistically significant trends (1990–2006)	Region I		Region II		Region III	
	Riverine inputs	Direct discharges	Riverine inputs	Direct discharges	Riverine inputs	Direct discharges
Cadmium	−40 %	−70 %	−20 %	−75 %	−60 %	−95 %
Lead	−85 %	No trend	−50 %	−80 %	No trend	−90 %
Mercury	No trend	No trend	−75 %	−70 %	−85 %	−95 %

sites around Iceland have been linked to natural factors (i.e. volcanic activity), but the exact source still needs to be confirmed.

PAHs are of continued regional and global concern

Polycyclic aromatic hydrocarbons (PAHs) are natural components of coal and oil and are also formed during the combustion of fossil fuels and organic material. They are one of the most widespread organic pollutants in the marine environment of the OSPAR area, entering the sea from offshore activities → **CHAPTER 7**, operational and accidental oil spills from shipping → **CHAPTER 9**, river discharges and the air.

Long-range atmospheric transport is an important pathway for PAHs within and to the OSPAR area and is of regional and global concern. Atmospheric emissions by OSPAR countries have been relatively constant over the past decade at about 1000 tonnes a year. However, given the expected growth in industrial activities, for example in Asia, the relative proportion of PAHs brought into the region from long-range transport is likely to increase.

Trends in PAH concentrations in fish and shellfish are predominantly downward, especially in Region III, but concentrations are still at levels which pose a risk of pollution effects in many estuaries and urbanised and industrialised locations → **FIGURE 5.2**.

Progress towards the cessation of release of PAHs from human sources by 2020 will require improved use of emission control technology in combustion processes. Effective implementation of the EU IPPC Directive is particularly important. With the expected global increase in PAH emissions from combustion of fossil fuels such as coal, it is doubtful whether the cessation target can be met.

PCBs are still released to water and air

Polychlorinated biphenyls (PCBs) are a group of substances with 209 forms (congeners) which are very persistent, concentrate in fatty tissues and display a variety of toxicological properties. Production of PCBs was banned in the mid-1980s but European-wide action has not been enough to eliminate all inputs to the marine environment. Remaining sources are PCB-containing equipment, waste disposal, remobilisation from marine sediments contaminated with PCBs as a result of historic releases, and, to an unknown extent, formation as by-products in thermal and chemical processes. Large reductions in the release and phasing-out of remaining stocks were achieved in the period 1998 to 2005, but releases to air and water are still continuing.

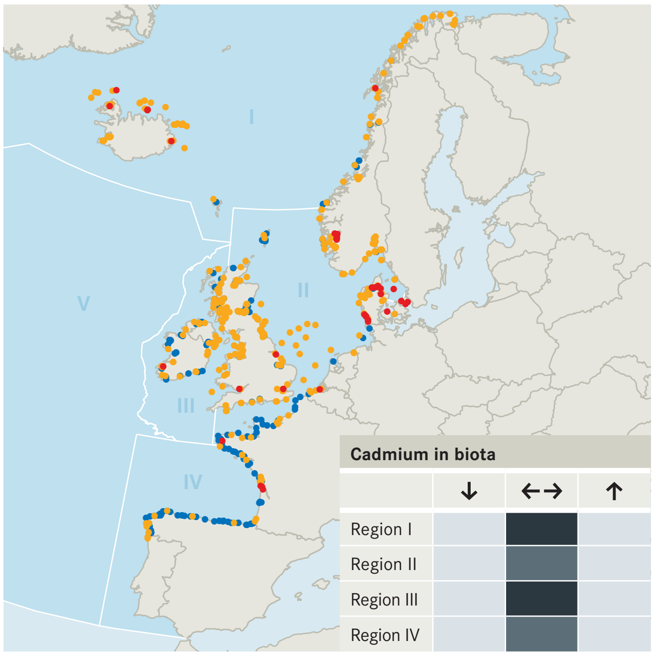
Contamination from PCBs is widespread and there are few areas where concentrations are close to zero → **FIGURE 5.2**. Concentrations are lowest along the northern coast of Norway (Region I). PCBs are however among the most prevalent pollutants in the Arctic and are widely distributed by long-range atmospheric transport. While PCB concentrations in Arctic species are decreasing, they are still found in some top predators at levels that cause concern for their health. At many locations in Regions II, III and IV, concentrations of at least one PCB congener in fish and shellfish pose a risk of causing pollution effects. Studies show that, some 25 years after their ban, PCBs may still be causing adverse biological impacts in parts of the OSPAR area → **BOX 5.3**.

BOX 5.3 PCBs and marine mammals

Although PCBs have been banned, their legacy contributes to a mix of persistent organic pollutants (POPs) giving concern in relation to marine mammals. POPs reach high concentrations in top predators and have long been suspected of causing reproductive failure and susceptibility to disease in marine mammals. Long-term observations under the UK Cetacean Strandings Investigation Programme suggest a link between contamination levels in harbour porpoises stranded along the UK coastline and an increased risk of infectious disease mortality.

In the Faroe Islands, regular monitoring of pollutant concentrations in long-finned pilot whales, a valued traditional food source for indigenous peoples, began in the mid-1990s. Decreases in environmental levels of DDT and PCB observed in several other parts of the OSPAR area are now beginning to be measured in pilot whales. Nevertheless, monitoring shows that pilot whale meat still represents a substantial dietary source of many other POPs and the Faroese Government has initiated a risk management process for their consumption.

Sperm whale stranded near Kings Lynn, east coast of UK


I
II
III
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Cadmium in biota
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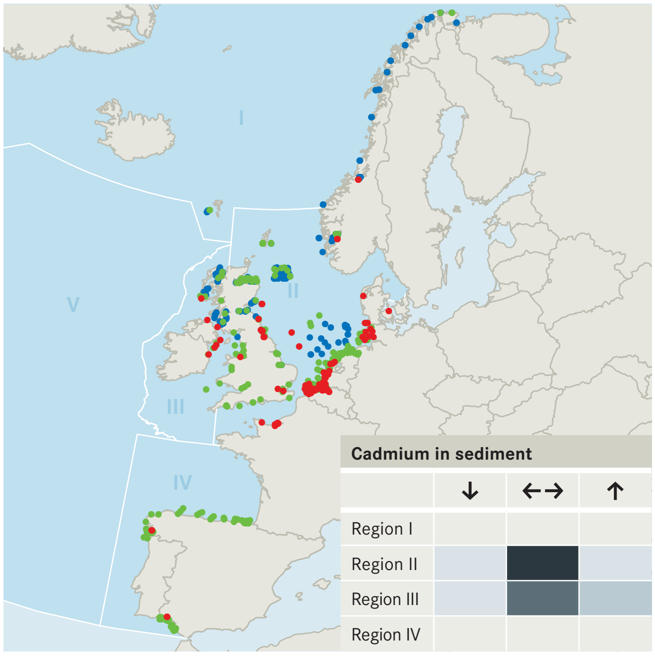
Region I
Region II
Region III
Region IV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Cadmium in sediment
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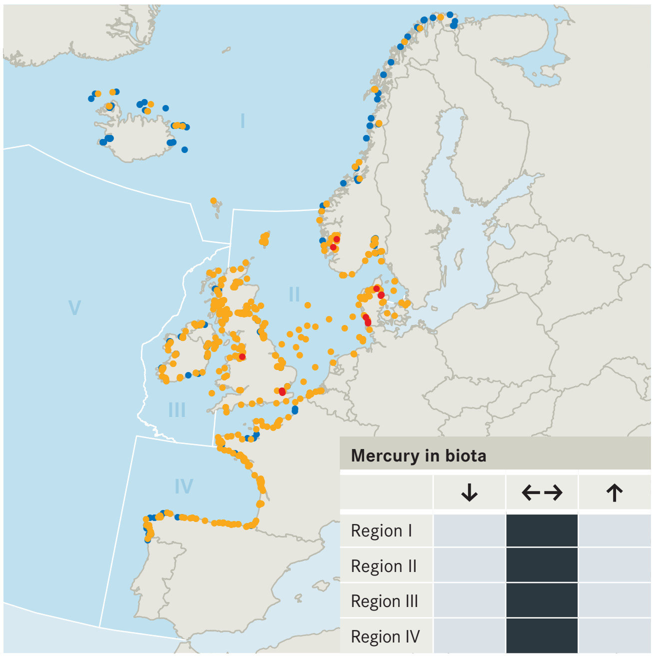
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Mercury in biota
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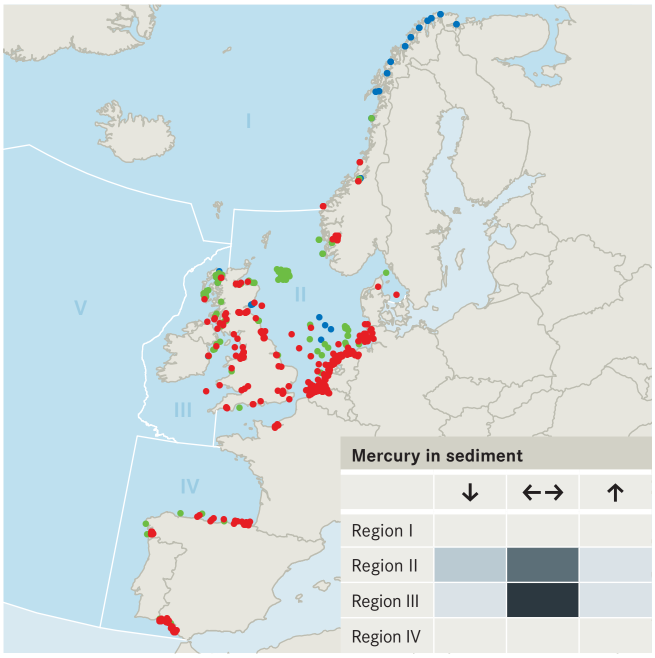
I
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Mercury in sediment
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Region III
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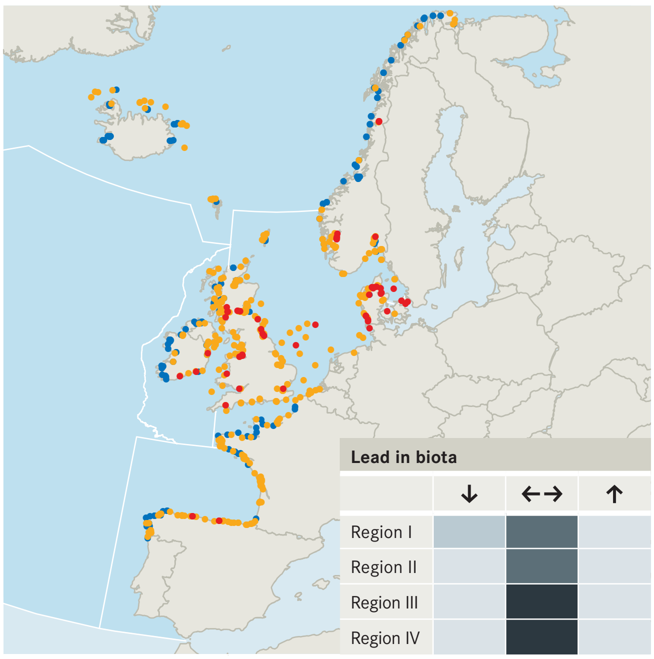
Lead in biota
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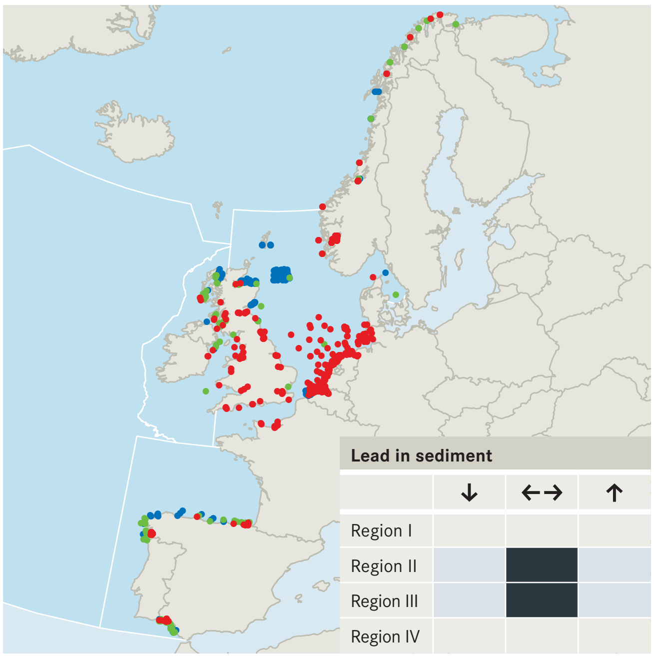
Region I
Region II
Region III
Region IV


Lead in sediment
↓ ↔ ↑
Region I
Region II
Region III
Region IV

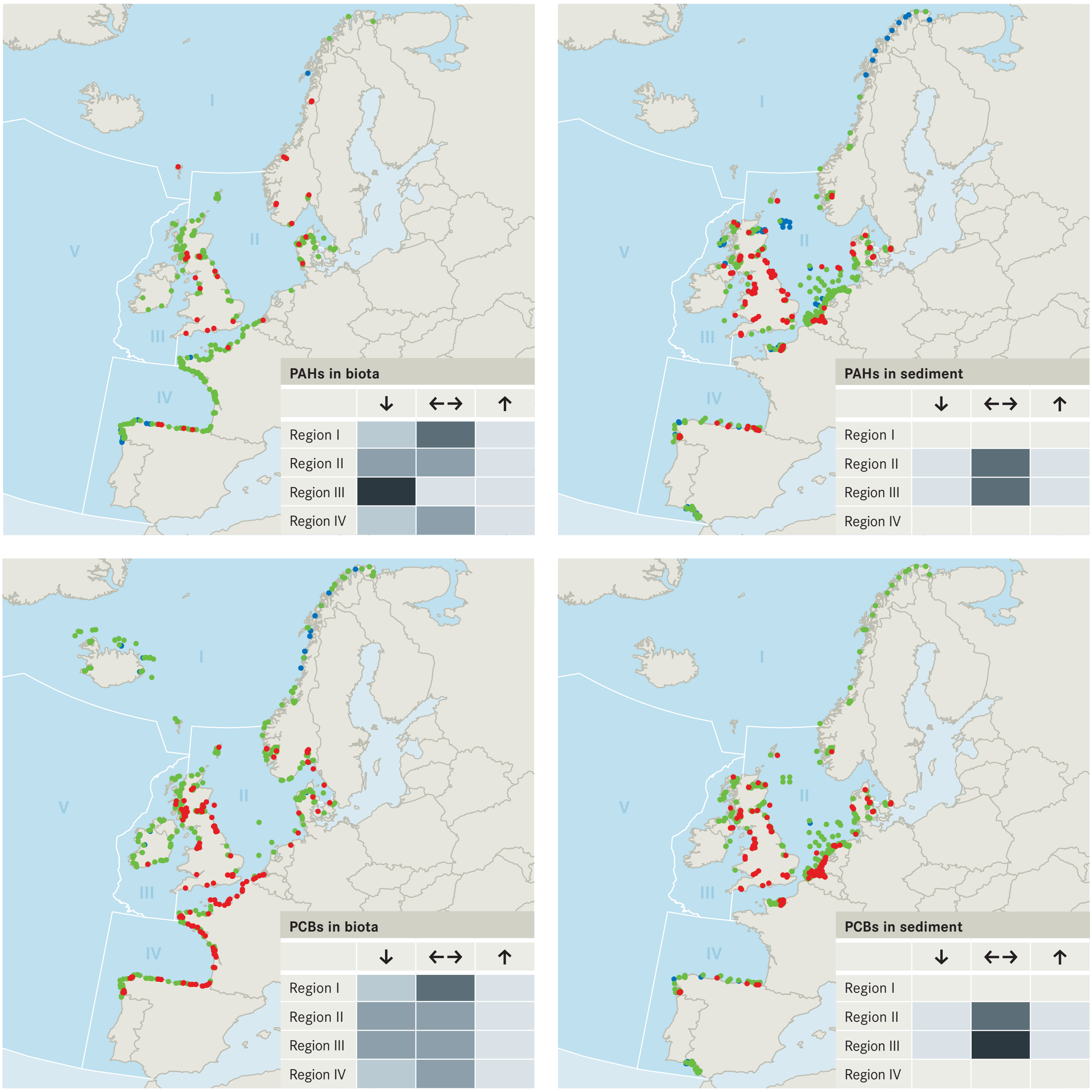


FIGURE 5.2 *Geographical distribution of status and temporal trends in contamination from cadmium, mercury, lead, PAHs and PCBs in biota (fish and shellfish) and sediments based on the OSPAR Coordinated Environmental Monitoring Programme. Status is indicated for the last year of monitoring in the period 2003–2007. Higher concentrations of heavy metals in biota around Iceland are due to natural factors. Geographic coverage of the assessment is limited, especially for sediments, as a result of lack of data reporting or the design of national monitoring programmes accounting for local conditions. No OSPAR monitoring data have been reported for Region V. Data coverage and assessment methodologies are explained in detail in the assessment reports 'Trends and Concentrations in Marine Sediments and Biota'.*

Spatial data are classified according to assessment criteria developed by OSPAR and ICES as follows:

- Status is unacceptable: concentrations are at levels such that there is an unacceptable risk of chronic effects occurring in marine species, including the most sensitive species (PAHs and PCBs in biota; PAHs, PCBs, and metals in sediment), or are greater than EU dietary limits for fish or shellfish but the extent of risks of pollution effects is uncertain (metals in biota).
- Status is uncertain: concentrations of metals in biota are lower than EU dietary limits for fish and shellfish and above background but the extent of risks of pollution effects is uncertain.
- Status is acceptable: concentrations of contaminants are at levels where it can be assumed that little or no risks are posed to the environment and its living resources at the population or community level.
- Status is acceptable: concentrations are near background for naturally occurring substances (cadmium, mercury, lead, PAHs) or close to zero for man-made substances (PCBs), i.e. the ultimate aim of the OSPAR Strategy for Hazardous Substances has been achieved.

Results of trend analysis of time series with data for five years or more in the period 1998–2007 are shown in the tables in each map. These present the percentage of 'downward trends' (↓), 'no trends' (←→) and 'upward trends' (↑) in assessed time series. 'No trends' means that trend analysis did not detect a statistically significant trend over time. 'No trend data' means that available time series were not sufficient for trend analysis.

No trend data
0–20%
20–40%
40–60%
60–80%
80–100%

Effects of TBT and substitute chemicals are of concern in some areas

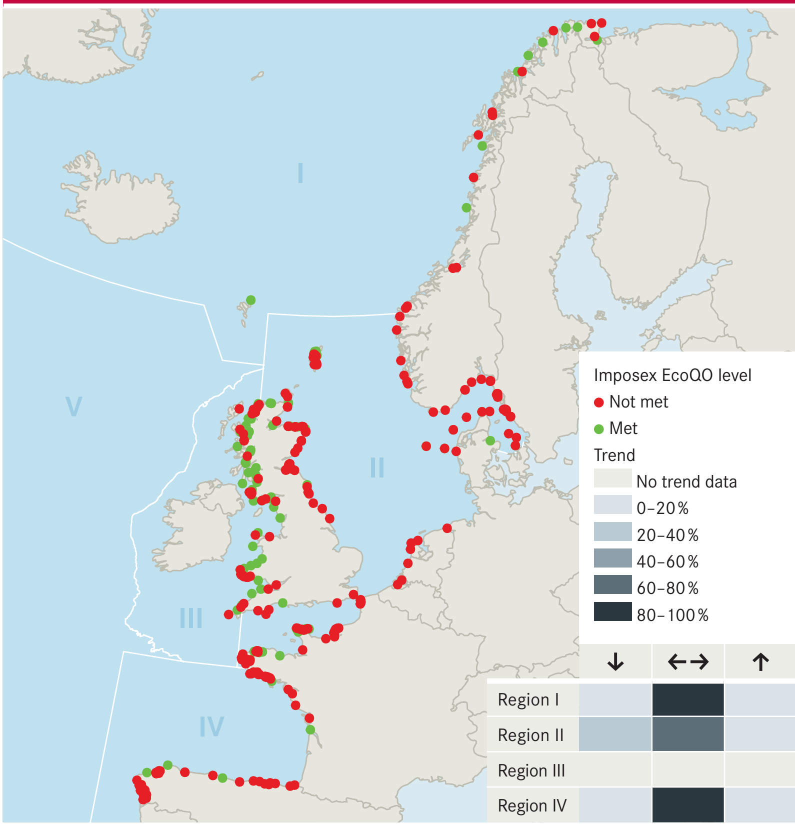
Over the past decade, a range of national and international measures have resulted in a continuous phase-out of paints containing TBT as an anti-foulant and their use on vessels, in aquaculture and on underwater structures in the OSPAR area. A global ban on TBT in anti-fouling systems on large vessels came into effect in 2008. Together, these measures address the main TBT-related pressures on the marine environment.

Marine snails are very sensitive to the harmful effects of TBT and are thus a good indicator for TBT pollution → **BOX 5.4**. Since 2003, when monitoring began, the intensity of TBT-specific effects on the dogwhelk and other marine snails has clearly reduced in Region II and there are few monitoring sites in the OSPAR area where such effects are increasing. Effect levels in Region I were stable between 2003 and 2007, while data for Regions III and for parts of Region IV are mostly insufficient for trend analysis. The EcoQO set for TBT-specific effects for the North Sea and applied through consistent assessment criteria in the other OSPAR Regions, is met at most sites in northern Norway and at some sites on the UK west coast and the coasts of France and Spain → **BOX 5.4**. Similarly, a number of sites in Iceland met the EcoQO in 2008. Nevertheless, TBT-specific effects are still found over large parts of the OSPAR area. There is a clear relationship with shipping, with high effect levels near some large harbours (e.g. Rotterdam, Clydeport, Vigo) and lower levels in areas with less large vessel traffic, such as along the west coast of Scotland and northern Norway. But even in these areas, harbours can have a noticeable impact, highlighting the importance of local sources and historic contamination of harbour sediments.

Dogwhelks

Copper and Irgarol (cybutryne) are the main substitutes for TBT and have been used as anti-foulants for more than a decade. Although not as detrimental as TBT they can also have adverse impacts on marine life. Rapid growth in the use of copper-based products in aquaculture over the past decade has increased the release of copper to the sea in major fish farming areas in northern Scotland and western and northern Norway.

BOX 5.4 Decreasing TBT-specific effects on dogwhelks and other marine snails



North Sea EcoQO: The average level of imposex in a sample of not less than 10 female dogwhelks (*Nucella lapillus*) should be consistent with exposure to TBT concentrations below the environmental assessment criterion for TBT. Where *Nucella lapillus* does not occur naturally, or where it has become extinct, other species may be used.

Some female marine snails develop male sex characteristics in response to TBT exposure; this is termed ‘imposex’. A small yacht painted with a TBT-based anti-foulant could, theoretically, release enough TBT in the course of a season to give ten million cubic metres of water a TBT concentration sufficient to affect sensitive gastropod species. A similar amount could be leached from the paintwork of a large tanker in an hour.

Monitoring imposex in marine gastropods is a good indicator for TBT pollution and helps to identify illegal use of stocks of TBT-containing anti-foulants or losses of TBT from dockyards, marinas and vessel maintenance activities such as sandblasting. It should also help to promote good practice in dealing with historically contaminated sediments, for example when disposing of dredged material, particularly from harbours, which continues to present a problem.

Pesticide regulation is working

The various uses of the six OSPAR priority pesticides → **TABLE 5.1** have been phased out progressively since 1998 and have now ceased for almost all substances. The positive effect of the phase-out of lindane is confirmed by clear decreases in atmospheric deposition to the OSPAR area → **BOX 5.5**.

The phase-out has resulted in a general reduction in concentrations of lindane in fish and shellfish across the OSPAR area → **FIGURE 5.3**. Concentrations are close to zero in some areas, for example western and northern Norway, and parts of Ireland, France and Iceland. However, concentrations in some other areas are still at levels with a risk of pollution effects. Particular examples are the Brittany coast, the German Bight, and some northern UK estuaries (Humber, Clyde, Forth, Tay). The localised nature of these hotspots, which may persist for years to come, may reflect historic use nearby.

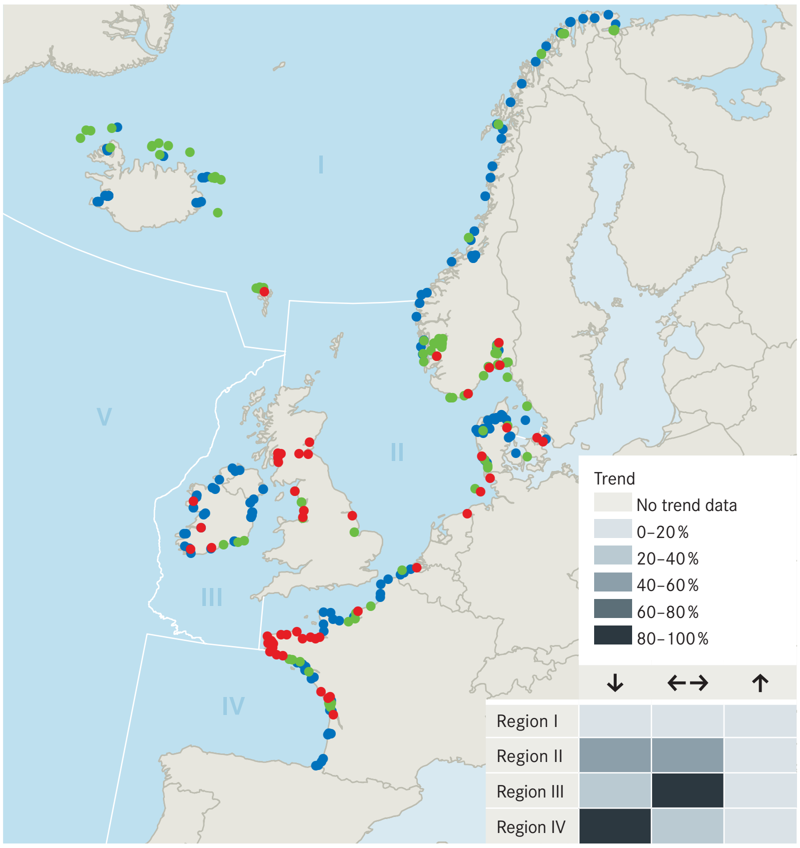


FIGURE 5.3 *Distribution and temporal trends in contamination from lindane in biota. Concentrations are unacceptable (red), acceptable (green) and close to zero (blue) (legend* → **FIGURE 5.2**).

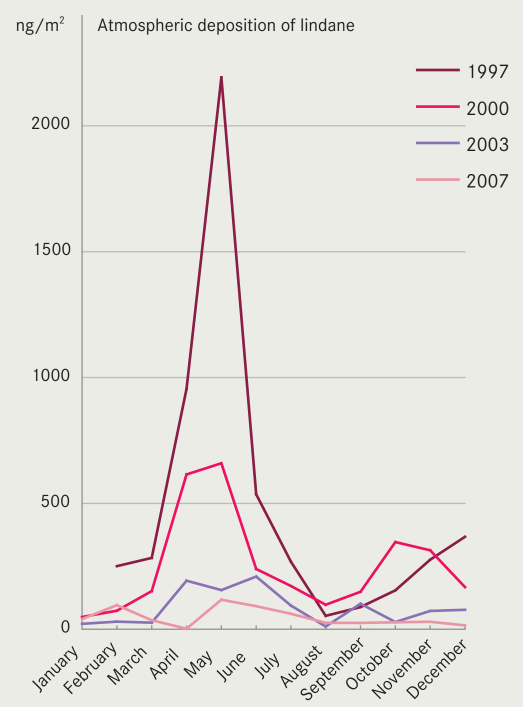
Better regulation is needed for some brominated flame retardants

Brominated flame retardants are a large group of chemicals used in high volumes and in a vast range of consumer products. Their regulation has not been uniform, with some substances more stringently regulated than others. OctaBDE and pentaBDE, as some of the most potentially hazardous of this group of substances, have been banned and their release will essentially cease by 2020. Others, such as decaBDE and hexabromocyclododecane (HBCD) need more regulation and in anticipation of this, industry has significantly reduced releases from point sources. The priority chemical tetrabromobisphenol-A (TBBP-A), which is expected increasingly to replace octaBDE in specific applications, is now the most commonly used brominated flame retardant in the OSPAR area and should be kept under review.

BOX 5.5 The ban on lindane has been successful

Most OSPAR countries had phased out lindane by 2000. Although data collected under the Comprehensive Atmospheric Monitoring Programme (CAMP) showed a sharp decline in the quantities deposited at the coasts in precipitation by 2000, lindane has continued to be found in the atmosphere and its decrease has slowed. In fact, a clear seasonal pattern has persisted with a spring peak in deposition each year (the figure shows the decline in the strength of the spring peak at a coastal station in north Germany). This suggests that some use of lindane has continued after 2000, for example as stockpiles are phased out. Another source of lindane is continental-scale transport from ongoing use in Asia. Re-release from the environment also occurs: one potential pathway is release as ice melts in the high Arctic.

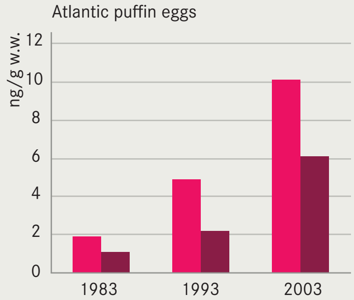
There continues to be a clear decreasing gradient in lindane deposition with increasing distance from mainland Europe. By 2007, deposition in the southern North Sea, for example, was up to 50 times lower than in 1997, but levels were still well above background.

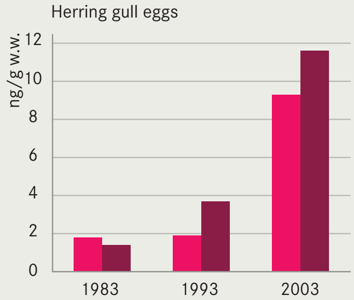


BOX 5.6 Hexabromocyclododecane in the Arctic

Hexabromocyclododecane is used in the production of textiles and in insulating materials. It hardly degrades and has shown potential for biomagnification in marine food chains. The importance of long-range transport of HBCD via air to the Arctic is confirmed by air concentrations over Svalbard that are only slightly lower than in southern Norway. Recent studies in the Norwegian Arctic (Region I) found HBCD throughout the marine environment, with concentrations in biota and sediments below levels considered to cause pollution effects and at lower concentrations than, for example, PCBs and PBDEs. Because POPs are always present in mixtures, other substances add to the total effect on marine life. The combined impacts may be higher in the cold Arctic environment where chemicals only degrade slowly. Precautionary action to keep levels of HBCD and other POPs low and to continue monitoring their presence in the Arctic is therefore important.

HBCD has been found in all analysed body fat and blood samples of polar bears in the Norwegian Arctic with concentrations in body fat (mean 25 ng/g wet weight) close to levels measured in glaucous gulls from Bear Island (Bjørnøya). A study on Bear Island showed higher concentrations of several contaminants, including HBCD, in brain and liver of dead and dying seabirds compared to concentrations in living birds. Observations in northern Norway suggest a significant increase in concentrations of HBCD in seabird eggs over the period 1983 to 2003 (see figures), but other studies found the highest concentrations in samples from the 1980s.





Over the period 2000–2005, polybrominated diphenyl ethers (PBDEs) and HBCD were found in all components of the marine ecosystems in Regions I, II, III and IV. The degree of contamination by these substances is still being revealed because regular OSPAR environmental monitoring only began in 2008 → BOX 5.6. Continued monitoring will be necessary to show whether actions to reduce the input of brominated flame retardants to the marine environment are effective.

Blood sampling from a tranquilised polar bear, Svalbard

Contamination from POPs requires global action

Long-range transport through air, water and biological pathways carries persistent organic pollutants (POPs), including perfluorooctane sulphonates (PFOS), SCCPs, and brominated flame retardants, to areas far from their sources. In the northern hemisphere, the prevailing air currents are towards the Arctic where many of these highly persistent contaminants end up. The tendency for these pollutants to bioaccumulate results in high concentrations in animals at or near the top of the food chain. This concerns predators such as polar bears, whales, seals and birds.

Monitoring shows that these pollutants are widely distributed through the marine environment, even in areas remote from emission sources. PFOS and related substances for example are extremely persistent and have long-term toxic effects on marine life and humans. They have been found in all environmental compartments in Regions I and II, both at polluted sites and far from direct sources.

Owing to this long-range transport, efforts to reduce emissions of POPs must occur at the global level. Recently octaBDE, pentaBDE, PFOS and lindane have been included under the UNEP Stockholm POPs Convention for global elimination. This should be followed by inclusion of SCCPs, endosulfan and HBCD. Even with a global ban coming into effect soon, these substances are so persistent that exposure and bioaccumulation will continue for many years.

Efforts on biological effects must continue

The presence of hazardous substances leads to a range of responses within marine organisms, such as the induction of specific enzymes, changes in tissue pathology and death. Contaminant-specific techniques have been developed which allow these responses to be measured, providing a means of linking the presence of contaminants and impacts. The most successful technique is the measurement of TBT-specific effects (imposex) in gastropods. Other techniques are under development to reflect the responses to multiple contaminants. For example, data on fish diseases are collected under the CEMP and combined in an index as a potential tool for assessing fish population health and to evaluate the impact of human-induced stresses on wild fish. While measurements in Region II show a worsening of fish health from the 1990s to the 2000s suggesting an overall decline in environmental conditions, this cannot be linked with observations of chemical contamination and causes still need to be investigated → FIGURE 5.4. Recent studies of individual fish diseases have now been able to link a general decline in liver tumours in fish in the Netherlands' waters of the North Sea since the late 1980s with a decrease in exposure to organic pollutants, such as genotoxic and carcinogenic PAHs.

It is not yet possible in most cases to link chemical monitoring with observations of effects in species in such a way that conclusions can be drawn about the impact of contaminants on the functioning of ecosystems at a regional level. OSPAR countries have made progress in standardising reference methods for monitoring biological indicators, but have not yet implemented a fully coordinated biological effects monitoring programme. This will be needed to support the regional assessment of hazardous substances. Efforts on biological effects monitoring and assessment should therefore continue and be enhanced, also in relation to combined effects on ecosystem function, for which chemical analysis is not suitable.

Understanding of endocrine disrupting effects must improve

Since the QSR 2000, there has been little improvement in knowledge about concentrations of potentially endocrine disrupting chemicals released to the marine environment. Recent work has highlighted the potential for synthetic substances to disrupt immune systems and chemical communication between organisms. Although research on these topics is expanding rapidly, the best known aspect of endocrine disruption is still the effects on sex hormone systems and reproduction in fish.

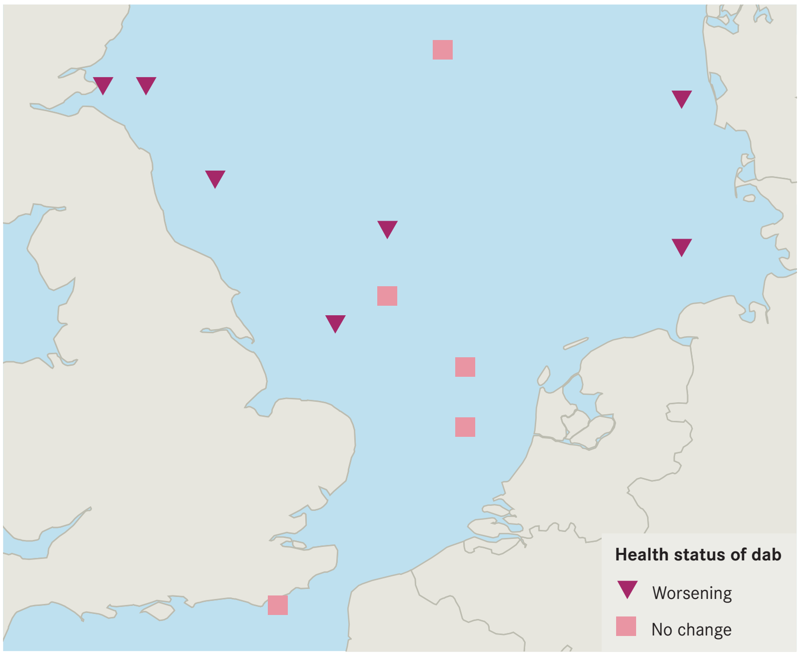
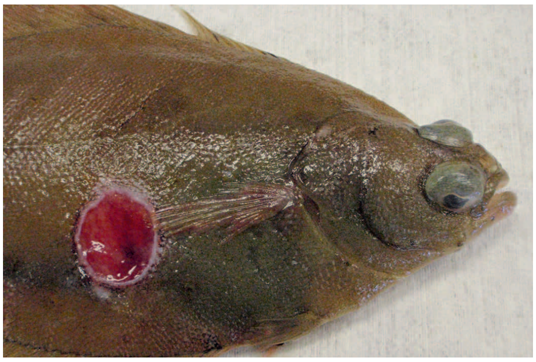


FIGURE 5.4 *Changes in the health status of dab in the North Sea in the period 2002–2007 compared to the period 1992–2001 based on the trial of a fish disease index. This involves the occurrence of various external disease symptoms, infections caused by external parasites and visible growth of liver tumours. Samples of dab collected from the southern North Sea show that its health status has worsened in many of the areas assessed. The index result is driven by the results for externally visible diseases; there was no significant change in the prevalence of liver tumours. The causes of this phenomenon need to be investigated.*



Dab with acute ulcer

OSPAR has developed guidelines for monitoring endocrine disrupting effects in fish. These are not a formal part of the OSPAR monitoring programme, but allow surveys, for example, of feminisation of male fish through measurement of intersex and vitellogenesis (the process of yolk formation specific to the female germ cell). Endocrine disrupting effects in fish occur in many areas, although their extent, severity, and consequences are not clear. Male flounder from estuaries in Belgium, Denmark, France, Germany, the Netherlands and the UK have elevated concentrations of plasma vitellogenin (linked to reduced reproductive success in male fish), as have cod from Norwegian inshore waters, and dab from offshore waters of the North Sea. There is some limited evidence to suggest that concentrations of plasma vitellogenin in male flounder from some UK estuaries may be falling.

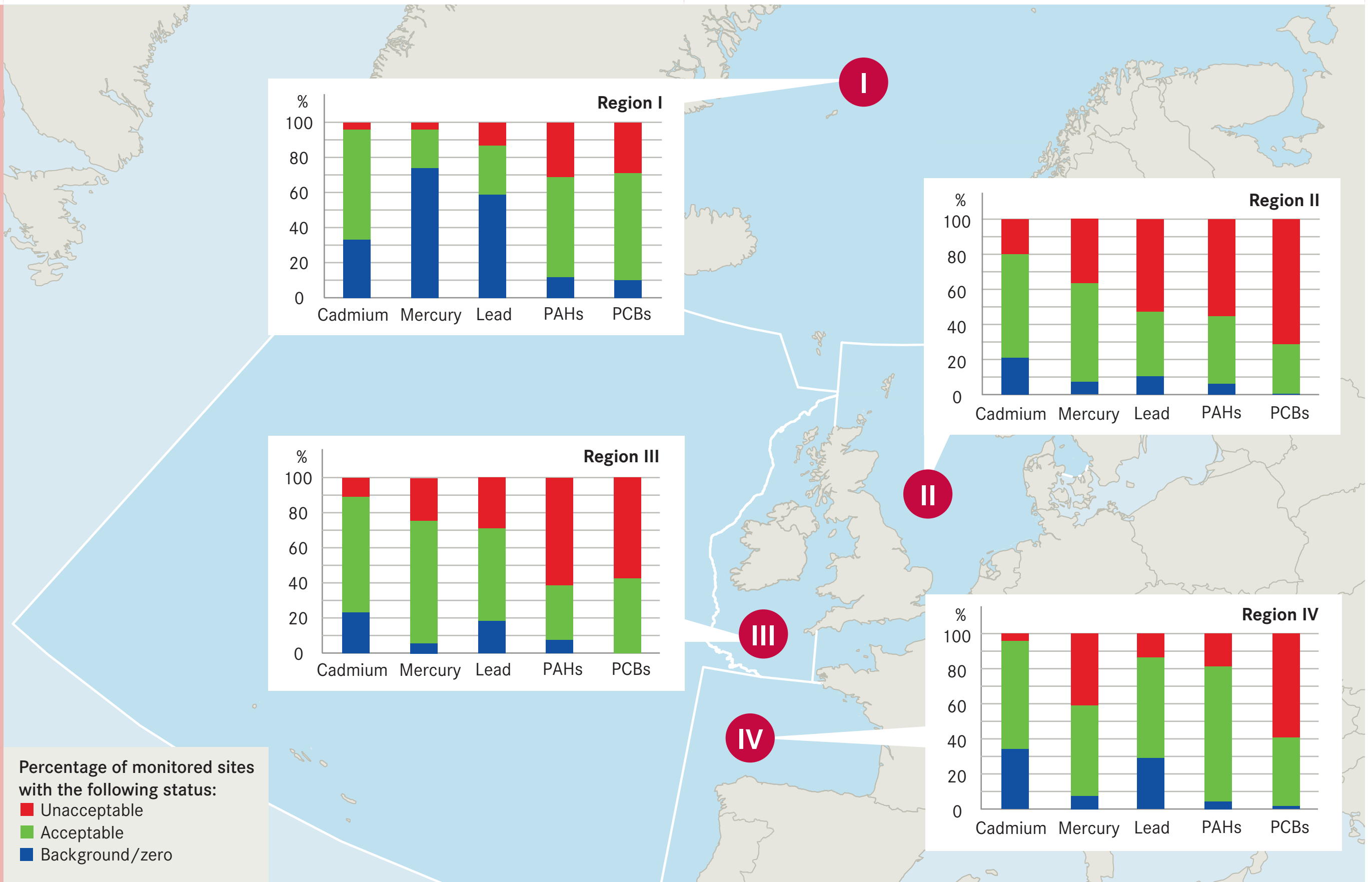
Emerging problems from substitute chemicals

In many cases, when a hazardous substance is phased out, its uses are filled by other chemicals. This often benefits the environment, but can lead to new and unexpected problems if properties of the replacement chemicals are not well understood. Medium-chain chlorinated paraffins (MCCPs) for example are increasingly used as substitutes for SCCPs following EU restrictions in 2002. They are less harmful than SCCPs, but are still of concern due to their persistence and accumulation in the marine environment. There is a clear need to keep environmental levels of chemicals used as substitutes under review as these could also pose environmental risks.

Market conditions affect progress towards OSPAR's objectives

Market conditions, production methods and volumes, and technological developments have brought structural changes in some major land-based and offshore industries. Some industries have ceased, while others have emerged, and many manufacturing industries have relocated to other parts of the world, for example, Asia. Rapidly developing economies and their associated industrial development and energy demand outside the OSPAR area are causing increasing pressure on the North-East Atlantic. This is principally through long-range atmospheric transport of contaminants such as mercury and PAHs. In addition, some imported goods contain hazardous substances that can reach the sea as the product is used and following its disposal. Typical examples are lindane, nonylphenol and brominated flame retardants.

BOX 5.7 Status of chemical contamination in OSPAR Regions



The status of chemical contamination in the OSPAR area is based on results from the OSPAR Coordinated Environmental Monitoring Programme → FIGURE 5.2. Concentrations in Region II are still widely above background values for mercury, cadmium, lead and PAHs and above zero for PCBs and are unacceptable in many, mostly coastal areas. Unacceptable concentrations also persist in some urban and industrialised areas on the coasts of Regions III and IV. Overall, contamination is lowest in Region I where many of the sites monitored meet the OSPAR objective of background values for heavy metals; however, concentrations of PAHs and PCBs are still unacceptable at a third of the sites monitored. PAHs and PCBs remain widespread in the OSPAR area with more than half the sites monitored in Regions II (PAHs and PCBs), III (PAHs and PCBs) and IV (PCBs) at unacceptable levels. Overall the situation is better for heavy metals, although more than 40 % of sites monitored show unacceptable levels of lead in Region II and mercury in Region IV.

Global action is required to control the input of such substances to the marine environment. Steady growth in the use of manufactured goods and the resulting waste streams is a growing source of potential pollution that needs tackling.

What happens next?

Levels in the environment are still of concern

Although OSPAR's assessments show that inputs of heavy metals and some organic contaminants to the sea have fallen considerably over the past 20 years, most priority chemicals are still being released to the environment. Progress in reducing air emissions and atmospheric and waterborne inputs of heavy metals and air emissions of PAHs has also slowed over the past ten years as it becomes technically and economically more difficult for industry to reduce releases further. Historic pollution in riverine, estuarine and marine sediments acts as a continued source of release.

Concentrations of heavy metals, PAHs and PCBs in sediment, fish and shellfish have decreased since 1998, but at a slower rate than in the previous decade. Problems related to high concentrations persist, especially in coastal areas near the main sources of pollution in Regions II, III and IV → BOX 5.7. Contamination of marine life with persistent hazardous substances (e.g. mercury, brominated flame retardants, PFOS, SCCPs) is widespread in all Regions. In Region I, contamination extends to the top level of the food chain in areas remote from most sources. This Region is particularly affected through long-range air transport and this gives rise to concern for the vulnerable Arctic ecosystem.

Additional effort is needed to achieve further progress

Moving closer towards the target of a cessation of discharges, emissions and losses of hazardous substances by 2020, requires OSPAR countries to fully implement existing measures, especially those required under the EU IPPC Directive, the EU Water Framework Directive and its Daughter Directive on priority substances, and the EU Marine Strategy Framework Directive. Abatement at source is still important and should be based on the precautionary principle and the principle of prevention. Best available techniques (BAT) and best environmental practices (BEP) must continue to be applied.

The OSPAR assessments show that priority chemicals can reach the North-East Atlantic through atmospheric transport and waste streams of imported products. The widespread presence of POPs in the OSPAR area emphasises the need for a global ban on the use of these chemicals. OSPAR should promote: the development of a legally binding global instrument on controls of emission sources of mercury within the framework of the United Nations Environment Programme (UNEP); and the inclusion of additional contaminants (e.g. SCCPs, HBCD and endosulfan) for phase-out under the Stockholm Convention on Persistent Organic Pollutants, and the Aarhus Protocol on Persistent Organic Pollutants to the UNECE Convention on Long-range Transboundary Air Pollution.

Achieving the cessation target will be difficult for many substances with sources for which control measures are difficult or impossible, for example, diffuse pollution from consumer products, historic pollution and releases from combustion processes.

OSPAR's role at the European level

OSPAR has identified threats from a wide range of substances of possible concern for the marine environment which need to be tackled by the appropriate forum. OSPAR should focus on substances posing risks to the marine environment that are not yet adequately covered by the EU and by other international bodies. Continued cooperation with industry is important.

OSPAR should continue to make input to the EU on the identification, selection and prioritisation of hazardous substances which are of concern for the marine environment. OSPAR should also promote actions under the EU REACH Regulation and other relevant EU legislation to reduce releases of these substances from products and wastes, and control risks for the marine environment.

Monitoring and assessment to support the EU Marine Strategy Framework Directive

OSPAR should continue its key role in developing monitoring strategies to track progress on controlling hazardous substances. The OSPAR Coordinated Environmental Monitoring Programme (CEMP) has provided well-tested, quality-assured methodologies for environmental monitoring that can contribute to the evaluation of good environmental status under the EU Marine Strategy Framework Directive and good chemical status under the EU Water Framework Directive.

The CEMP should be further developed for future monitoring and assessment, supported by the following:

- Improved understanding of the effects of hazardous substances, particularly cumulative effects and endocrine disruption.
- Improved biological effects monitoring, integrated, where appropriate, with chemical monitoring.
- Extending datasets further offshore beyond the densely populated and industrialised coasts.
- Improved information collection on the production, uses and pathways to the marine environment, especially for substances which are not deemed suitable candidates for marine monitoring.
- Use of research results on concentrations and effects of hazardous substances on deep-sea species and ecosystems.

There is increasing evidence that climate change may alter pathways of hazardous substances to the North-East Atlantic and make marine ecosystems more vulnerable to chemical pollution. OSPAR should include considerations of climate change in future monitoring and assessment of hazardous substances.

Delivering OSPAR Strategy objectives for hazardous substances

→ LEGEND: BACK-COVER FOLD-OUT

OSPAR Region	Towards the cessation target 2020	Status relating to background/zero	Status change 1998–2006	Key factors and pressures	Outlook for pressures	Action needed
Region I	Some progress * *	Some problems * * *	Mixed * *	Long-range air transport Sea-based activities	↑	OSPAR EU, UNECE, UNEP
Region II	Some progress * *	Many problems * * *	Mixed * *	Land-based inputs Long-range air transport Sea-based activities	?	OSPAR EU, UNECE, UNEP
Region III	Some progress * *	Some problems * * *	Mixed * *	Land-based inputs Long-range air transport Sea-based activities	?	OSPAR EU, UNECE, UNEP
Region IV	Some progress * *	Some problems * * *	Mixed * *	Land-based inputs Long-range air transport Sea-based activities	?	OSPAR EU, UNECE, UNEP
Region V	Some progress * *	No information	Not assessed	Long-range air transport Sea-based activities	?	OSPAR

6 RADIOACTIVE SUBSTANCES

OSPAR countries have concentrated their efforts to reduce inputs of radionuclides by focussing on the nuclear sector; β-activity discharges from this sector have fallen by 38 % on average since the period 1995–2001. Environmental concentrations and exposure of humans and biota to some monitored radionuclides from the nuclear sector are low. Offshore oil and gas extraction is a substantial source of inputs of naturally occurring radionuclides to the sea, but monitoring began too recently to assess trends.

OSPAR Contracting Parties should cooperate

→ to continue to apply and further develop BAT for minimising discharges of radioactive substances from the nuclear sector;
→ to assess the contribution of the offshore oil and gas industry to marine radioactive pollution and to identify and implement appropriate management measures;
→ to continue monitoring programmes, improve assessment tools and develop environmental quality criteria, to evaluate the impacts of discharges on the marine environment.

Key OSPAR assessments

→ Towards the Radioactive Substances Strategy objectives
→ Implementation of BAT to minimise radioactive discharges
→ Liquid discharges from nuclear installations in 2007

The marine environment is exposed to radiation from both natural and artificial sources. Naturally occurring radionuclides (radioactive forms of elements) are derived from the weathering of minerals in the Earth's crust and from cosmic rays, while artificial radionuclides are released to the marine environment from a variety of past and present human activities associated with the nuclear industry and military uses. These include the operation of nuclear power plants and nuclear fuel reprocessing plants, atmospheric nuclear weapons testing and fallout from the 1986 Chernobyl accident. Human activities have also led to elevated levels of naturally occurring radionuclides, such as those released from offshore oil and gas installations and the phosphate fertiliser industry. Other potential sources of radionuclides in seawater are former dump sites for nuclear waste and sunken nuclear submarines. Estuarine and marine sediments that have accumulated radionuclides over long periods can be an additional source long after discharges from the point sources have stopped. OSPAR works under the Radioactive Substances Strategy to reduce inputs and levels of radionuclides in order to protect the marine environment and its users.

OSPAR Strategy objectives for radioactive substances

→ Prevent pollution of the maritime area from ionising radiation through progressive and substantial reductions of discharges, emissions and losses of radioactive substances.
→ Reduce by 2020 discharges, emissions and losses of radioactive substances to levels where the additional concentrations in the marine environment above historic levels, resulting from such discharges, emissions and losses, are close to zero.
→ The ultimate aim is of concentrations in the environment near background values for naturally occurring radioactive substances and close to zero for artificial radioactive substances. In achieving this objective, the legitimate uses of the sea, technical feasibility, and radiological impacts on man and biota should be taken into account.

What are the problems?

Radioactive substances affect living organisms

Radioactivity is associated with energy released from radionuclides through radiation. Ionising radiation occurs as electromagnetic rays (γ-rays), α-particles and β-particles. It can cause genetic, reproductive and cancerous effects in living organisms. Because of this, it has the potential to cause negative effects on marine organisms at the level of populations and to affect human health through seafood consumption. The potential for harm through radiation depends on the properties of the radionuclides, the amount of radiation energy absorbed by marine organisms (i.e. the dose) and the pathway through which they are exposed: γ-rays and β-particles can penetrate the skin, while α-particles cannot, but are particularly dangerous if ingested or inhaled.

The main sources from which radioactive substances are discharged into the OSPAR area are the nuclear sector (associated with electricity generation) and the non-nuclear sector (mainly the offshore oil and gas industry and medical uses).

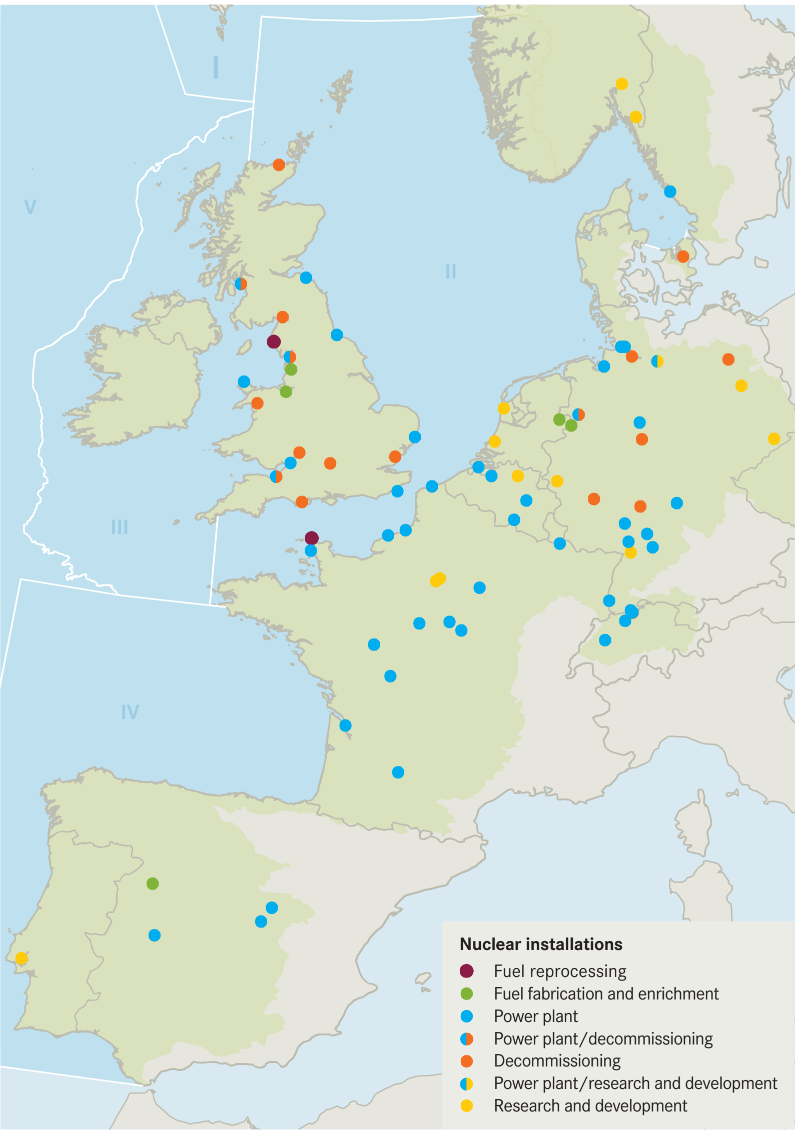
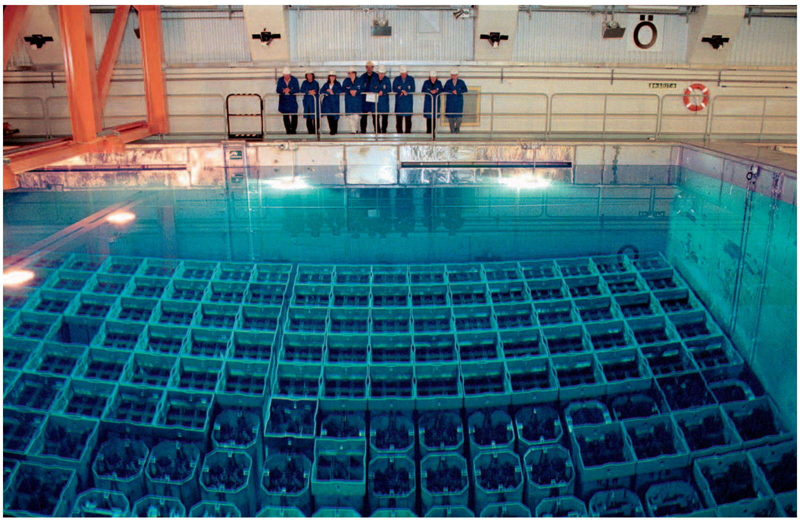


FIGURE 6.1 *Nuclear installations in OSPAR countries discharging directly or indirectly to the OSPAR area in 2007.*



Spent fuel storage pond

The nuclear sector is the main source of artificial radionuclides

The number of nuclear installations in OSPAR countries discharging radionuclides directly or indirectly to the OSPAR area has been stable over the past ten years. In 2007, the 92 nuclear installations in operation and decommissioning in the OSPAR catchment comprised: nuclear power plants, which harness the heat produced in nuclear reactions and convert this to electrical energy; nuclear fuel fabrication and enrichment plants, which provide the uranium fuel for the power plants; nuclear fuel reprocessing plants, which recycle used nuclear fuel to recover uranium and plutonium; and research and development facilities relating to all aspects of the nuclear sector → FIGURE 6.1.

Nuclear fuel reprocessing plants and fuel fabrication and enrichment plants account for 98% of discharges of radionuclides from the nuclear sector. The radionuclides that are used as indicators of discharges from this sector are caesium-137 (^{137}Cs), technetium-99 (^{99}Tc), plutonium-239 (^{239}Pu), plutonium-240 (^{240}Pu), and tritium (^{3}H) → TABLE 6.1. Inputs of radionuclides to the sea are associated with liquid discharges and to a lesser extent with solid wastes and emissions to air.

Offshore oil and gas activities discharge naturally occurring radionuclides

The offshore oil and gas industry is the largest non-nuclear contributor of discharges of radioactive substances to the marine environment. Almost all the radionuclides discharged from this sector are from produced water (water extracted from the reservoir with the oil and gas) and from descaling the insides of pipes. A less important source is the use of radioactive substances (e.g. tritium) as tracers. The naturally occurring radionuclides in produced water include lead-210 (^{210}Pb), polonium-210 (^{210}Po), and radium-226 and -228 (^{226}Ra and ^{228}Ra).

Other non-nuclear sources are minor

The main source of radioactive discharges in the medical sector is from the use of radioactive iodine-131 (^{131}I) in the treatment of thyroid complaints → TABLE 6.1. However, its short half-life and discharge via sewers means that only negligible levels of ^{131}I reach the marine environment.

TABLE 6.1 *Radionuclides used as indicators of radioactive discharges for assessing progress in implementing the OSPAR Radioactive Substances Strategy.*

	Source	Radionuclide	Radiation	Half-life
Nuclear sector	Nuclear industries	Technetium-99 (^{99}Tc) Caesium-137 (^{137}Cs) Plutonium-239 (^{239}Pu)[1] Plutonium-240 (^{240}Pu)[1] Tritium (^{3}H)[2]	β-activity, β-activity, γ-activity α-activity α-activity β-activity	213 000 yr 30.17 yr 24 100 yr 6560 yr 12.3 yr
Non-nuclear sector	Offshore oil and gas industry	Lead-210 (^{210}Pb) Radium-226 (^{226}Ra) Radium-228 (^{228}Ra) Thorium-228 (^{228}Th)[3]	β-activity α-activity, γ-activity β-activity α-activity	22.3 yr 1600 yr 5.76 yr 1.9 yr
	Medical uses	Technetium-99 (^{99}Tc)[4] Iodine-131 (^{131}I)	β-activity β-activity, γ-activity	213 000 yr 8 d

[1] ^{239}Pu and ^{240}Pu are measured together ($^{239,240}Pu$). [2] Tritium discharges are reported, but no evaluation of these data has been carried out due to the lack of practicable abatement options. This will be kept under review. [3] Insufficient data reported for assessment. [4] Due to the short half-life (6 hours) of ^{99m}Tc, ^{99}Tc has been identified as the indicator radionuclide for the medical use of ^{99m}Tc.

Waste from the phosphate fertiliser industry was an important source of naturally occurring radionuclides to the marine environment until the early 1990s. All discharges from this industry ceased by 2005, due to plant closures and the use of operating systems that avoid discharges. Yet, past discharges still contribute to environmental concentrations and radiation doses.

What has been done?

Efforts have focused on pollution from nuclear installations

OSPAR's work to prevent and reduce pollution from radioactive substances has focused on the nuclear sector and the application of best available techniques (BAT) to minimise pollution of the marine environment by radioactive discharges. Examples of BAT for the nuclear sector include treatment systems for converting radionuclides in effluents into solid waste for disposal. Even when BAT is applied, low level radioactive discharges into the environment are usually unavoidable. Such liquid discharges and emissions to air are regulated through licences from the authorities. Regular reports to OSPAR indicate that the use of BAT is stipulated in national legislation and regulations and that management systems are in place to minimise radioactive discharges from the nuclear sector. OSPAR has established common tools and methods for monitoring and reporting discharges from nuclear installations, as well as baselines against which to monitor progress in reducing the amount of radioactive substances discharged by the nuclear sector. Statistical methods to evaluate progress towards achieving the objectives of the Radioactive Substances Strategy have also been identified for discharges from the nuclear sector. The work of OSPAR complements that by other international organisations, such as the EU and the International Atomic Energy Agency (IAEA).

OSPAR has not developed BAT for reducing discharges of radionuclides from the non-nuclear sector, but started collecting data on annual discharges from non-nuclear sources in 2005.

Discharge of produced water

Environmental quality criteria are not yet developed

Traditionally, radiological protection has been based on the protection of humans. However, it is now recognised that environmental protection must be addressed in its own right and that tools must be developed to assess radiation exposure and risk to marine organisms. OSPAR has assessed doses to marine life from the most significant radionuclides and will develop environmental quality criteria for the marine environment in the light of progress in other international forums. OSPAR is currently reviewing the development by the International Commission on Radiological Protection of a framework to demonstrate radiological protection of the environment, as well as the development of policy and regulatory approaches by other international bodies, such as the EU and the IAEA. These organisations, together with countries and other key organisations (the UN Scientific Committee on the Effects of Atomic Radiation, the International Union of Radioecology, the Organisation for Economic Co-operation and Development), participate in the comprehensive IAEA Plan of Activities on the Radiation Protection of the Environment.

Did it work?

Progress for the nuclear sector

OSPAR has identified indicator radionuclides for discharges from each of the sectors against which progress towards the objective of the OSPAR Radioactive Substances Strategy is being assessed → TABLE 6.1. This was achieved by establishing the composition of discharges from the various sectors and the significance of the radiation dose of the radionuclides involved. OSPAR has collected data on annual discharges of indicator radionuclides from the nuclear sector since 1990 and from non-nuclear sources since 2005. The data for the nuclear and non-nuclear sectors differ widely with respect to temporal period and quantity. For the nuclear sector, the period between 1995 and 2001 has been agreed as the baseline period against which progress towards the objective of the Radioactive Substances Strategy is evaluated. Mean values of discharges of the individual indicator radionuclides in the baseline period have been established. There are too few reported data to develop a baseline for assessing trends in discharges from the non-nuclear sector. As well as the individual indicator radionuclides, total α-activity and total β-activity (excluding tritium) are used to indicate discharges of radioactive substances across sectors as a whole.

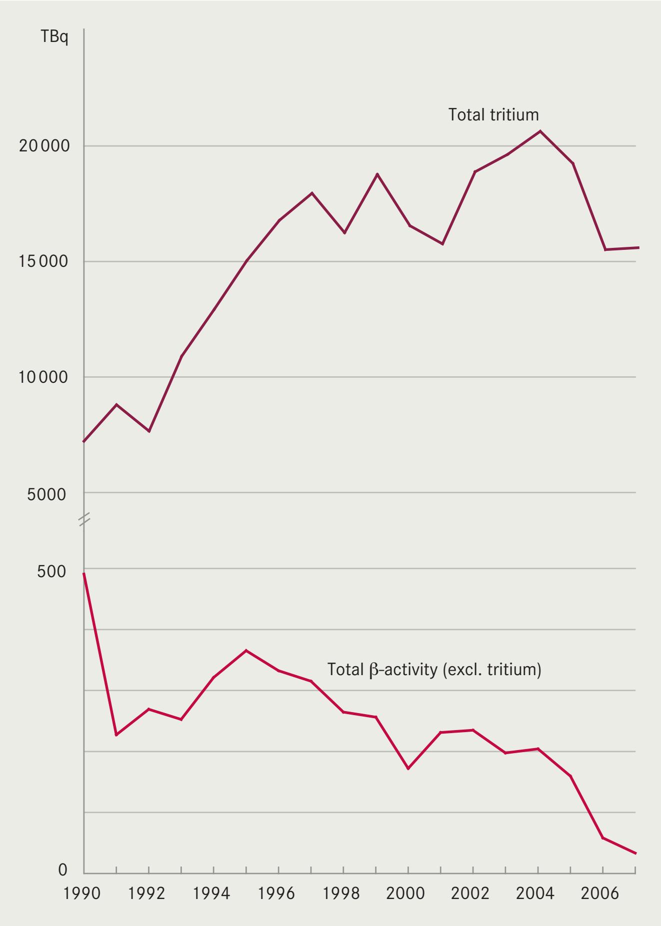


FIGURE 6.2 *Annual discharges of total β-activity (excl. tritium) and tritium from the nuclear sector between 1990 and 2007. Discharges of total α-activity are not shown because they are much smaller; they decreased from almost 2.5 TBq in 1990 to less than 1 TBq in 1995 and have remained below 1 TBq/yr since then.*

FIGURE 6.3 *Average discharges of total α-activity and total β-activity (excl. tritium) from the nuclear sector in the period 2002–2006 relative to the baseline period 1995–2001. The increase in α-activity discharges is not statistically significant.*

Discharges of some radionuclides from the nuclear sector have decreased

Annual discharges from nuclear installations show that of the assessed radionuclides the β-emitter tritium accounts for most discharges, numerically several magnitudes more than the total α-activity and total β-activity from other radionuclides discharged from the nuclear sector → FIGURE 6.2. Tritium discharges mainly relate to nuclear reprocessing plants. Although they appear high in terms of activity, tritium discharges have very low radiotoxicity to humans and biota. There is currently no technology capable of removing tritium from industrial radioactive waste streams.

Average discharges from the nuclear industries in the period 2002–2006 relative to the 1995–2001 baseline period show that there has been a statistically significant decrease of 38 % in total β-activity discharges (excluding tritium), but no statistically significant change in total α-activity discharges → FIGURE 6.3.

France and the UK have demonstrated through their reports on implementing OSPAR Recommendation 91/4 that BAT has been applied to minimise radionuclide discharges from their reprocessing plants. For example, the French authorities required the operators of the La Hague facility to achieve further reductions in discharges when they reviewed discharge authorisations. Since 2002, the nuclear fuel reprocessing plant at Sellafield (UK) has achieved reductions in discharges of ^{99}Tc, a radionuclide to which both the 1998 and 2003 OSPAR Ministerial Meetings drew special attention → BOX 6.1. Discharges of ^{99}Tc are expected to fall further and be maintained at low levels.

Nuclear and non-nuclear sectors contribute in different ways

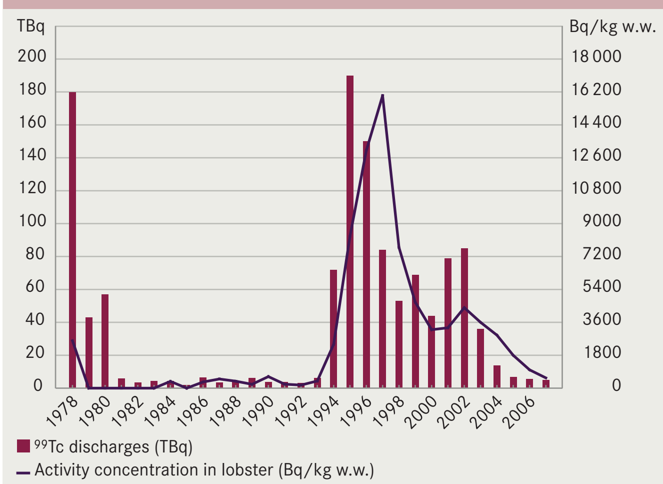
The activity concentrations of naturally occurring radionuclides discharged from the offshore oil and gas industry are very low, both in produced water and in scale from pipes. However, the volumes of produced water are very large which results in substantial discharges of radionuclides. Annual discharges of total α-activity from the offshore oil and gas industry ranged from 6.4 TBq in 2005 to 7.4 TBq in 2007, while annual discharges of total β-activity (excluding tritium) were lower ranging from 4.3 TBq in 2005 to 4.9 TBq in 2007. These are best estimates calculated from the radioactivity of individual indicator radionuclides, rather than from measurements of total α-activity and total β-activity.

BOX 6.1 Drastic reduction in technetium discharges from Sellafield

The reduction of ^{99}Tc discharges from the nuclear fuel reprocessing plant at Sellafield (UK) shows how OSPAR measures have helped to address a site-specific source of radioactive discharges. At Sellafield, reprocessing of spent nuclear fuel produces liquid waste containing ^{99}Tc and other radionuclides. The waste was initially discharged to the Irish Sea after several years of decay storage. Following public concern over these discharges, the waste was retained in storage tanks after 1981. The Enhanced Actinide Removal Plant (EARP) was built at Sellafield to treat the waste, but was not designed to remove ^{99}Tc. As a result, when EARP started treating the backlog of waste in 1994, ^{99}Tc discharges and concentrations in the marine environment increased.

In response to concerns expressed by some OSPAR countries, in particular Ireland and Norway, and the joint statement by OSPAR Ministers for a reduction of ^{99}Tc discharges, the UK reduced Sellafield's ^{99}Tc discharge limit from 200 to 90 TBq/yr, from 1 January 2000, and reviewed potential abatement techniques for ^{99}Tc. The solution implemented in 2003 for new arisings of waste was vitrification and storage on land, but this technology was unsuitable for the residual stored waste. Research by Norway showed that doses to critical groups in the UK from ^{99}Tc discharges to sea were higher than via disposal on land. This finding supported the development of a method involving precipitation of ^{99}Tc and then storage on land.

A full-scale trial of the technique was launched, during which discharges from waste treatment were suspended. The trial was a success and the technology was implemented, allowing the UK to reduce the ^{99}Tc discharge limit to 10 TBq/yr in April 2006. Actual discharges were below 5 TBq in 2007. By the end of 2007 all the stored technetium-bearing waste (medium-active concentrate) had been treated and associated discharges of ^{99}Tc from this main source at Sellafield ended.



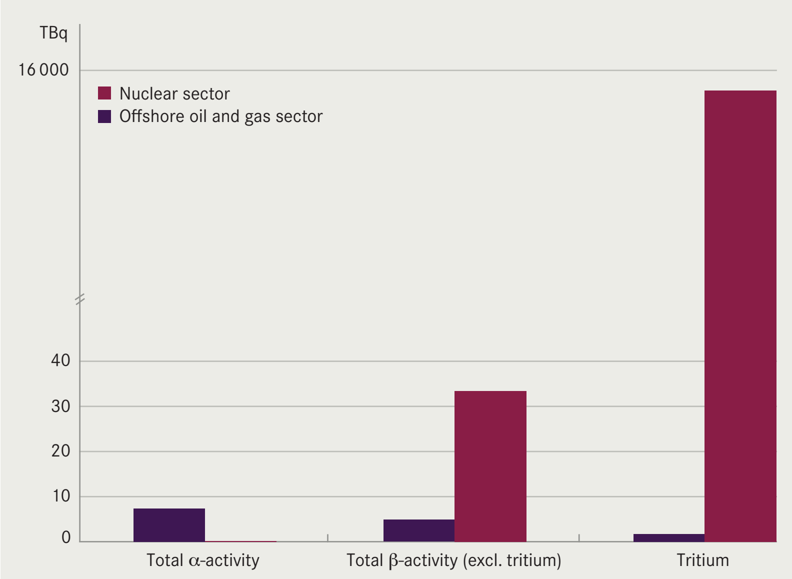


FIGURE 6.4 *Comparison of activity discharges from the offshore oil and gas sector and the nuclear sector in 2007.*

Seaweed is used as matrix to measure marine concentrations of radioactive substances

A comparison of the estimated radioactivity discharged in 2007 from the offshore oil and gas industry and that measured in discharges from the nuclear sector provides an indication of the relative magnitudes of the radioactivity discharged → **FIGURE 6.4**. On the basis of these data, the offshore oil and gas industry is the dominant source of total α-activity, whereas the nuclear sector is the dominant source of total β-activity. For tritium, discharges from the nuclear sector are far higher than those from its use as a tracer in the Norwegian oil and gas industry.

Radionuclides used in the medical sector (e.g. ^{131}I and ^{99m}Tc) are either short-lived or estimated to make a very small contribution to marine radioactivity at the regional level. The total activity of ^{131}I discharged by nine OSPAR countries in 2007 was estimated at 20 TBq. In 2007, the sum of the ^{99}Tc discharged from the decay of the medical product ^{99m}Tc for the five OSPAR countries that reported data was only 1 MBq. OSPAR will no longer require reporting data on ^{99}Tc from medical uses.

How does this affect the quality status?

Environmental concentrations of some radionuclides from the nuclear sector have decreased

To assess progress towards the OSPAR objective on concentrations of radioactive substances in the marine environment, the OSPAR maritime area was sub-divided into 15 monitoring areas, taking into account ocean circulation, the location of nuclear sources and potential impact areas. For each of the 15 areas, where data were available, mean concentrations of the indicator radionuclides associated with discharges from the nuclear sector in seawater, seaweed, molluscs and fish in the period 2002–2006 → **TABLE 6.1** were compared with mean concentrations for the 1995–2001 baseline period → **FIGURE 6.5**. Limited concentration data are available for the naturally occurring radionuclides identified by OSPAR as indicators for discharges from the offshore oil and gas industry → **TABLE 6.1** as well as for the α-emitting, naturally occurring radionuclide ^{210}Po (half-life 138.4 days), which is an important contributor to the total dose received by man and marine organisms.

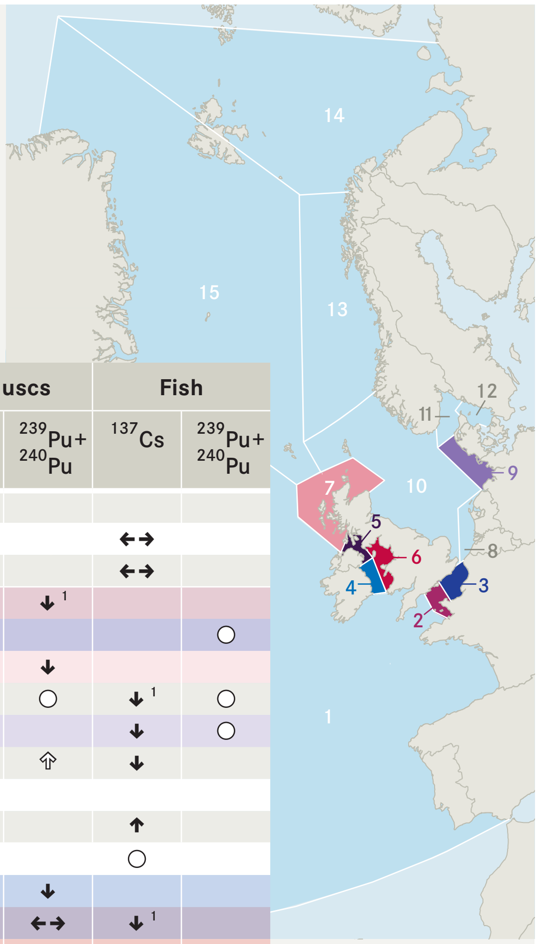
It was not always possible to compare the mean concentrations for the period 2002–2006 with the corresponding concentrations for the baseline period (1995–2001) or to undertake statistical analysis. This was due to a lack of data or because too many values were below the limits of detection → **FIGURE 6.5-A**. In some cases, only one of the two statistical tests applied provided evidence for a significant change. Of the 24 cases where both statistical tests gave strong evidence for a change between the baseline period and the assessment period, the change was a reduction in every case but one (^{137}Cs in fish in the Kattegat).

There are statistically significant falls relative to the baseline period in the mean concentration of ^{137}Cs in seawater, seaweed, molluscs and fish in many of the monitoring areas in Regions II and III → **FIGURE 6.5-A**. Statistically significant changes in indicator radionuclides other than ^{137}Cs vary across the 15 monitoring areas, especially for seawater. The changes in mean concentrations of other radionuclides than ^{137}Cs in seaweed, molluscs and fish are more consistent, with decreases relative to the baseline period in a number of monitoring areas in Regions II and III. This is particularly apparent in parts of the Channel (monitoring area 2) and the Irish Sea and Scottish waters (monitoring areas 4 and 7), due to the reductions in discharges from La Hague (France) and Sellafield (UK). The higher ^{99}Tc discharges from Sellafield in the mid- to late 1990s are

FIGURE 6.5

A: *Summary of statistical tests on mean concentrations in 2002–2006 relative to the baseline period (1995–2001) by OSPAR Region, monitoring area, environmental compartment and radionuclide.*

B: *Time series of environmental concentrations (1995–2006) for some indicator radionuclides and matrixes with statistically significant change between assessment and baseline period.*



A

OSPAR Regions and monitoring areas		Seawater ^{3}H	Seawater ^{137}Cs	Seawater ^{99}Tc	Seawater $^{239}Pu+^{240}Pu$	Seaweed ^{137}Cs	Seaweed ^{99}Tc	Molluscs ^{137}Cs	Molluscs $^{239}Pu+^{240}Pu$	Fish ^{137}Cs	Fish $^{239}Pu+^{240}Pu$
Region I	13		⇩	←→	←→	←→	←→				
	14		○	←→	←→					←→	
	15		⬇		←→	⬇ [1]	←→			←→	
Region II	2	⇩ [1]	○			⬇ [1]	⬇		⬇ [1]		
	3	○	○			⇧ [1]	⬇ [1]				○
	7	○	○			⬇ [1]	⬇		⬇		
	8	←→	○		○				○	⬇ [1]	○
	9	⇧ [1]	⬇	○	←→					⬇	○
	10	⇧ [1]	←→	○	←→		←→		⇧	⬇	
	11		←→	←→	←→	←→	←→				
	12	○	⇧ [1]	⬇		⬇	←→			⬆	
Region III	1	⇩ [1]	○	○		⇩ [1]	○			○	
	4		⬇	⇩		⬇	⬇		⬇		
	5		⬇				←→		←→	⬇ [1]	
	6	←→ [1]	⬇	←→			⇩	⬇	←→		
	7	○	○			⬇ [1]	⬇		⬇		
Region IV	1	⇩ [1]	○	○		⇩ [1]	○			○	

Change in concentration:
↓ Downward; ↑ Upward; ←→ No change
⬇ Confirmed by two statistical tests
⇩ Confirmed by one of two statistical tests

○ Data do not allow statistical tests
1 Some/most data for baseline and/or assessment period are below detection limit

Blank field: no data

B

reflected in peaks of this radionuclide in seaweed (monitoring areas 4 and 7) → **FIGURE 6.5-B**. However, some monitoring areas in Regions I and II still have elevated concentrations of radionuclides due to out-flowing Baltic Sea water contaminated with radionuclides from the 1986 Chernobyl accident → **FIGURE 6.6** or due to the remobilisation of radionuclides from Irish Sea sediments from past discharges and their transport by the prevailing ocean currents. Concentrations in monitoring areas in Region I mostly show no change because concentrations in water and biota are very low. Given the limited data for Region IV, few statistical changes can be determined. There are no monitoring data for Region V.

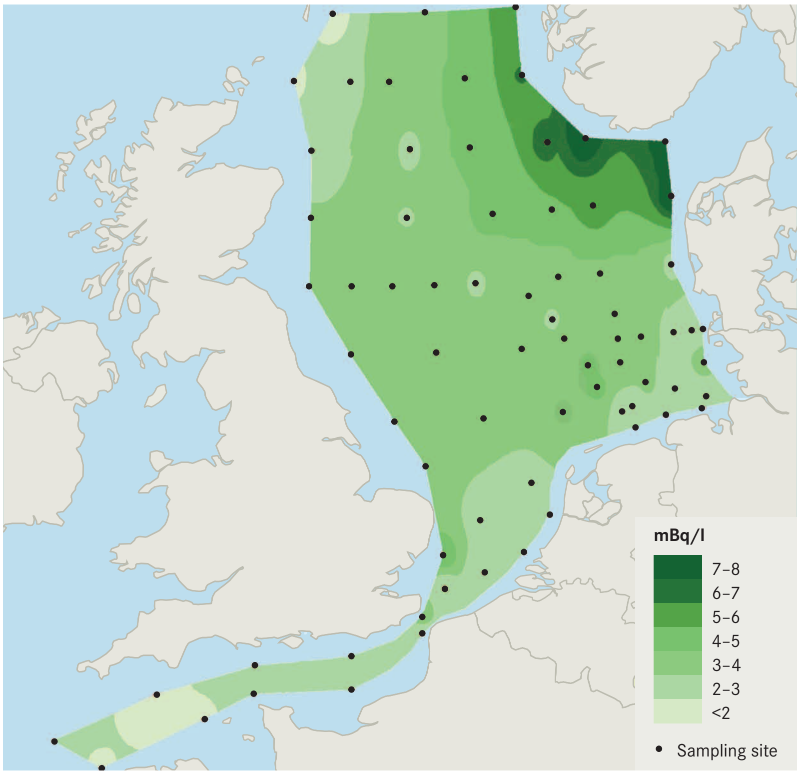


FIGURE 6.6 *Distribution of ^{137}Cs concentrations in the North Sea in summer 2005 showing the influence of the Chernobyl fallout from the Baltic Sea.*

Source	Radionuclide	Maximum doses (µSv/yr)
Nuclear sector	^{3}H	0.01
	^{99}Tc	1
	^{137}Cs	1
	^{239,240}Pu	1–10
Offshore oil and gas industry	^{210}Po	10–1000
	^{210}Pb	1–10
	^{226}Ra	10
	^{228}Ra	10

Elevated concentrations of naturally occurring radionuclides difficult to detect

Concentrations of naturally occurring radionuclides in seawater or marine organisms represent total environmental concentrations, i.e., both natural background concentrations and any contributions from the offshore oil and gas industry. OSPAR has not assessed trends in concentrations of naturally occurring radionuclides associated with discharges from the offshore oil and gas industry due to the limited amount of data available. As concentrations of these radionuclides from natural sources vary considerably within the OSPAR area, it is difficult to detect elevated levels originating from offshore oil and gas activities. Further work is needed to improve data availability and to assess the significance of naturally occurring radionuclides being discharged from the offshore oil and gas industry.

Doses to man are well below internationally accepted dose limits

Doses to man from seafood consumption have been calculated in two ways, either from reported levels of radionuclides in seafood or by modelling the possible uptake by seafood of radionuclides measured in seawater. The estimated doses to man from radionuclides associated with the nuclear sector cover a wide range of values → **TABLE 6.2**, but are well below the current international dose limit of 1000 µSv/yr set by the IAEA and EU for members of the public arising from all practices involving radioactive materials. ^{137}Cs and ^{239,240}Pu represent most of the total dose arising from discharges from the nuclear sector. In comparison, doses from naturally occurring radionuclides (e.g. ^{210}Po) can be up to one thousand times higher than those arising from ^{137}Cs and ^{239,240}Pu. Doses calculated for the naturally occurring radionuclides include the natural background concentration and should not be taken as coming entirely from the oil and gas industry.

Impacts on biota are unlikely

OSPAR has considered knowledge available on the impact of environmental radioactivity on marine life and its application to the OSPAR area. An EU project has recently proposed a method – ERICA (Environmental Risk from Ionising Contaminants: Assessment and management) – to assess and manage environmental risk from radioactive substances. The ERICA environmental risk assessment methodology sets a screening value of 10 µGy/h to characterise the potential risk to the structure and function of marine ecosystems. This is the lowest level at which effects at the ecosystem level are likely to occur according to current scientific understanding. According to the data available,

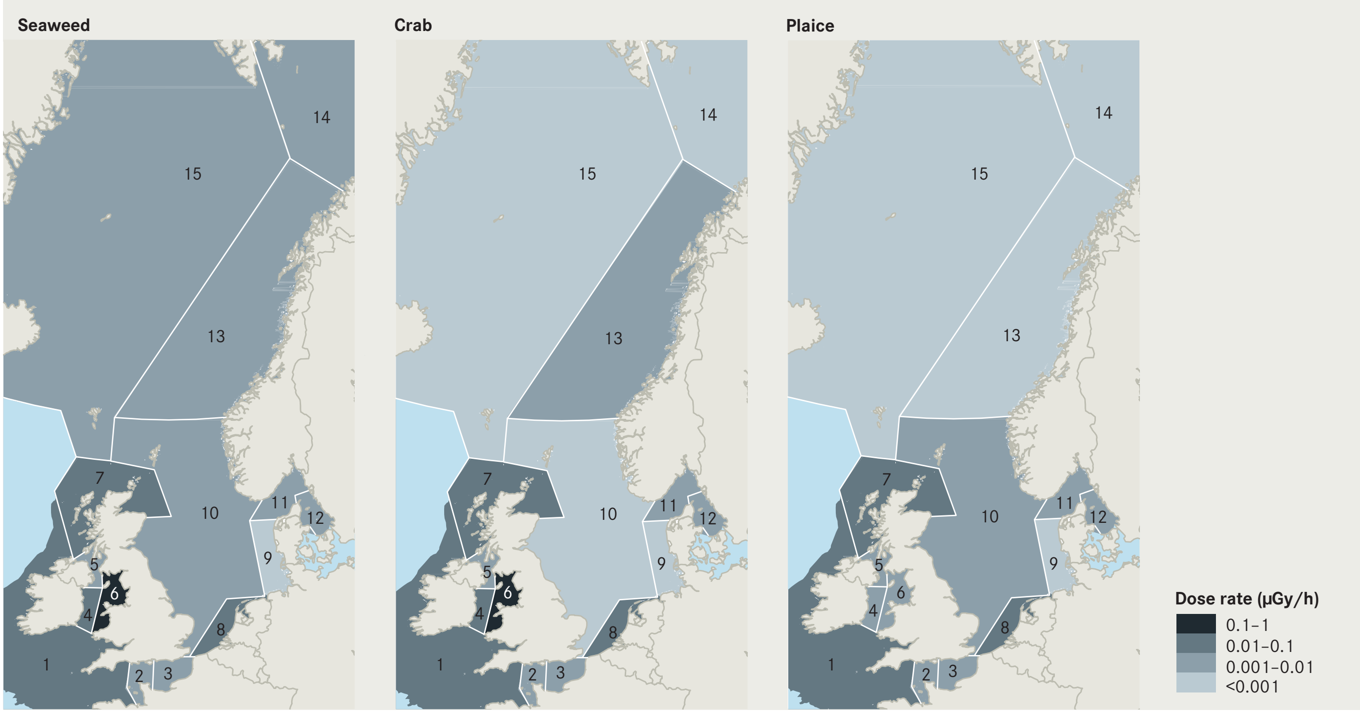


FIGURE 6.7 *Maximum total dose rates to seaweed, crab and plaice estimated from data on concentrations of the assessment radionuclides (^{137}Cs, ^{99}Tc, $^{239,240}Pu$) in seawater in 2006.*

calculated dose rates to marine biota are below this screening value. In the OSPAR area, the highest dose rates to biota occur in the Irish Sea near Sellafield (monitoring area 6). Monitoring areas 9 to 15 have the lowest dose rates → **FIGURE 6.7**.

What happens next?

Progress made for the nuclear sector but efforts must continue

To date, progress on reducing discharges of radioactive substances has focused on the nuclear sector. This sector accounts for the main inputs to the marine environment of β-emitting radionuclides in the OSPAR area, mostly in Regions II and III. For some radionuclides such as tritium, reduction technologies at an industrial scale are not currently available. OSPAR countries have reduced discharges of specific radioactive substances from the nuclear sector, reported the application of BAT, and determined doses to humans and marine biota. National reporting provides the following evidence:

- Total β-activity discharges (excluding tritium) from the nuclear sector, in particular discharges of ^{99}Tc, have fallen and related concentrations in seawater and biota have decreased in a number of monitoring areas.
- The effect of discharges and concentrations of radioactive substances from the nuclear sector on the overall quality status of the OSPAR area and doses and impacts on humans and biota are considered low.
- In Regions I and II, elevated concentrations of certain radionuclides are mainly due to the transport of these radionuclides by ocean currents.

However, there are currently too few data to show conclusively whether the objective of the Radioactive Substances Strategy for 2020 will be met. Abatement at source is still important, based on the precautionary approach and the principle of prevention, and BAT must continue to be applied and developed to minimise the impact of radioactive discharges.

Progress on the non-nuclear sector cannot yet be assessed

Best estimates suggest that a substantial contribution to the releases of radioactive substances in the OSPAR area is made by the naturally occurring radionuclides discharged with produced water from the offshore oil and gas industry, which is concentrated in Regions II, III and the Norwegian Sea (Region I). Additional discharges from offshore installations result from descaling operations. Inputs to the sea of radioactive substances from medical uses are minor compared to those from the nuclear sector and the offshore oil and gas industry. Collection of data for the non-nuclear sector and the associated indicator radionuclides only began in 2005, so the time series available are too short to assess trends in discharges, concentrations and doses in the marine environment. OSPAR should endeavour to assess the contribution of the non-nuclear sector to the pollution of the OSPAR area by radioactive substances and to identify appropriate management measures for implementation by OSPAR countries.

Evidence base and assessment tools must improve

OSPAR should improve the evidence base and assessment tools for evaluating progress towards the OSPAR objectives for all indicator radionuclides from the nuclear and non-nuclear sectors. OSPAR should achieve this by the following:

- Continue to collect systematically data on discharges and concentrations of the indicator radionuclides.
- Further develop tools to estimate and assess doses to evaluate impacts of discharges on the environment.
- Further develop statistical trend analysis techniques, taking advantage of experience gained in other contexts.
- Develop environmental quality criteria for the protection of the marine environment against adverse effects of radioactive substances.

Delivering OSPAR Strategy objectives for radioactive substances

→ LEGEND: BACK-COVER FOLD-OUT

OSPAR Region	Reduce discharges of radioactivity[1]	Change[1] in environmental radioactivity from assessed radionuclides	Key factors and pressures	Outlook for pressures	Action needed
Region I	Nuclear industry: none Offshore oil/gas industry: **?**	←→ * *	Offshore oil and gas industry Transport of nuclear discharges (Regions II, III) Legacy discharges Transport of Chernobyl fallout	?	OSPAR OSPAR
Region II	Nuclear industry: ↓ * * * Offshore oil/gas industry: **?**	←→ * *	Nuclear industry Offshore oil and gas industry Transport of nuclear discharges (Region III) Legacy discharges Transport of Chernobyl fallout	?	OSPAR OSPAR
Region III	Nuclear industry: ↓ * * * Offshore oil/gas industry: **?**	↓ * *	Nuclear industry Offshore oil and gas industry Legacy discharges	?	OSPAR OSPAR
Region IV	Nuclear industry: ↓ * * * Offshore oil/gas industry: non-discharging	←→ *	Nuclear industry	?	OSPAR OSPAR
Region V	Nuclear industry: none Offshore oil/gas industry: none	No data	Transport of legacy and contemporary nuclear discharges (Region III)	?	OSPAR

[1] *Mean of period 2002–2006 relative to mean of baseline period 1995–2001.*

7 OFFSHORE OIL AND GAS INDUSTRY

Oil discharges with produced water have fallen on average by 20 % in the OSPAR area and most countries have met the OSPAR 15 % reduction target, but volumes of produced water are expected to increase. Pollution from drilling fluids and cuttings piles has been considerably reduced. Impacts of offshore oil and gas activities have reduced around some installations, but the evidence base for environmental impacts is limited.

OSPAR Contracting Parties should cooperate
→ to continue efforts to phase out discharges of hazardous substances and reduce discharges of oil through a risk-based approach to management of produced water;
→ to consider the suitability of existing measures to manage oil and gas activities in Region I;
→ to continue monitoring and assessment and improve the evidence base for evaluating the impacts of the offshore industry on marine ecosystems.

Key OSPAR assessments
→ Overall impacts of offshore oil and gas activities
→ Environmental effects of releases of oil and chemicals from cuttings piles
→ Environmental monitoring of impacts from offshore oil and gas activities

Offshore oil and gas activities have developed in the OSPAR area over the past 40 years. Environmental impacts occur throughout the lifecycle of these activities, including during the exploration, production and decommissioning phases. Exploration includes seismic surveys and the drilling of exploratory wells. Production includes the drilling of production wells, and the construction, placement and operation of infrastructure (e.g. platforms, pipelines). Decommissioning, the final phase of an oil and gas field development, involves activities such as the plugging of wells and removal of infrastructure. The transportation of oil and gas by pipeline or tanker has the potential to cause impacts outside the area of production.

OSPAR works under the Offshore Oil and Gas Industry Strategy to establish environmental goals and measures to prevent pollution and protect the marine environment, consistent with the objectives set by OSPAR, especially those for hazardous substances → **CHAPTER 5** and for radioactive substances → **CHAPTER 6**.

OSPAR Strategy objectives for the offshore oil and gas industry
→ **Prevent and eliminate pollution and take the necessary measures to protect the maritime area against the adverse effects of offshore activities.**
→ **Safeguard human health and conserve marine ecosystems and, when practicable, restore marine areas which have been adversely affected.**

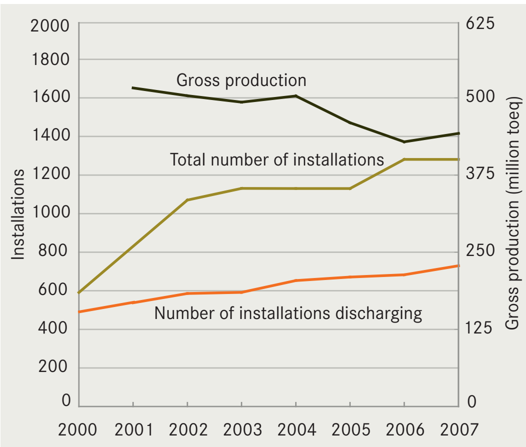


FIGURE 7.1 *Numbers of offshore installations and total production of oil and gas (2000–2007). The increase in the number of installations between 2001 and 2002 is mainly due to a change in the way of counting installations. Offshore installations are any man-made structures, plants or vessel or parts thereof, whether floating or fixed to the seabed, that are placed within the OSPAR area for the purpose of offshore activities.*

What are the problems?

Pressures are greatest in the North Sea and expected to increase in the Arctic

The total amount of oil and gas produced within the OSPAR area has decreased by about 14 % since 2001 to around 442 million tonnes of oil equivalents (toeq) in 2007, while the number of offshore installations has increased → **FIGURE 7.1**. This indicates a trend towards the development of smaller fields. In 2007, around 60 % of all operational installations reported air emissions and discharges to the sea as a result of oil and gas extraction.

A network of pipelines connects the oil and gas fields with the onshore distribution network → **FIGURE 7.2**. The OSPAR area has more than 50 000 km of pipelines transporting oil and gas products from around 1300 installations.

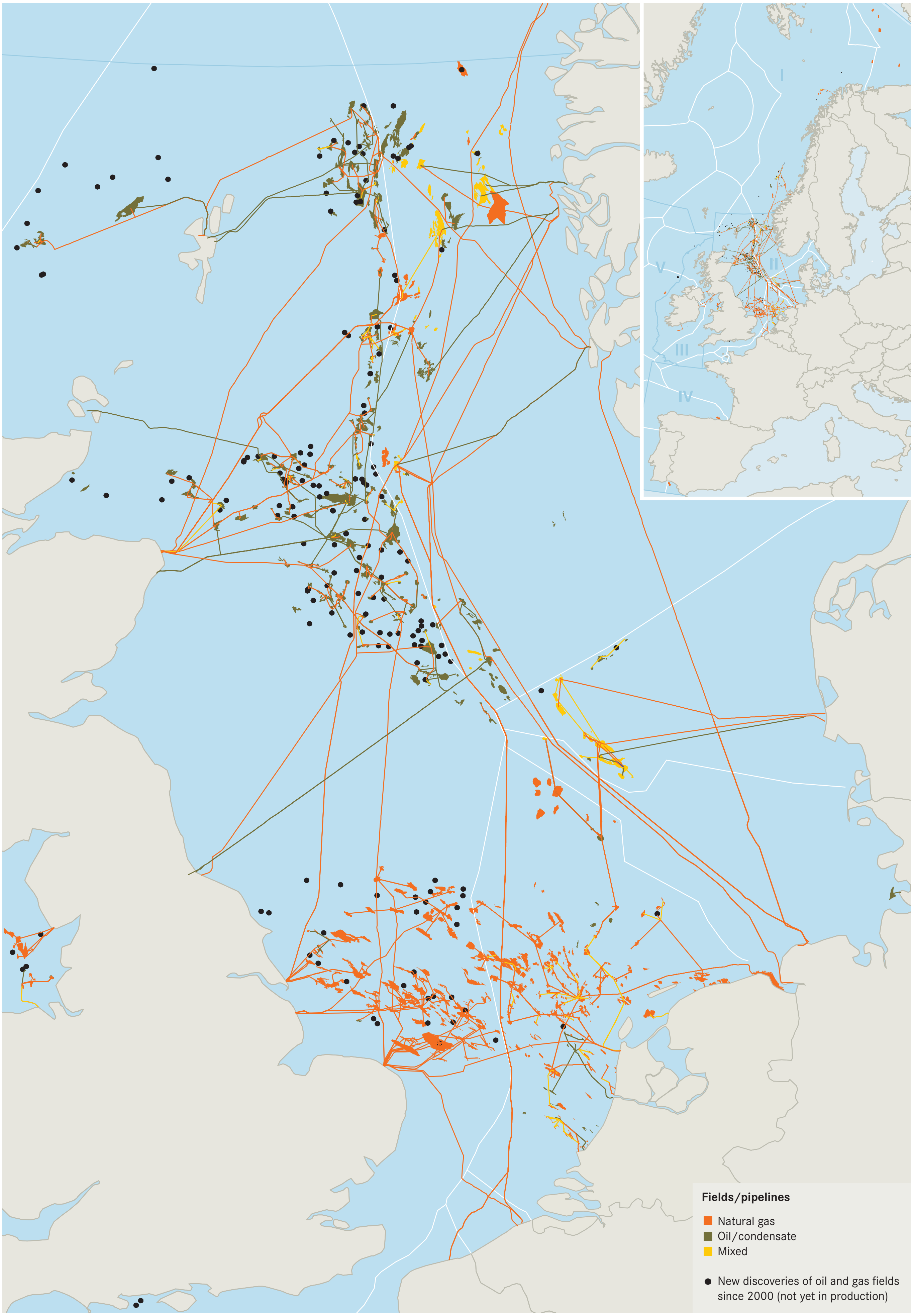


FIGURE 7.2 *Offshore oil and gas fields under exploitation, new discoveries not yet in production and pipelines in 2009.*

The major offshore oil and gas developments within the OSPAR area are in the North Sea and Norwegian Sea; oil and gas in the northern North Sea and Norwegian Sea and mostly gas in the southern North Sea. Some production also takes place in the Irish Sea and Celtic Sea (gas only), the Bay of Biscay, the Gulf of Cadiz (gas only), and the Barents Sea → **TABLE 7.1**. There is exploration for oil and gas in Region V, but as yet no production.

Environmental pressures from offshore oil and gas operations are greatest in Region II. However, oil and gas production has peaked in the North Sea and is now declining. For other parts of the OSPAR area, such as the Barents Sea, production is expected to increase. This is due to rising global demand and increased access to Arctic resources as sea ice retreats following the rise in global temperature. Some large projects are already underway, for example, the development of the *Shtokman* field in the Russian Barents Sea. A significant proportion of the world's known oil and gas reserves are in the Arctic, with offshore areas of Greenland, the Faroe Islands, Iceland, northern Norway and Arctic Russia of particular interest. Increased production in Region I will bring an increase in environmental pressure. Marine ecosystems in the Arctic are considered to be particularly sensitive to impacts from offshore activities and effective management of oil spills and other impacts is important.

Different pressures on the marine environment

Routine operation of production platforms leads to the release of oil, chemicals and naturally occurring radioactive materials to the sea, especially through discharges of produced water and partly from drill cuttings → **FIGURE 7.3**. Accidental oil spills can arise from different sources during operation.

The main source of oil discharge from routine production is produced water. This is the water that comes from the reservoir along with the oil. Produced water contains hazardous substances occurring naturally in the reservoir, such as heavy metals, aromatic hydrocarbons, alkyl phenols and radionuclides. Produced water also contains residues of chemicals used in the production process, including corrosion inhibitors and demulsifiers (chemicals that increase the separation of oil from water).

Drilling requires the use of fluids that may contain a range of chemicals. These chemicals may be water-based or based on organic-phase fluids (e.g. lighter oil fractions and synthetic fluids). Drilling fluids are generally recycled and are only disposed of once spent, but a small amount binds to rock fragments (cuttings) and is disposed of with the rest of the solid material removed from drilled rock. These cuttings can accumulate in piles at drilling sites. Old cuttings piles may contain oil (drilling fluids used to be mainly oil-based) and other contaminants and these are released into the sea over time. This is especially the case if these old cuttings piles get physically disturbed, for example by work around platforms or trawling. At some sites, cuttings are re-injected into the seabed to reduce their environmental impact, but there is some concern that this contaminated material could break through to the seabed.

TABLE 7.1 *Oil and gas production in OSPAR countries in 2007.*

Region	Oil production (million toeq)	Gas production (million toeq)
Region I	24.3	31.1
Region II	205.4	172.8
Region III	0.9	7.2
Region IV	0.007	0.0
Region V	0.0	0.0
Total	230.6	211.1

Other pressures from oil and gas activities include emissions of volatile organic compounds, methane, sulphur dioxide, nitrogen oxides and carbon dioxide to the atmosphere. Chemicals can leak, for example, from pipeline valves and leach from coatings and anodes of pipelines and subsea structures. The seabed is physically disturbed when pipelines, cables, subsea structures and platforms are installed. Construction of offshore installations, drilling and seismic surveys during exploration are also sources of underwater noise → **CHAPTER 9**. Carbon dioxide storage in sub-seabed geological formations such as abandoned oil and gas wells is an emerging offshore activity and will for example involve drilling of injection wells and placement of offshore installations → **CHAPTER 3**.

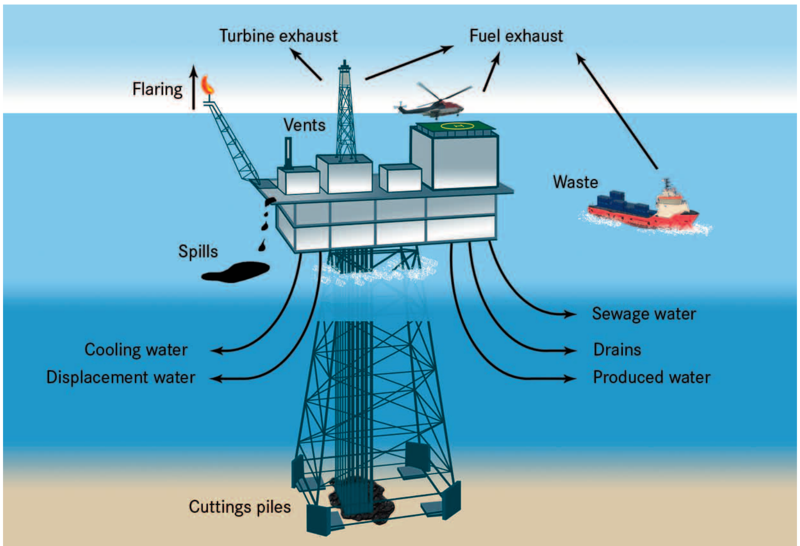


FIGURE 7.3 *Substances are released from a range of sources during routine offshore oil and gas production.*

TABLE 7.2 *OSPAR measures to manage pressures from the offshore oil and gas industry.*

Discharges of chemicals and oil	
	Decision 2000/3: Restriction of use and discharges of organic-phase drilling fluids and contaminated cuttings Recommendation 2006/5: Management of offshore cuttings piles Recommendation 2001/1: Management of produced water and 15% reduction target for oil discharged with produced water
Use of chemicals offshore	
	Decision 2000/2: Harmonised Mandatory Control System to manage use and discharges of chemicals offshore Recommendation 2000/4: Harmonised chemical pre-screening scheme Recommendation 2000/5: Harmonised chemical notification Recommendation 2005/2: Phase out of OSPAR priority chemicals Recommendation 2006/3: Phase out of candidate substances for substitution
Decommissioning	
	Decision 98/3: Ban of disposal of disused offshore installations
Environmental management	
	Recommendation 2003/5: Promotion of use and implementation of environmental management systems

Parts of Brent Spar being brought ashore for disposal

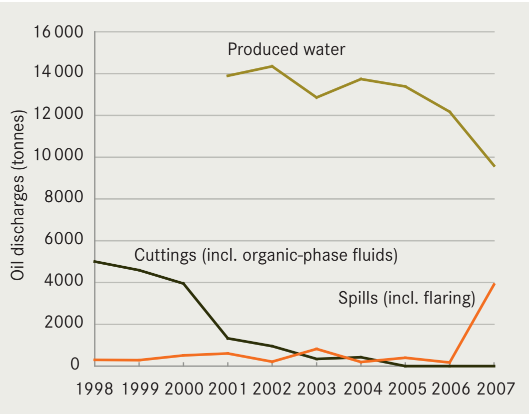


FIGURE 7.4 *Annual discharges of oil from the different sources within the offshore oil and gas industry (1998–2007). A new OSPAR reference method for the analysis of dispersed oil in produced water has been implemented since 2007. This partly explains the reduction between 2006 and 2007 in discharges of oil in produced water. A single large oil spill in Norway in 2007 accounts for the steep increase in oil spills compared to previous years.*

What has been done?

Potentially polluting activities are subject to a wide range of measures

Although international organisations such as the EU and the International Maritime Organization have developed environmental measures relevant to the offshore industry, OSPAR is the key international organisation addressing environmental aspects of offshore oil and gas activities in the North-East Atlantic.

OSPAR has adopted a wide range of programmes and measures to reduce pollution from all phases of offshore activities → **TABLE 7.2**. These include the reduction of oil in produced water, substantial restrictions on the use and discharge of organic-phase drilling fluids, and the banning of dumping or leaving in place disused offshore installations, subject to derogation in certain specified cases. Nearly all offshore operators have now followed OSPAR's promotion of environmental management systems for offshore installations to support the objectives of the Offshore Oil and Gas Industry Strategy and have adopted comparable schemes.

OSPAR countries are also committed to phasing out discharges of certain chemicals used offshore and to do so by 2010 for OSPAR priority chemicals and by 2017 for substances identified by OSPAR as candidates for substitution. OSPAR has continued to promote a shift towards the use of less hazardous substances, or preferably non-hazardous substances, in the offshore industry through its harmonised mandatory control system. Using harmonised notification formats and harmonised pre-screening procedures for offshore chemicals, decisions on the regulation of offshore discharges have become more transparent and more predictable. There is a need to bring the harmonised mandatory control system further in line with the EU REACH Regulation.

Did it work?

Oil discharges have been reduced

Produced water has been the major source of oil discharges from the offshore oil and gas industry over recent years, with the small remainder mostly from accidental oil spills → **FIGURE 7.4**. Although the overall volume of produced water generated has increased with the increasing age of the fields, the amount of produced water discharged has remained reasonably constant since 2000 as more produced water is injected into sub-surface formations. Most countries have met and partly exceeded the OSPAR target of a 15% reduction in the total amount of oil in produced water, leading to an overall decrease of more than 20% in the OSPAR area between 2000 and 2006 → **FIGURE 7.5**. This has been achieved through injection of produced water and the considerable efforts of the offshore industry to optimise processes and introduce new water treatment technology.

Most oil spills are small

Accidental oil spills arise from several sources, including pipelines, valves and broken hoses, and during offloading and filling of tanks. More than 95% of all spills are less than one tonne in volume → TABLE 7.3. As infrastructure ages, the risk of accidents (e.g. leakage from older pipelines) may increase, resulting in more spills of oil and chemicals in future.

The frequency of small oil spills has progressively declined since 2000 while the number of larger spills has remained relatively stable. The volume of oil spilled varies widely from year to year. In 2006, around 170 tonnes of oil were spilled, whereas almost 4000 tonnes were spilled in 2007. The total for 2007 is dominated by a single large oil spill off Norway in which the amount of oil spilled was almost as much as the total discharged in produced and displacement water for the whole OSPAR area in 2007. The time and place of a spill are important; a relatively small spill can have a greater impact for example during the spawning season than a much larger spill at a different time.

Discharges of contaminated cuttings have largely stopped

Cuttings from wells drilled with water-based drilling fluids are discharged to sea in most OSPAR areas, whereas cuttings from wells drilled with organic-phase drilling fluids (which are still used in lower sections of wells) are re-injected into sub-surface formations in line with OSPAR measures or transported onshore for treatment and disposal. Discharges of drill cuttings contaminated with oil and organic-phase drilling fluids largely ceased in 2005. Cuttings contaminated by oil at levels below 1% can still be discharged to sea. Technologies which can clean cuttings to below 1% oil are now available for offshore facilities. Recent assessments of the potential for pollution from old cuttings piles through leaching or as a result of disturbance (e.g. decommissioning, trawling, dredging) indicate no significant impacts and that their management could be addressed by OSPAR countries as part of the decommissioning plan for the installation.

Discharges of priority chemicals are 90% lower than in 2003

Comprehensive data on the use and discharge of chemicals are only available for 2003 onward. Since then, the amount of chemicals used offshore has increased, but there has been a slight decrease in the amount discharged → FIGURE 7.6.

Around 900 000 tonnes of chemicals were used offshore in 2007 of which 250 000 tonnes were discharged to sea. Most substances used and discharged offshore pose little or no risk (PLONOR) to the marine environment; in 2007 almost 87% of chemicals discharged were PLONOR substances. This includes substances such as barite (barium sulphate) used in large volumes as a weighting agent in water-based drilling muds, methanol used as gas hydrate inhibitor or potassium chloride

Fluorescence imaging of cuttings piles

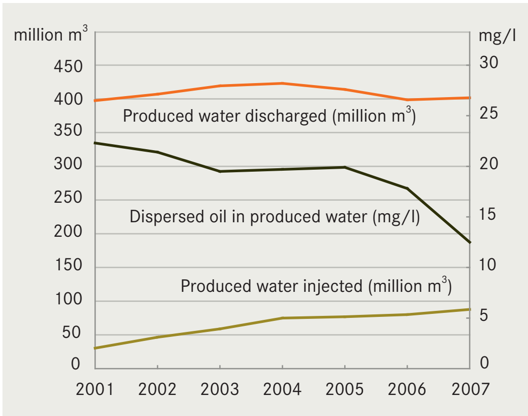


FIGURE 7.5 *Annual amounts of produced water discharged and injected (2001–2007).*

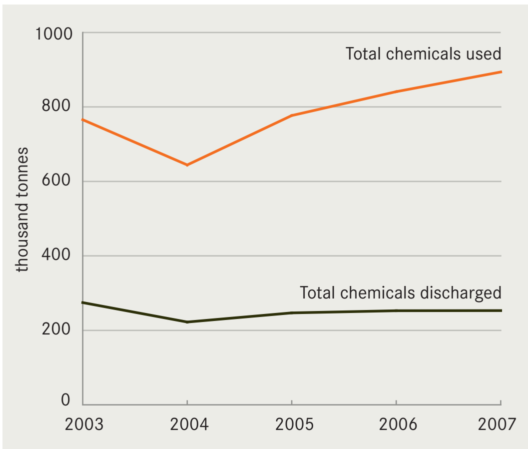


FIGURE 7.6 *Total use and discharge of chemicals offshore (2003–2007).*

TABLE 7.3 *Number and total quantities of oil spilled in small (≤1 tonne) and large oil spills in the OSPAR area.*

Spills		2000	2001	2002	2003	2004	2005	2006	2007
> 1 t	Number	22	25	27	19	24	17	15	22
	Quantity, tonnes	454	537	158	744	157	345	135	3882
≤ 1 t	Number	700	743	774	602	654	638	494	493
	Quantity, tonnes	60	68	56	80	42	54	38	25

used in brine solutions in drilling and completion of wells. About 2500 tonnes of the chemicals discharged in 2007 were substances identified by OSPAR for priority action or substances that should be substituted by less hazardous substances. Discharges of substances identified by OSPAR for priority action have been reduced by around 90 % since 2003. This is mostly due to their substitution by less hazardous alternatives. Also, concentrations of naturally occurring heavy metals in produced water are generally low.

Most offshore structures are brought ashore for disposal

Since the ban on dumping of, or leaving in place, disused offshore installations in 1999, 122 offshore installations have been brought ashore for disposal. In this period, permits have been issued for four concrete sub-structures and the footings of one large steel structure being left in place. The decommissioning of the *Frigg* field is one example → BOX 7.1. Derogations from the dumping ban may be considered for 59 steel installations with a substructure of more than 10 000 tonnes, and 22 gravity-based concrete installations.

Some emissions to air are decreasing

Carbon dioxide accounts for the greatest proportion of emissions to air from offshore installations with around 32 million tonnes emitted in the OSPAR area in 2007. Emissions of carbon dioxide and nitrogen oxides have been relatively stable since 1999, while sulphur dioxide and methane emissions have been substantially reduced. Emissions of non-methane volatile organic compounds have halved. Measures taken by operators to reduce fugitive emissions (gas escapes, for example, from leaks or processes) and the use of vapour recovery systems at off-loading facilities have helped reduce emissions of methane and other volatile organic compounds → FIGURE 7.7.

Flaring

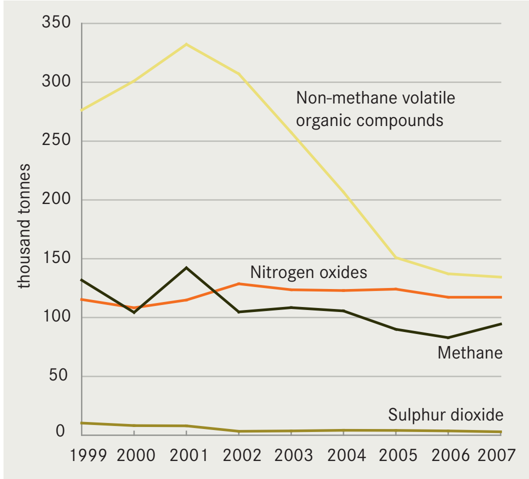


FIGURE 7.7 *Emissions to air from the offshore industry (1999–2007).*

How does this affect the quality status?

Areas affected by contaminated drill cuttings have reduced

Based on the collected evidence, environmental conditions around many installations have improved, especially in Region II. This Region had high, but very localised, impacts throughout the 1980s and 1990s. After further restrictions in use and discharge of organic-phase drilling fluids in 2001, monitoring at Danish, Netherlands’, Norwegian and UK rigs has shown that sediment oil concentrations have reduced significantly and that the benthic fauna have started to recover.

The *Ekofisk* field in the Norwegian sector is an example of a mature production site which has been in operation since the early 1970s. The restrictions in use and discharge of oil-based drilling fluids and the recent decline in oil and gas activities at the site have resulted in reduced discharges and decreasing sediment concentrations of oil and barium (from barite). This has led to a clear recovery of the sediment dwelling animal communities; the area disturbed fell by 85 % to less than 20 km^2 between 1996 and 2005. In contrast, areas impacted by oil and barium sulphate and with disturbed benthic fauna are still increasing at younger oil and gas production sites.

Areas contaminated by cuttings piles have also been reduced through natural erosion and because the oil leaching rate is now lower than when the cuttings were first deposited. Possible releases of oil and chemicals from old cuttings piles that are physically disturbed do not appear to be causing increased impacts on the environment.

BOX 7.1 Decommissioning of *Frigg* – a joint effort

Frigg is the largest decommissioning project ever in the OSPAR area. It is a transboundary gas field with six platforms straddling the UK and Norwegian sectors.

The UK and Norway have cooperated closely since the project began in the 1970s. A bilateral treaty allowed the field to develop and operate as a single unit, starting in 1977. Both governments approved the decommissioning of the three concrete structures on the UK shelf and the three structures (one concrete) on the Norwegian shelf following the end of exploitation in 2004. National authorities and the operator collaborated on a single cessation plan for the field, which included a comprehensive environmental impact assessment. OSPAR Decision 98/3 was followed throughout the process and OSPAR countries have been consulted.

The *Frigg* concrete sub-structures are allowed to remain in place. This was considered the most environmentally friendly option, taking into account considerations such as the potential carbon dioxide (CO_2) emissions involved in the different disposal alternatives. These ranged from 265 000 tonnes CO_2 for refloat and disposal onshore to 14 000 tonnes for leaving concrete structures in place. External steel structures are being removed and disposed of on land. The operator must recycle as much of the equipment and material as practicable, applying most appropriate techniques and best environmental practice. The decommissioning plan includes measures to mitigate and reduce environmental impacts.

Frigg field in operation in 2004 (upper) and Frigg sub-structures after decommissioning, started in 2008 (lower)

Water column monitoring shows mostly low biological response

Water column monitoring to determine possible effects from polycyclic aromatic hydrocarbons (PAHs) and other chemicals such as alkyl phenols discharged with produced water has been carried out to a limited extent in the OSPAR area.

Monitoring in the Netherlands' sector has shown that caged blue mussels accumulate the PAH naphthalene up to 1000 m from a platform. Water column monitoring in the Norwegian sector began in 1999 and has shown that caged blue mussels exposed to produced water discharges accumulate PAHs from the surrounding seawater. These concentrations decreased with increasing distance from the point of discharge. Levels of biological responses in caged mussels showed similar gradients to those for contaminant concentrations.

Concentrations of PAHs and alkyl phenols and measured biological responses in wild fish such as cod and haddock caught in the vicinity of offshore installations from Norwegian waters in 2002 and 2005 showed a mixed pattern mostly with no increased concentrations, but some elevated biological responses suggesting past exposure.

The results from water column monitoring are complex to interpret, particularly for wild fish for which it is not possible to link observed biological responses to a specific exposure source. Monitoring data are limited and do not yet allow conclusions to be drawn on the significance of the observed biological responses for marine life and ecosystems.

Recovery from physical impacts may be longer for sensitive species

Temporary physical impacts are caused when structures like platforms and pipelines are first put in place. These temporary physical impacts are more extensive than the long-term impacts of the structure. Disturbance from trenching and/or burying pipelines is greater than when pipelines are just laid on the seabed. Temporary impacts usually occur between 5 and 10 m from the pipeline, although this is influenced by size of the pipeline, sediment type and trenching method.

Creating hard substrates such as pipelines, platform legs and subsea templates in soft-sediment areas provides shelter for fish and other mobile marine organisms, but alters the benthic communities by providing settling areas for hard-substrate communities.

Deployment of a net cage to expose fish and mussels for water quality monitoring at the Ekofisk oil field

Potential environmental impacts vary across the OSPAR area, depending on differences in bottom topography, geology, water mass movement and biology. Recovery may take longer for sensitive species and in deeper and colder waters. Soft-bottom fauna can recolonise within a year or two, especially in shallow waters with a sandy/muddy seabed.

What happens next?

Environmental status has improved

Cooperation between OSPAR and the offshore industry has allowed a range of issues to be addressed, including discharges of produced water and the use and discharge of chemicals. This cooperation has also supported the introduction of environmental management systems by operators.

The target of a 15 % reduction in oil discharges in produced water has been achieved at the OSPAR level, set against a trend for increasing produced water generation. The increase in produced water is due to the maturing of oil reservoirs, particularly in Region II. Injection of produced water has proved technically challenging for some installations, mainly due to reservoir properties. Substitution of certain chemicals by other less hazardous chemicals has also proved technically challenging. Impacts of offshore oil and gas activities have reduced around some installations but the evidence base is limited. Concerns over impacts of the offshore industry on the marine environment continue, especially those relating to oil and chemicals discharged with produced water, impacts from historic cuttings piles and atmospheric emissions.

Further management efforts are needed to address all impacts

OSPAR should address the following priorities for action:

- Continue to work towards the target for ceasing discharges, emissions and losses of hazardous substances and achieving a reduction of oil in produced water discharged to the sea to a level which will ensure that the discharges will present no harm to the marine environment by 2020.
- Move towards a risk-based approach to managing produced water that embraces more substances than oil.
- Consider aligning the management of chemicals used and discharged offshore (substances covered, the data and information base, and management criteria) through OSPAR's harmonised mandatory control system with the requirements of the EU REACH Regulation.
- Continue monitoring and assessment and improve the evidence base for future assessments of the impacts of the offshore industry on marine ecosystems.

OSPAR should examine whether there are specific issues relating to ageing installations and infrastructure and, if required, develop appropriate measures, taking into account possible extensions in the life of infrastructures. OSPAR should also investigate the impact of underwater noise from the offshore oil and gas industry and, as appropriate, develop guidance on best practice for its mitigation.

Oil and gas production is at different stages and intensities in the OSPAR Regions. OSPAR should consider whether its current measures are suitable for the northern part of Region I where increasing oil and gas activity is expected.

Delivering OSPAR Strategy objectives for the offshore oil and gas industry

→ LEGEND: BACK-COVER FOLD-OUT

OSPAR Region	Prevent/eliminate pollution	Environmental status 1998–2006	Key factors and pressures	Outlook for pressures	Action needed
Region I	Partly achieved * * *	Improved *	Oil discharges and spills Input of contaminants Air emissions	↑	OSPAR OSPAR
Region II	Partly achieved * * *	Improved *	Oil discharges and spills Input of contaminants Air emissions	↓	OSPAR OSPAR
Region III	Partly achieved * * *	Improved *	Minor activity: Oil discharges and spills Input of contaminants Air emissions	← →	OSPAR OSPAR
Region IV	Mostly achieved * * *	?	One non-discharging installation: Air emissions	← →	OSPAR
Region V	Not applicable	Not applicable	Exploration activities: Oil spills Air emissions	?	OSPAR

8 USE OF LIVING MARINE RESOURCES

Fishing pressure continues to have a considerable impact on marine ecosystems and many problems remain despite efforts to improve management. Exploitation of many stocks continues to be beyond the levels they can sustain, while the status of a large number of stocks cannot be fully assessed due to poor data. Habitat destruction and the depletion of key predator and prey species and consequent food web effects are of concern. Mariculture is a growing activity which needs careful management to minimise potential impacts. Hunting of marine mammals is managed so that there is a low risk of depleting populations.

OSPAR Contracting Parties should cooperate

- → to achieve further reductions in fishing pressure and ensure that priority action is taken to address discarding practices, which remain a key issue, especially in EU waters;
- → to ensure that deep-water fisheries take into account the special vulnerability of both the species exploited and their habitats;
- → to keep as low as possible, and preferably eliminate, the by-catch of marine mammals, sharks, seabirds and turtles;
- → to encourage developments in scientific support for fisheries management;
- → to integrate fisheries management with wider maritime management, promoting consistency and synergy between fisheries policies and the policies regulating other maritime uses.

Key assessments

- → OSPAR assessment of the environmental impact of fishing
- → ICES assessment of the environmental impact of fishing
- → OSPAR assessment of the environmental impact of mariculture

Human use of living marine resources provides a wide range of goods and services of economic value to OSPAR countries. However, these uses exert pressure on the coastal and offshore environment which can have a wide range of impacts on marine ecosystems. Use of living marine resources covers the exploitation of marine species by man for food, feed, fertilizer or the production of other products of value or use, and includes activities such as fishing, mariculture and hunting. These activities are of high economic significance in some OSPAR countries and in some regions within countries. The QSR 2000 concluded that resolving questions on fisheries, which OSPAR recognises are most appropriately regulated through relevant international and regional agreements, was the most important issue concerned with human uses of the sea across all five OSPAR Regions.

OSPAR's Biodiversity and Ecosystems Strategy addresses both the protection of species, habitats and ecosystem processes and the management of human uses of the sea. Chapter 10 reports on progress in protecting and conserving species and habitats. This chapter, and Chapter 9, report on OSPAR's work on assessing the impacts of each human use of the sea, the action taken to reduce their impacts and the progress being made.

OSPAR Strategy objective for biodiversity and ecosystems
To protect and conserve the ecosystems and the biological diversity of the maritime area which are, or could be, affected as a result of human activities, and to restore, where practicable, marine areas which have been adversely affected.

The Strategy includes the following actions:

- → Assessment of the impact of human activities on the marine environment.
- → Drawing up of programmes and measures for controlling human activities that have an adverse impact on species and habitats that need to be protected and conserved, where this is necessary.
- → Drawing the attention of fisheries management authorities to questions where OSPAR considers that action is desirable. For this purpose, OSPAR considers the management of fisheries to include management of marine mammals.

Vigo fish market, Spain

FISHING

The OSPAR area contributes around 10 % of global fisheries yields. Fishing pressure continues to have a considerable impact on marine ecosystems and many problems remain despite efforts to improve management.

Key assessments
→ OSPAR assessment of the environmental impact of fishing
→ ICES assessment of the environmental impact of fishing

Fishing is of high economic significance for some OSPAR countries. Iceland, Norway and the Russian Federation are among the world's most important fishing nations. Fisheries products represent 20 % of national GDP for the Faroe Islands and Greenland and over 90 % of their exports. In the EU, fishing accounts for less than 1 % of total GDP but is highly significant in some regions; Denmark, Spain, France and the UK are responsible for nearly 60 % of the total EU commercial fisheries production.

Fisheries in the OSPAR area are regulated through a combination of different arrangements → FIGURE 8.1. These include national policies and regulations, the EU Common Fisheries Policy, bilateral and multilateral agreements between countries with shared stocks, and measures adopted by the three regional fisheries management organisations: the North East Atlantic Fisheries Commission (NEAFC), the International Commission for Conservation of Atlantic Tunas (ICCAT), and the North Atlantic Salmon Conservation Organization (NASCO) → TABLE 8.1.

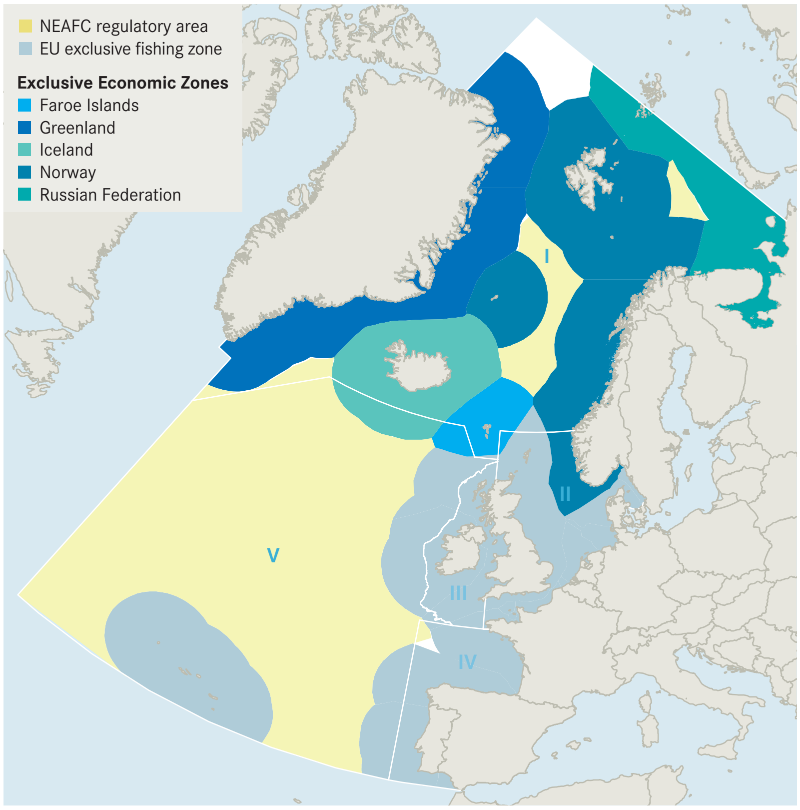


FIGURE 8.1 *Fisheries management zones in the OSPAR area. Ice-bound areas beyond national jurisdiction are shown in white. High Seas waters are shown in yellow.*

The OSPAR Convention fully recognises the competence of these authorities to regulate fisheries. OSPAR informs these fisheries authorities when it considers that there are questions where action is needed to protect and conserve the North-East Atlantic in relation to fisheries. In 2008, OSPAR and NEAFC adopted a memorandum of understanding that detailed their roles in conserving marine biodiversity within their respective areas.

What are the problems?

A range of direct and indirect effects

Fisheries have a range of direct and indirect effects on marine ecosystems. Fishing causes the death of many species including those being targeted and a range of other species such as non-targeted invertebrates and fish (including sharks), seabirds, turtles and marine mammals (seals and small cetaceans). Excessive fishing pressure on targeted species may lead to impaired reproductive capacity and a risk of stock collapse. Deep-water species have been shown to be particularly sensitive to fishing pressure. Some unwanted by-catch is discarded at sea. Discard rates have been high in some North-East Atlantic fisheries and were estimated to amount to 1.4 million tonnes in the early 2000s. Discards have been shown to affect the structure of biological communities. Fish are discarded for a variety of reasons. There are strong economic incentives in many fisheries to discard fish to maximise the value of the landing ('high-grading'). This is illegal under all fisheries policies.

Certain types of fishing gear physically disturb or damage the seabed and so affect benthic habitats and communities, including those which OSPAR has listed as threatened and/or declining, such as seamounts and cold-water coral reefs.

Fishing causes changes in community structure and marine food webs, which may be irreversible. The depletion of larger predatory species has strong effects on fish community structure. Recent research has shown that impacts from fishing on the abundance of fish can be transmitted into deep offshore areas below the maximum depth of commercial operations. While certain impacts of fishing are inevitable, one longstanding challenge of sustainable fisheries management is to minimise long-term negative effects on ecosystems while seeking long-term economic and social viability of the fisheries.

TABLE 8.1 *Bilateral and multilateral fisheries management arrangements in the OSPAR area.*

Organisation	Contracting Parties	Objective and fisheries
North East Atlantic Fisheries Commission (NEAFC)	EU, Faroe Islands, Greenland, Iceland, Norway, Russian Federation	*Objective:* long-term conservation and optimum utilization of fishery resources in order to provide sustainable economic, environmental and social benefits *Stocks:* Atlanto–Scandian herring, mackerel, blue whiting, redfish, Rockall haddock and deep-sea fisheries in the Atlantic and Arctic Oceans
International Commission for Conservation of Atlantic Tunas (ICCAT)	46, including EU, Iceland, Norway, Russia and several states whose High Seas fleets fish in the ICCAT Area	*Objective:* conservation of tunas and tuna-like species to permit the maximum sustainable catch for food and other purposes *Stocks:* ~30 High Seas species – tunas, billfish, mackerel and shark 'by-catch' in Atlantic and adjacent seas
North Atlantic Salmon Conservation Organization (NASCO)	Canada, EU, Faroe Islands, Greenland, Iceland, Norway, Russian Federation and the USA	*Objective:* to promote the conservation, restoration, enhancement and rational management of salmon stocks in the North Atlantic Ocean through international cooperation *Stocks:* Faroe Islands and Greenland High Seas salmon fisheries
The International Whaling Commission (IWC)	At present 88 Contracting Parties	*Objective:* global conservation and management of whale stocks
The North Atlantic Marine Mammal Commission (NAMMCO)	Faroe Islands, Greenland, Iceland, Norway	*Objective:* conservation and management of marine mammals in the North Atlantic
Bilateral Coastal States Consultations	EU, Norway Norway, Russian Federation	*Objective:* management of joint stocks in the North Sea, including the Skagerrak, and other management issues *Objective:* joint management of cod, haddock and capelin in the Barents Sea and other management issues
Various bilateral agreements between parties in the North-East Atlantic	EU, Faroe Islands, Greenland, Iceland, Norway, Russian Federation	*Objective:* exchange of quotas in each other's waters; other management issues
Coastal state cooperation on stocks that straddle into international waters (coastal state groups)	Various depending on species	*Blue whiting:* EU, Faroe Islands, Iceland, Norway *Mackerel:* EU, Faroe Islands, Norway *Norwegian spring spawning (Atlanto–Scandian) herring:* EU, Faroe Islands, Iceland, Norway, Russian Federation *Redfish in the Irminger Sea:* Faroe Islands, Greenland, Iceland

Most fisheries are fully exploited

Most traditional fish stocks in the OSPAR area, and indeed globally, are fully exploited, overexploited or depleted → **FIGURE 8.2**. Of the 600 global marine fish stocks monitored by the UN Food and Agriculture Organization (FAO), 3 % are underexploited, 20 % are moderately exploited, 52 % are fully exploited, 17 % are overexploited, 7 % are depleted and 1 % are recovering from depletion.

North-East Atlantic fisheries peaked at 13 million tonnes in 1976 and have since fallen to around 10 million tonnes a year. Higher yields, more security of supply and lower environmental impacts would follow from reductions in fishing effort. All OSPAR countries are committed to implementing an ecosystem-based approach to fisheries management and use of the precautionary approach.

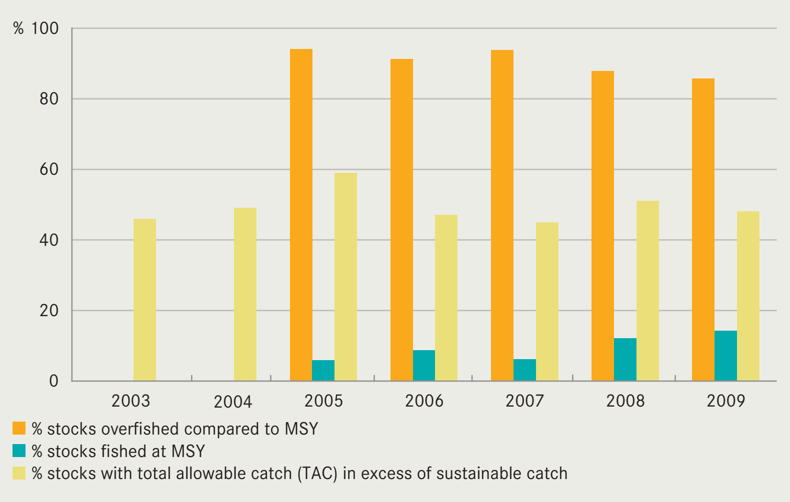


FIGURE 8.2 *Status of fish stocks assessed by the International Council for the Exploration of the Sea (ICES) for which maximum sustainable yield (MSY) is defined. This equates to 32 to 35 stocks over the period 2005 to 2009, except for 2006 when 23 stocks were assessed on this basis. MSY was not used in fisheries advice before 2005. ICES advice covers over 135 separate fish and shellfish stocks. Source: ICES data.*

Constant change makes management challenging

Fisheries management is challenging because fisheries are constantly changing. There may be changes in the availability of commercial species, changes in the market price, changes in capital and fuel costs, or changes in the regulatory regime. New fisheries develop to meet market demand or when effort is diverted from other fisheries. Areas fished change, for example, as fish stocks and migration patterns respond to environmental change, when technical developments allow new areas to be exploited or as a result of management, such as closed areas. Management of deep-sea fisheries is difficult due to a lack of data underpinning stock assessments.

Fishing may increase the vulnerability of ecosystems

Fish stocks are an integral part of ecosystems and, as such, are both strongly dependent on, and support, the good health of the ecosystem. Altered community structure and marine food webs therefore affect commercial fish stocks, particularly during periods of environmental change. In combination with other environmental impacts, such as pollution, climate change and ocean acidification, the effects of fishing may increase the vulnerability of ecosystems.

What has been done?

Important developments in fisheries management

At the World Summit on Sustainable Development in 2002, OSPAR countries committed to maintain or restore stocks to levels that can produce the maximum sustainable yield (MSY), with the aim of achieving these goals for depleted stocks on an urgent basis, and where possible not later than 2015. All fisheries management regimes in the OSPAR area recognise the need for sustainable harvest rates and that fleet overcapacity needs to be addressed, in particular when stocks are outside safe biological limits. Some of the main developments in fisheries management in the OSPAR area since the QSR 2000 have been as follows:

- The adoption of long-term management plans for several commercial fish stocks. In EU waters, these include recovery plans for cod in the North Sea, Irish Sea and Celtic Sea; plaice and sole in the North Sea; and the northern stock of hake. Long-term management plans for mackerel, blue whiting and Norwegian spring spawning (Atlanto-Scandian) herring have been adopted by coastal states and NEAFC. All these plans include targets for fish stocks to be harvested at fishing mortalities that correspond to MSY.
- The continued management of fisheries in Region I through quota-based systems allocating either a share of the total allowable catch (TAC) or fishing days. This has been complemented by increased use of closed areas both for stock recovery and protection of vulnerable marine ecosystems (VMEs).
- Abolition of some of the financial subsidies that previously promoted excess fishing capacity.
- Increased attention to the management of deep-sea fish species. This has included controls on deep-sea fishing effort managed by the EU and NEAFC, including quotas and temporary and seasonal closure of some fisheries, for example NEAFC measures on the pelagic redfish. In 2009, the UN FAO published a set of technical guidelines aimed at helping the fisheries sector reduce its impacts on deep-sea fish species and ecosystems.
- Initiation of a new EU policy on discards in 2007 to reduce unwanted by-catch and progressively eliminate discards in European fisheries. This has included a ban on high-grading in the North Sea from 1 January 2009, which has been extended to other parts of the Atlantic in 2010. Discards have also been banned in NEAFC High Seas fisheries from 2009. These actions will complement the bans on discards that have been in place in fisheries in Region I since the 1990s, in Faroese, Icelandic, Norwegian and Russian waters.
- Steps to address by-catch of marine mammals through the EU Common Fisheries Policy with measures such as acoustic deterrents (pingers) required in certain fisheries. The pelagic driftnet fishery for albacore tuna was banned in 2002 because of high cetacean by-catch. Driftnets are now banned in all EU waters. The EU is developing a policy on by-catch of seabirds and sharks.
- A reform of the ICES system for providing scientific advice on fisheries management. Within the EU, data for management advice are now provided through the new EU framework for data collection and Regional Advisory Councils have been set up to involve fishing industry stakeholders more closely in the decision-making process.

Pelagic mid-water trawl, typically used in herring and mackerel fisheries

- The call of the UN General Assembly on states and regional fisheries management organisations to take measures to protect VMEs in the High Seas from the adverse impacts of bottom fisheries and to ensure the long-term sustainability of deep-sea fish stocks. In response, several large areas of the High Seas have been closed to bottom fishing by NEAFC for the purpose of protecting VMEs.
- Introduction of various area-based measures across the OSPAR area including closed areas, marine protected areas (MPAs) and gear management areas. Specific examples include closures for the protection of VMEs, such as cold-water corals; implementation of fisheries measures within MPAs; restrictions on the use of bottom gear in certain areas; and bans on the use of gillnets in the deep seas.
- Targeting of illegal, unregulated and unreported (IUU) fishing by sharing of blacklists between regional fisheries management authorities and port states, and improved port state control.
- The emergence of ecolabelling and certification for sustainable fisheries as market-driven initiatives toward sustainable fisheries.

Did it work?

Reductions in fishing fleet offset by increased efficiency

The fishing fleet capacity in the OSPAR area has been reduced. The quota systems used in Region I have helped to cut fleet size and fishing effort. The number of Icelandic demersal trawlers and trawling effort has almost halved since 1990, with a 25 % decline in engine power and an equivalent decrease in gross tonnage. In the same period the number of fishing vessels in Norway has reduced by 43 %, and fishing fleet tonnage and engine power have decreased by 10 %. Efforts to reduce fleet capacity in EU waters have seen a total decrease in vessel numbers of 26.7 % in the period 1995 to 2009. Tonnage and power have fallen correspondingly. Reductions in vessel numbers, size and engine power have, however, tended to be offset by technological advancements allowing improved fishing efficiency.

Fishing effort is falling in some areas but increasing in others

In Region I, the closure of large areas in Norwegian waters to fisheries has contributed to a reduction of effort. In the Faroe Islands, the number of fishing days allocated has been cut by 33 % since 1996.

Overall fishing effort in Region II fell by about 25 % between 2000 and 2006. In the North Sea, beam and otter trawl fishing effort decreased by 31 % and 44 % respectively between 1997 and 2004, although Nephrops trawl effort grew by 65 %. Beam trawling has been increasingly replaced by twin-rigging and

flyshooting, which require less fuel. In the western Channel, fishing effort increased over the period 2000 to 2007, mainly driven by the use of gears that are not covered by effort limitations, and trawl effort is high.

In Region III, there has been a fall in trawl effort in the Irish Sea and to the west of Scotland, but overall fishing effort has stayed high. Some beam trawlers have switched to otter trawling or to scallop dredging, a non-quota fishery.

In Region IV, the number of French vessels fishing in the Bay of Biscay fell between 2000 and 2006, with the exception of liners and gillnetters. However, the fishing effort increased or remained stable for each sector, apart from the anchovy fishery, which was closed from 2005 to 2009. This stability in effort contrasts with an observed decrease in fishing mortality for most fish stocks in the Bay of Biscay. This may be a result of more stocks that are not assessed being targeted or a decrease in fishing efficiency from use of more selective gear.

Management measures for deep-sea fishing effort were first introduced in 2004, including a deep-water licence scheme and TACs. Effort reductions have been in place since 2005. Effort reduction on deep-sea species should lead to a fishing effort level in 2009 which is 65 % of the ceiling defined in 2003.

EU effort management regimes cover the major part of the OSPAR area. An assessment of the effectiveness of these regimes is underway.

Small beam trawler, typically fishing in sandy areas for flatfish and other demersal species

Landings have fallen overall but trends vary

The total landings of demersal fish, pelagic fish, and shellfish fell between 1998 and 2008 → FIGURE 8.3. However, a progressive decrease is only observed after 2002. Between 1998 and 2002 the total catch was more variable with a moderate increase observed between 1999 and 2002. Only in Region V were more fish and shellfish landed in 2008 relative to 1998.

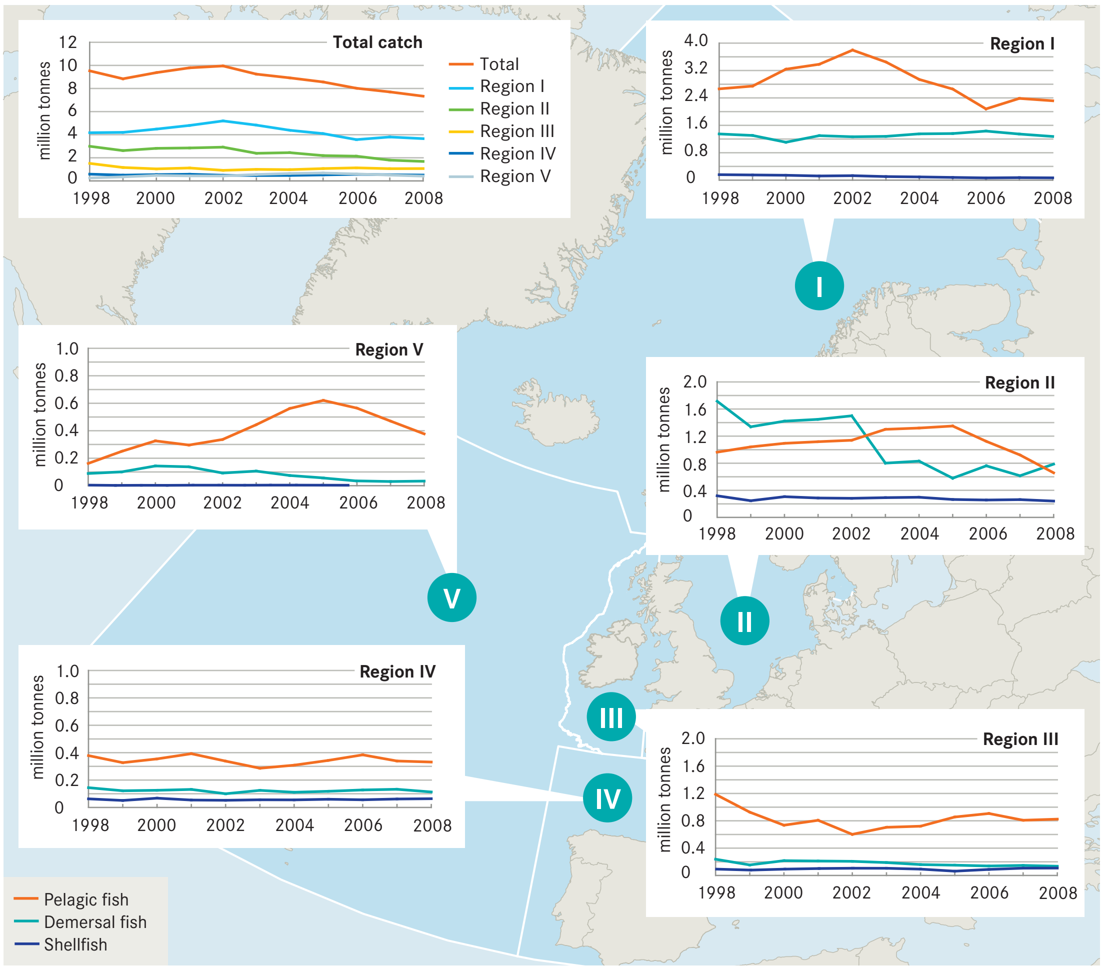
One of the reasons for the overall decline in landings is the definition of more restrictive catch limits. There has, however, been considerable variation across the Regions. In Region I, demersal landings were relatively stable over the period, while landings of pelagic fish and shellfish declined. In Region II, demersal landings continued to increase until 2005, but have since declined such that in 2008 the catch was lower than in 1998. Pelagic catch has decreased throughout the decade. In Region III, pelagic landings fell to a minimum in 2002. Since then there has been a slight increase, but the landings of pelagic fish in 2008 remain lower than in 1998. Demersal landings in Region III have remained relatively constant. In Region IV, landings showed little change. The greatest increase in landings occurred in Region V, with pelagic landings rising from around 0.2 million tonnes in 1998 to over 0.6 million tonnes in 2005. However, since then pelagic landings have fallen to around 0.39 million tonnes. These trends have been mainly due to the development of the blue whiting fishery for which a TAC was agreed in 2005.

Controls on discards are tightening

It is too early to assess the effect of recent action in EU waters on discards, and discard rates have remained high in some EU fisheries until very recently, with, for example, extensive discarding having been reported in many roundfish, flatfish, and Nephrops fisheries in the North Sea and some similar fisheries in Regions III and IV. There are indications that discard rates may have increased where stocks comprise a high proportion of juvenile fish. There has been some success in reducing discard rates in EU Crangon trawl fisheries as a result of measures requiring the use of sorting devices.

In Region I, discard bans have been in place in Norwegian, Faroese and Icelandic fisheries since the 1990s with side-measures that discourage high-grading. Sorting grids have become widely used in demersal fisheries in Region I to limit the catch of juvenile or other stocks. The most successful programmes for reducing discards have been those developed in close collaboration with industry. For example, in the blue whiting fishery around the Faroe Islands, use of sorting grids became mandatory in 2007 to avoid by-catch of saithe and cod. This measure was developed in collaboration with the fishing industry

FIGURE 8.3 *Landings from the North-East Atlantic of demersal fish, pelagic fish, and shellfish over the period 1998–2008. Source: ICES Statlant database.*



and supported by education programmes and grants for equipment. Monitoring suggests that the by-catch has been reduced successfully. Also, OSPAR countries are using surveillance programmes aimed at monitoring the proportion of undersized fish in catches. When the proportion exceeds a certain limit, fishing areas are closed for some time with immediate effect.

Further efforts are needed to reduce by-catch of marine mammals

Despite many efforts to reduce the by-catch of non-commercial species, including sharks and marine mammals, not all measures are efficient. More must be done to reduce mortality and improved observer programmes are needed. Some threatened shark species have a zero TAC in EU waters, but awareness and catch identification can be poor. Some species that were previously fished commercially and which are now seriously depleted, such as common skate in Region III, have become by-catch in fisheries targeting more abundant species. In some cases, markets have developed for former by-catch species (e.g. blue shark in oceanic pelagic fisheries); these species are now considered part of the target catch and are mostly retained.

Harbour porpoises, dolphins and seals are still commonly entangled in fishing gear. Mortality rates for harbour porpoises caught in gillnets, and common dolphins caught in pelagic trawl nets continue to cause concern. Cetacean by-catch rates in the driftnet fishery for albacore tuna were addressed when it was banned in 2002 and driftnets were later banned in all EU waters. However, as a consequence pair trawling has developed in some areas, which also has by-catch implications. Research into mitigation measures is ongoing. Results from the use of acoustic deterrents (pingers) have been mixed → BOX 8.1.

Success in reducing IUU fishing in some areas

NEAFC initiatives have enabled fisheries monitoring centres to improve the planning of inspections at sea, and its blacklists and port state control system are efficient tools for combating IUU fishing. Other enforcement initiatives have contributed to combating IUU fishing. Increased cooperation between Iceland, Norway, the Russian Federation, the EU and EU Member States, helped by the NEAFC Scheme of Control and Enforcement, resulted in a large fall in illegal fishing of cod in the Barents Sea from around 100 000 tonnes in 2005 to about 15 000 tonnes in 2008 → BOX 8.2. Nevertheless, IUU fishing is still known to be taking place in other parts of the OSPAR area, with substantial under-reporting of catches from the southern stock of hake and the southern component of the combined stock of mackerel suspected.

BOX 8.1 Minimising by-catch of harbour porpoises

North Sea EcoQO: Annual by-catch of harbour porpoises should be reduced to below 1.7 % of the best population estimate.

Harbour porpoises are small cetaceans found in coastal waters throughout most of the OSPAR area. This species is occasionally by-caught by several types of fisheries, especially those using bottom-set gill- and tangle nets. These nets are otherwise considered to be relatively selective and environmentally friendly and their use is increasing.

There is no reliable information on by-catch numbers in the North Sea, as monitoring programmes are lacking in most gillnet fisheries. In the southern North Sea, up to half of stranded porpoises have been killed incidentally in fishing gear, a rate that justifies concern. The harbour porpoise is an important top predator in the North-East Atlantic and there have been historical declines in some areas. The species is protected under the EU Habitats Directive. The OSPAR EcoQO aims to reduce by-catch in the North Sea to a level that would allow the population to recover to at least 80% of the ecosystem's long-term carrying capacity for this species.

There are two challenges in evaluating whether the EcoQO is met. First, the status and inter-relationships of the North Sea harbour porpoise population units are not well understood; accurate estimates of the porpoise population and abundance numbers are required for all areas in which they occur. Second, further independent monitoring of by-catch must be implemented. Compulsory observer schemes with good coverage and including the use of cameras may be the only way to ensure effective monitoring. Observation should continue after the introduction of mitigation measures.

Catches of marine mammals in the North Sea are now always incidental. Most fishermen do not want such by-catch, not least because of gear damage and slower fishing operations. However, individual fishermen rarely catch a harbour porpoise and so may not consider this a significant environmental problem.

Fishermen have little to gain in providing information on by-catch. Killing and landing of harbour porpoises are forbidden under several jurisdictions. Widespread observations suggest efforts by fishermen to actively conceal by-catch, for example by opening body cavities to sink the carcass. Along the coast of the Netherlands, mutilated carcasses of porpoises are periodically washed ashore, raising public and political concern.

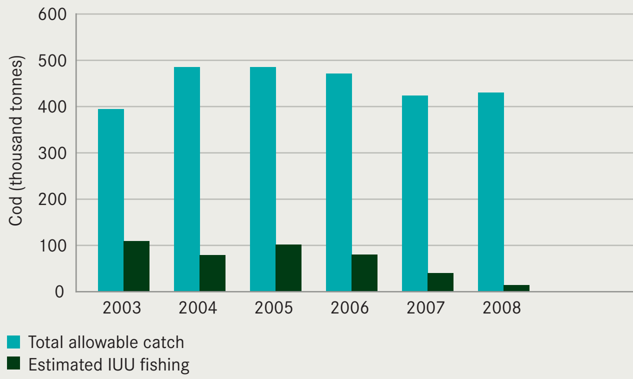
Pingers (acoustic alarms) have been seen as one of the most promising prevention measures. EU Regulation 812/2004 makes these compulsory for bottom-set gill- and tangle nets operated from vessels of 12 m length or over, excluding many smaller vessels. Pingers have been applied under Danish law in cod wreck net fisheries since 2000 and are being trialled elsewhere in the North Sea. However, there are still concerns about their practicality and effectiveness over the long term, about negative impacts from the noise they emit and about the best means of enforcing their use. Designing effective measures must take account of local conditions and fishing practices, and must use the expertise and experience of fishermen.

BOX 8.2 Illegal, unregulated and unreported fishing of cod in the Barents Sea

During 2001, the transfer of cod and haddock from fishing vessels to transport vessels (trans-shipment), which forms part of Russian fishing operations in the Barents Sea (see photo), became subject to a joint Norwegian-Russian operational risk assessment. This concluded that only 45 % of all identified cases of trans-shipment were reported to Russian Fisheries Control Authorities. The absence at that time of control agreements between Russia and countries where trans-shipped fish were typically landed (mostly EU countries) left the door wide open for IUU fishing on a massive scale.

Realising that the scale of IUU fishing in the Barents Sea was potentially serious, Norwegian and Russian Fisheries Control Authorities agreed to work jointly towards the prosecution of well-documented cases of landing of unreported catch. Between 2005 and 2007, the Norwegian Directorate of Fisheries submitted 53 such cases to its Russian counterparts, comprising a total of 20 000 tonnes of cod and haddock landed in EU countries, but not reported to Russian Authorities for registering against the quota. Prosecution in Russia led to an impressive number of convictions resulting in several fishing companies going bankrupt or otherwise being dissolved, thereby rendering some 26 fishing and transport vessels passive by the quayside.

In 2005, Norway and Russia agreed to prohibit trans-shipments other than to vessels flying the flag of either NEAFC Contracting Parties or Cooperating Non-Contracting Parties. This frustrated operations by convenience-flagged vessels to the extent that since 2007 illegal trans-shipment has not occurred. In close cooperation with the EU, a port state control scheme has been introduced in the NEAFC framework which enables landings by Russian vessels in EU countries to be closely monitored by the Russian Fisheries Control Authorities. Implementation of this scheme has made a significant contribution to the decline in illegal fishing of cod in the Barents Sea.



How does this affect the quality status?

Too many fish stocks are still outside safe biological limits

The status of around 130 commercial fish stocks in the OSPAR area is assessed annually by ICES as a basis for advice to fisheries authorities on the management of fishing. The approach used is to assess individual fish stocks in terms of spawning stock biomass (SSB), representing the total weight of fish in the stock able to spawn, and fishing mortality (F), representing the fishing pressure on the stock. An analysis of 37 stocks covered by ICES in the OSPAR area for which there was an agreed assessment in 2008 showed that around 45 % of these stocks had a significantly higher level of SSB in 2007 compared with 1997, while around 60 % of stocks had a significantly lower fishing mortality → FIGURE 8.4. This analysis shows that the key stock parameters have been moving in the right direction for many stocks suggesting that recent efforts in fisheries management are having the desired effect of pushing exploitation rates downwards. However, a number of the fish stocks considered by this analysis remain beyond safe biological limits according to the ICES precautionary approach.

Within the fisheries management framework the use of SSB and F is guided by defined reference points. These provide an expression of the status of the stock. For SSB, these reference points include a limit reference point (B_{lim}) below which reproductive capacity is considered to be impaired and there is a probability of stock collapse, and a precautionary limit reference point (B_{pa}) which, traditionally, has been the reference point below which stocks are described as being outside safe biological limits. Since 2004, stocks with an SSB below B_{pa} but greater than B_{lim} have been described as being at risk of suffering reduced reproductive capacity. Reference points for fishing mortality (F_{lim} and F_{pa}) define whether harvest rates are sustainable; when the fishing mortality of a stock is greater than F_{lim} the stock is being harvested unsustainably. If SSB is kept above the agreed precautionary limit (B_{pa}) it is likely that the point at which there is a serious stock collapse will never be reached. The safest way to achieve this is to keep fishing mortality below the levels that would in the long term result in SSB below the agreed precautionary limit. Over the period 2003 to 2009 the number of stocks assessed by ICES as being outside safe biological limits (i.e. below the precautionary limit B_{pa}) varied from 23 to 28 while

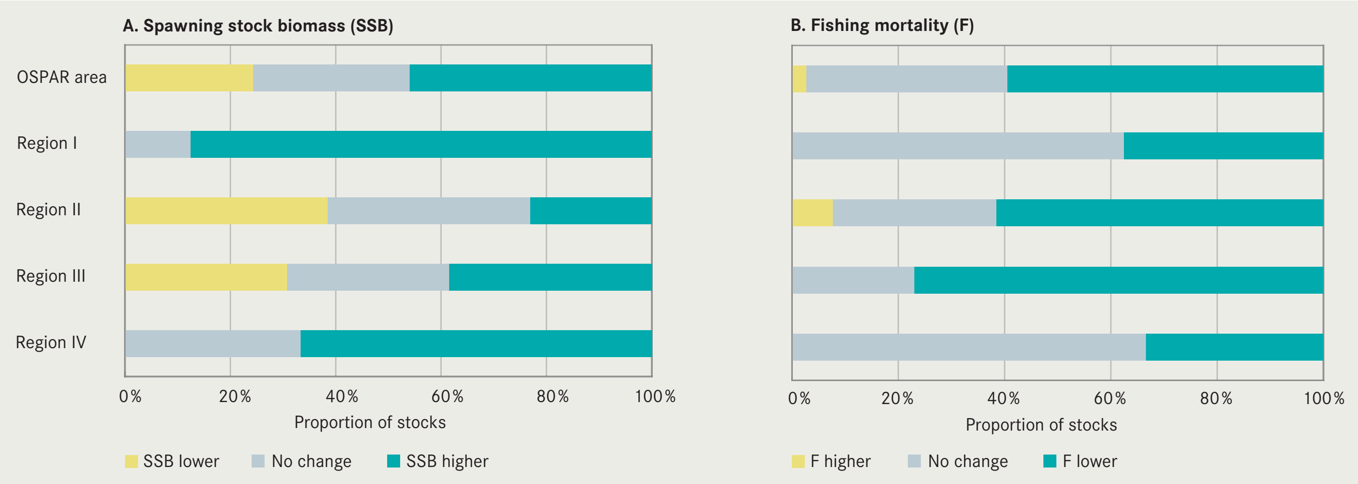


FIGURE 8.4 *Proportion of stocks where (A) spawning stock biomass and (B) fishing mortality are significantly different in 2007 compared with 1997 for OSPAR Regions I to IV and for the OSPAR area as a whole. No data for Region V.*

8 to 11 stocks were assessed as being within safe biological limits → **FIGURE 8.5**. In 2006, around 20% of fish taken from EU-managed waters was taken from stocks outside safe biological limits.

Improved management of stocks depends on developments in science and data quality

A key limitation in ICES stock assessments is that reference points have been defined only for stocks for which sufficient data are available. Some 48 to 56 stocks were designated as being of unknown status between 2003 and 2009 due to poor data → **FIGURE 8.5**. Reforms under the EU Common Fisheries Policy have allowed the systems for providing fisheries management advice to become more transparent, to involve stakeholders, and to take into account ecosystem aspects. These are positive developments, but place increasing demands on the fisheries science for information and improved accuracy. ICES advice on these topics is generally followed when setting the TACs for the following year. For many stocks advice is based on weaker scientific evidence and historic catch figures, which give some indication of how the stock develops.

Status of stocks and assessment capacities varies between Regions

In the North Sea, OSPAR has established an Ecological Quality Objective (EcoQO) on commercial fish stocks based on the reference points for SSB. These have been defined for 15 stocks accounting for roughly 20% of total landings in the Region → **BOX 8.3**.

Saithe, Loch Carron, Scotland

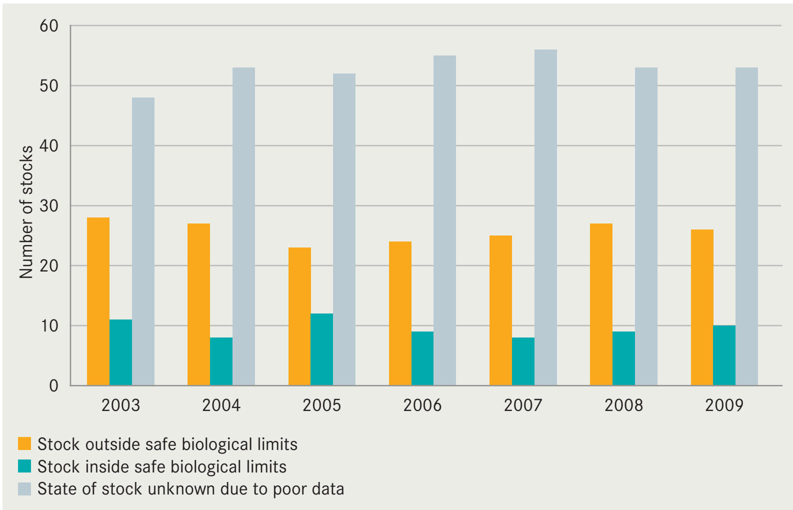


FIGURE 8.5 *Status of ICES assessed stocks (excluding those in the Baltic Sea) for the period 2003 to 2009. Data source: ICES.*

BOX 8.3 Are commercial fish stocks in the North Sea at sustainable levels?

North Sea EcoQO: Maintain the spawning stock biomass above precautionary reference points for commercial fish stocks where those have been agreed by the competent authority for fisheries management.

The OSPAR EcoQO for commercial fish species aims to maintain safe levels of fish species by management of fisheries based on the precautionary principle. The EcoQO is based on evaluations of the status of commercial fish stocks prepared by ICES and used in fisheries management.

The status of SSB in relation to the EcoQO for the stocks for which reference points have been defined is shown below for the period 1998 to 2009. Evaluations of fishing mortality are also shown. Since 1998, there has been an improvement in the status of several fish stocks in Region II, including plaice and hake, which have both been the subject of recovery plans under the EU Common Fisheries Policy.

However, the status of cod stocks throughout the North Sea continues to be of concern, as both SSB and fishing mortality are still on the wrong side of the limits for sustainability. In 2009, SSB for North Sea herring was below the precautionary limit, although fishing pressure has been reduced. Excessive fishing pressure on mackerel (combined stock) increases the risk of SSB moving below the precautionary limit. The North Sea mackerel stock for EU waters, which is assessed within a combined stock, has been considered to be depleted since the 1970s. Herring and mackerel populations play a major role in the structure and function of the North Sea ecosystem. The North Sea and Eastern Channel stock of whiting is among the further eleven stocks in Region II whose status is uncertain either due to a lack of defined reference points or inadequate data.

Species	Stock	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cod	North Sea, Eastern Channel, Skagerrak	! (orange)	! (red)	! (red)	! (red)	! (red)	! (red)	! (red)	! (red)	! (red)	△ (red)	! (red)	! (red)
Cod	Kattegat	! (red)	! (orange)	! (red)	! (red)	! (red)	! (red)	! (red)	? (red)	? (red)	? (red)	? (red)	? (red)
Haddock	North Sea, Eastern Channel, Skagerrak	△ (green)	△ (orange)	! (red)	△ (green)	✓ (green)	✓ (green)	✓ (green)	✓ (green)	✓ (green)	✓ (green)	✓ (green)	✓ (green)
Saithe	North Sea, Skagerrak, west of Scotland	✓ (green)	✓ (green)	✓ (orange)	✓ (green)	✓ (green)	✓ (green)	✓ (green)	✓ (green)	✓ (green)	✓ (green)	✓ (green)	✓ (green)
Hake	Northern stock	△ (orange)	△ (red)	△ (orange)	✓ (orange)	✓ (orange)	△ (orange)	△ (orange)	✓ (green)	✓ (green)	✓ (green)	✓ (green)	✓ (green)
Plaice	North Sea	! (orange)	△ (orange)	✓ (green)	△ (green)	△ (orange)	△ (orange)	△ (orange)	✓ (orange)	✓ (orange)	✓ (orange)	✓ (green)	✓ (green)
Plaice	Skagerrak, Kattegat	△ (green)	△ (green)	△ (green)	✓ (green)	△ (orange)	△ (green)	△ (green)	?	?	?	?	?
Plaice	Eastern Channel	! (orange)	! (green)	! (orange)	! (orange)	! (orange)	△ (orange)	△ (orange)	?	?	?	?	?
Sole	North Sea	△ (red)	△ (green)	△ (green)	△ (orange)	△ (orange)	△ (orange)	△ (green)	△ (green)	△ (orange)	✓ (red)	△ (orange)	✓ (green)
Sole	Eastern Channel	△ (orange)	△ (orange)	△ (orange)	✓ (orange)	✓ (green)	✓ (green)	✓ (green)	✓ (green)	✓ (green)	✓ (green)	△ (green)	△ (green)
Herring	North Sea, Eastern Channel, Skagerrak	! (red)	△ (orange)	△ (orange)	△ (orange)	△ (green)	△ (green)	△ (green)	△ (green)	△ (green)	△ (orange)	△ (orange)	✓ (orange)
Mackerel	Combined (Western, Southern, North Sea)	! (green)	! (green)	! (orange)	! (orange)	! (orange)	! (orange)	! (orange)	! (orange)	△ (orange)	!	△ (green)	△ (green)
Norway pout	North Sea and Skagerrak	✓ (green)	✓ (green)	✓ (green)	✓ (green)	✓ (green)	✓ (green)	! (red)	! (red)	? (red)	? (green)	? (orange)	? (green)
Blue whiting	Portugal to Norway	△ (green)	△ (green)	! (green)	△ (green)	△ (green)	! (green)	! (green)	! (green)	! (green)	△ (green)	△ (green)	✓ (green)

Spawning stock biomass

$<B_{lim}$ (red)	Reduced reproductive capacity
$>B_{lim}$ and $<B_{pa}$ (orange)	Risk of reduced reproductive capacity
$>B_{pa}$ (green)	Full reproductive capacity
(no colour)	No assessment

Fishing mortality

!	$>F_{lim}$	Harvested unsustainably
△	$<F_{lim}$ and $>F_{pa}$	At risk of being harvested unsustainably
✓	$<F_{pa}$	Harvested sustainably
?		No assessment

For other Regions, the availability of reference points varies → **TABLE 8.2**. In Region I, a large proportion of landings are from stocks with defined reference points and only two stocks were not at safe levels in 2009 according to ICES. For Regions III and IV, reference points have been defined for relatively few stocks and other criteria are used to assess a large proportion of the stocks. For example, the stocks of whiting to the west of Scotland and in the Irish Sea are considered to be depleted on the basis of historic catch and landing information. Likewise no assessments of the herring stock to the west of Ireland and in the Celtic Sea have been made in relation to the reference points since 2003, but ICES has recommended either that a rebuilding plan is put in place or that there is no fishing. In 2009, a management plan was put in place for Celtic Sea herring. Some of the recovery plans in these Regions have started to show a positive effect, for example, the status of the northern stock of hake has improved in Regions III and IV, but the poor status of cod in Regions II and III is a continuing concern → **BOX 8.4**.

Most deep-sea stocks in Region V are data poor and analytical assessments cannot be undertaken. Many deep-sea species are particularly sensitive to exploitation as they are slow-growing and slow to reproduce. Some species aggregate around specific

Orange roughy

features, such as seamounts, which make them vulnerable to exploitation. OSPAR has included the orange roughy in its list of threatened and/or declining species. There is strong evidence that some deep-sea fish have been depleted around the continental slope in Region V. Current ICES advice for a number of deep-sea stocks emphasises their continued vulnerability. For example, ICES advised that there should be no direct fishing for blue ling during 2009 and 2010, while fisheries for greater forkbeard, blackscabbard fish and greater silver smelt should not be allowed to expand unless it can be shown that it is sustainable. Long-line fisheries appear to have depleted populations of giant redfish on seamounts of the northern Mid-Atlantic Ridge.

TABLE 8.2 *Status of spawning stock biomass for stocks in Regions I, III and IV and widely distributed stocks for which reference points are available based upon 2009 ICES advice.*

	Region I	Region III	Region IV	Widely distributed stocks
Number of stocks where reference points are currently defined	9[a]	8[b]	3	3
% of landings accounted for by these stocks	50	7	20	
Stocks suffering reduced reproductive capacity in 2009 which have had this status for more than three years (SSB <B_{lim})	Cod (Faroe Plateau)	Cod (west of Scotland) Sole (Irish Sea) Cod (Irish Sea)	Hake (southern stock)	
Other stocks at risk of suffering reduced reproductive capacity in 2009 (SSB <B_{pa})	Haddock (Faroe Plateau)	Cod (Celtic Sea)[c] Haddock (west of Scotland) Plaice (Celtic Sea)	Anchovy (Biscay)	
Stocks at full reproductive capacity in 2009 (SSB >B_{pa})	Cod (North-East Arctic) Haddock (North-East Arctic) Saithe (North-East Arctic) Herring (Norwegian spring-spawning) Herring (Icelandic) Capelin (Barents Sea)	Haddock (Rockall)	Sole (Biscay)	Blue whiting (combined stock in Regions I and V) Hake (northern stock) Mackerel

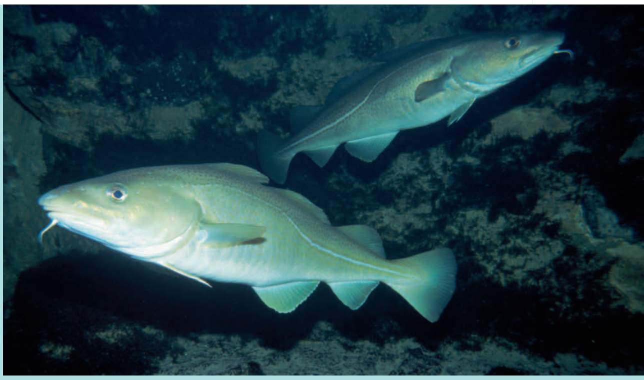
[a] *The status of the Faroe stock of saithe in 2009 was unknown.*
[b] *No assessment of herring stock to west of Ireland and in Celtic Sea since 2003.*
[c] *On the basis of ICES assessment in 2008. No assessment was possible in 2009.*

BOX 8.4 Contrasting fortunes after a decade of recovery measures for Irish Sea cod and northern hake

In 1999, ICES stated that Irish Sea cod and northern hake stocks were outside safe biological limits. ICES advised that fishing mortality should be reduced and that recovery plans should be developed and implemented as soon as practicable for both species. This began the era of recovery plans which were implemented with stakeholder engagement. Stocks are currently managed through a combination of TACs, area closures, technical measures and effort restrictions.

In 2000, the cod spawning grounds in the Irish Sea were closed for ten weeks from mid-February, in order to maximise the reproductive output. Subsequent changes between 2001 and 2003 reduced the closures to the western Irish Sea only, coupled with changes in trawl design to improve selectivity. In 2004 and again in 2008, the EU introduced a new cod recovery plan which established rules for determining TACs and a fishing effort regime. These measures were not effective in rebuilding the cod stock and in 2009 it was still classified by ICES as suffering reduced reproductive capacity and as being harvested unsustainably.

In June 2001, an EU Emergency Plan was implemented for the northern hake stock. Two areas were defined, south-west of Ireland and in the Bay of Biscay, where 100 mm mesh sizes had to be used by all otter trawlers. In addition, a Biologically Sensitive Area was established off the south-west of Ireland where fishing effort was controlled. The recovery plan adopted in 2005, where a target fishing mortality of 0.25 was set, allowed setting of catch limits consistent with stock rebuilding. Recruitment of the northern hake stock has been relatively stable over the past decade, and since 2006, ICES has classified the northern hake stock as being at full reproductive capacity and stated that the fishery was sustainable.



Atlantic cod (upper); northern hake (lower)

Bluefin tuna

Several commercially important pelagic stocks straddle more than one Region. These include blue whiting, mackerel, herring and northern bluefin tuna. Of most concern is the status of northern bluefin tuna in the East Atlantic and the Mediterranean, for which, based on 2008 estimates, SSB has declined by 70 % since 1950 with the bulk of this decline having occurred in the past ten years. In 2006, fishing mortality was estimated to be more than three times the level the stock could sustain. It is estimated that catches have been reduced to a level within the TAC set for 2008 following intense verification within EU waters in the Mediterranean. ICCAT has adopted TACs for the period 2009–2011 which continuously decrease, but substantial further reductions are needed to move towards sustainable levels. The distribution of mackerel has changed dramatically in recent years with a northward and westward movement of both immature and mature fish corresponding to changes in sea surface temperature. This presents challenges for allocation of quotas and supporting science.

Some improvements in demersal fish community structure

The structure of fish communities has been affected by fishing, with size composition altered and certain species no longer being found in some areas because mortality rates were unsustainable (e.g. common skate in Region II). Several characteristics of the fish community can be used to indicate its general health, for example, abundance/biomass/productivity, size composition, species richness, species evenness, and average life-history traits (such as age or length at maturity, growth rate or ultimate body length). OSPAR has set an EcoQO to indicate the general health of the demersal fish community in Region II based upon its size composition → BOX 8.5. An assessment of bottom trawl data for this QSR shows that – although size composition in the North Sea has not yet reached the level of the EcoQO – measurements of the other characteristics suggest that overall the general health of the demersal fish community in the North Sea has improved since 2000.

In Region III, nearly all aspects of the demersal fish community have improved over the past decade, particularly in the north, to the extent that the community is now in a similar state to that observed when data were first available in the early 1980s. The size composition and the abundance/biomass/productivity of the community are, however, still of concern. In the pelagic community in Region III, there has been an increase in smaller pelagic fish as a result of fishing pressure on their predators.

In Region IV, bottom trawl data were only available for the French continental shelf. Most aspects of the fish community are in a poorer state than in the mid-1980s. There have been improvements in life-history trait composition and species richness over the past decade, but little change in other indicators.

In Region V, bottom trawl data were only available for the Rockall Bank Plateau area. Species diversity and the size composition of the demersal fish community have improved over the past decade, while the abundance/biomass/productivity has changed little.

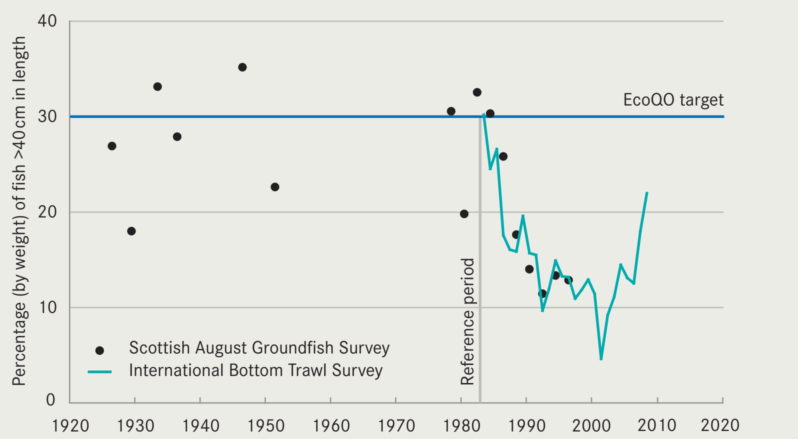
Over the past decade the size composition, species richness and species evenness aspects of the demersal fish community have all improved in Regions II, III and V, while only species richness has improved in Region IV. There has been little change in the abundance/biomass/productivity aspects, while Regions III and IV showed an improvement in life-history trait composition. Currently four of the five aspects are generally on parity with the situation prevailing when data in each Region were first available; the exception being the size composition of the community. Here the assessment indicates that, despite recent improvements, a full recovery to earlier conditions has yet to be achieved.

Mixed demersal trawl ready for sorting

BOX 8.5 OSPAR EcoQO for size composition of fish communities

North Sea EcoQO: At least 30 % of fish (by weight) should be greater than 40 cm in length.

The average length of fish in a community can be used to indicate the impact of fishing. This is because larger species of fish and larger and older individuals are more likely to be caught by fisheries than smaller species and individuals. This means that the relative abundance of small and early maturing species increases as a result of overfishing. This effect can be monitored through changes in the average length of fish in the catch per year, using species from the International Bottom Trawl Survey (IBTS) coordinated each year by ICES in the North Sea. The reference period for the OSPAR EcoQO is the early 1980s, a period when stock assessments suggested that stocks were not being over-exploited and that fishing was at sustainable levels. Analysis of the Scottish August Groundfish Survey (SAGFS), a long-running survey which ended in 1997, confirmed that 30 % of fish at greater than 40 cm in length is an appropriate management target. From the early 1980s, the proportion of demersal fish in the North Sea greater than 40 cm fell from around 30 % to its lowest point of less than 5 % in 2001. The proportion of large demersal fish has subsequently recovered to around 22 % in 2008. This is an improvement, but there is still some way to go to reach the EcoQO.



Physical disturbance has increased in some areas and reduced in others

Heavy towed demersal fishing gears (e.g. beam trawls, otter trawls, scallop dredges) cause considerable physical damage to seabed habitats and communities. They are a major source of disturbance on the continental shelf to habitats such as horse mussel beds, sea-pen and burrowing megafauna communities and *Sabellaria spinulosa* reefs. Considerable damage has been caused to cold-water corals and seamounts in deep waters with an estimated 30 % to 50 % of cold-water coral areas impacted in the Norwegian Sea. On the shelf in Region II, beam trawling is reported to have reduced benthic biomass by 56 % and benthic production by 21 % compared to an unfished situation → FIGURE 8.6. Set nets and longlines also affect fragile ecosystems that can take many decades to recover. Some of the remaining fragile habitats have been protected by closing fishing grounds. Although shallower, coarser and higher energy sediments in general recover faster than deeper water muds, trawling on sandbanks has also caused long-term changes.

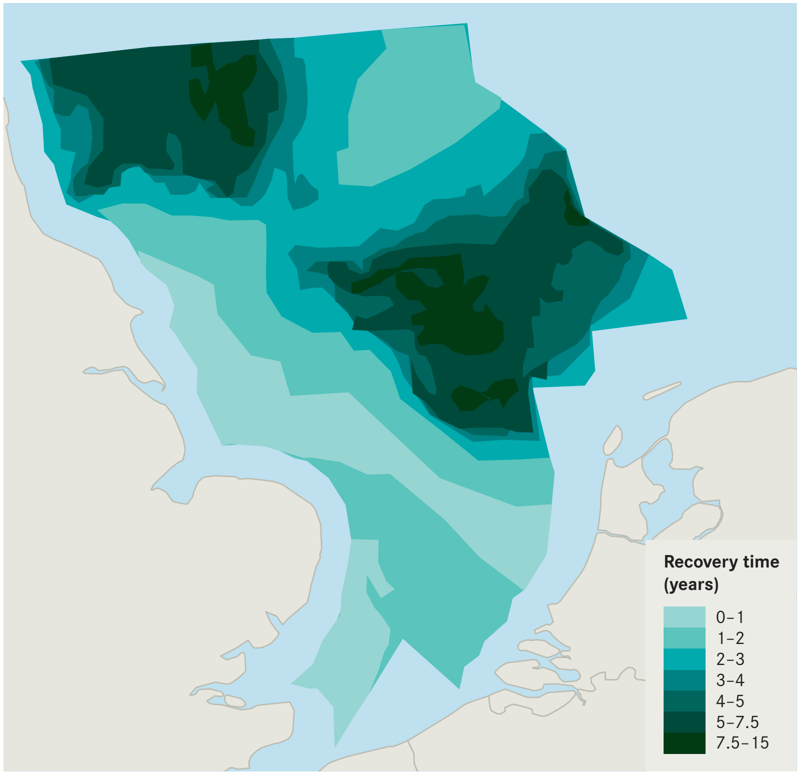


FIGURE 8.6 *Estimated recovery time (years) for southern and central North Sea benthic communities following one pass of a beam trawl (from Hiddink et al., 2006). Recovery is a measure of the time required for benthic production to return to 90 % of the production in the absence of trawling disturbance. Impacts of trawling are greatest in areas with low levels of natural disturbance, while the impact of trawling is relatively low in areas with high rates of natural disturbance.*

Trawl marks on a Lophelia pertusa reef, Norway

The area disturbed by fisheries has increased in some Regions. This is the case for the Great Mud Bank (Grande Vasière) in the Bay of Biscay (Region IV). In the North Sea (Region II), although there has been a decline in overall hours fished, fishing effort has moved to areas that were previously lightly fished due to closures elsewhere. Nephrops trawling has increased by 65 % in some areas. Displacement and changes in the distribution of fishing effort can have significant impacts due to local variations in the sensitivity of seabed habitats to disturbance. This has to be accounted for if large declines in previously heavily fished areas are offset by even slight increases in previously unfished or lightly fished areas.

Fishing activity affects the food web

Changes in fishing activity, discards and fish community structure affect the food web and in turn populations of predators and scavengers. These relationships are complex and often linked to other factors. In Region I, there is a close link in the population dynamics of cod, herring and capelin in the Barents Sea and hence overfishing of one species can have a strong effect on the food web. Currently the management of these stocks is well balanced. The increase in smaller pelagic fish in Region III, as a result of fishing pressure on their predators, has been linked to a decline in abundance of *Calanus* zooplankton. Climate factors are also implicated with an overall decline in zooplankton abundance of 70 % in the North-East Atlantic since the 1960s.

In the northern North Sea, there is evidence that the regime shift in the composition and breeding cycle of *Calanus* zooplankton in the 1980s (*C. finmarchicus* progressively replaced by *C. helgolandicus*) has depressed the productivity of lesser sandeel. The breeding success of black-legged kittiwake in the northern part of Region II appears to be linked to variation in local sandeel abundance, and is susceptible to being depressed as a result of industrial fishing activities.

The distribution of seabirds at sea is influenced considerably by the supply of discards that are used as food for some scavenging species. In Region IV, a strong link has been shown between the demersal fishing fleet in the Gulf of Cadiz and the Cantabrian Sea and the distribution of scavenging seabirds.

There are indications that fishing has affected the genetic evolution of a number of fish species in the OSPAR area, particularly with regard to the onset of sexual maturation (cod in the North-East Arctic and cod, haddock and plaice in the North Sea), but there is no overall assessment of the effect on all exploited stocks.

What happens next?

Further efforts are needed to address the many problems that remain

Since the QSR 2000, the fishing industry, governments and marine organisations have made considerable efforts to move towards a sustainable fishing industry, both at a local scale and at an OSPAR-wide scale. Improved fisheries management for some stocks has resulted in improvements in spawning stock biomass (SSB) and lower fishing mortality for some stocks, especially in Regions I and II. Nevertheless, commercial fishing is still exploiting stocks that are outside precautionary limits for SSB and there has been little or no change in the number of stocks whose status cannot be assessed due to poor data. Fishing mortality continues to exert excessive pressure on marine ecosystems through the removal of non-commercial species, discards and physical disturbance of the seabed. In the North Sea, the size composition of fish communities has improved, but still remains below the target value set by the North Sea EcoQO.

OSPAR is committed to supporting improvements in fisheries management

Fisheries management must continue to improve. This can only be achieved through continued co-operation between the regulatory bodies, advisory organisations, the fishing industry and other stakeholders. OSPAR is committed to promoting and facilitating cooperation between itself and the competent authorities for fisheries management in the OSPAR area, namely, the EU, NEAFC, ICCAT, the Faroe Islands, Greenland, Iceland, Norway, and the Russian Federation. This will include sharing information and work towards each organisation's respective aims. These aims will then become more closely related through the use of an ecosystem-based approach to management, including fisheries.

OSPAR and OSPAR countries should cooperate with the relevant fisheries management authorities with the following aims:

- Promote further the mutual integration of fisheries management with ecosystem-based management of the North-East Atlantic by its implementation being made compatible with the broader integrated management tools also applicable to a wider set of human activities in the OSPAR area.
- Promote consistency, where applicable, between current EU, Faroese, Greenlandic, Icelandic, Norwegian and Russian Federation fisheries legislation and long-term management plans with OSPAR EcoQOs and the developing descriptors of good environmental status under the EU Marine Strategy Framework Directive.
- Ensure that fisheries are managed in a sustainable manner in the context of the EU Common Fisheries Policy, so as to underpin OSPAR's long-term aims for protecting and conserving biodiversity and ecosystem functioning in the North-East Atlantic.

– Collaborate on the development of management regimes that meet fisheries management, nature conservation and environmental objectives and the objective of the EU Marine Strategy Framework Directive to take measures to reach good environmental status in EU waters by 2020.

OSPAR countries should cooperate in working towards improved assessment of the effects of fishing on the marine ecosystems of the OSPAR area, with a view to supporting improved fisheries measures which will contribute to the good environmental status of the marine environment across the OSPAR area. This will require collaborative efforts with the competent authorities for fisheries management and the fishing industry. Key issues on which OSPAR needs to support the work of fisheries management bodies include the following:

– Reductions in fishing pressure that allow the most depleted stocks to recover and slow the rate of fisheries-induced evolution. These should take full account of technological improvements.
– Developments in scientific support for fisheries management including methods for assessing a greater range of single stocks, including where appropriate reference points, and multi-species interactions.
– Further development of policy on discards and supportive measures on selective gears and new fishing techniques.
– Effective minimisation of by-catch, including of threatened and/or declining sharks, seabirds and marine mammals.
– Improved information on deep-sea species, so that the management of these species takes into account the special vulnerability of both the species exploited and their habitats.
– Development of fishing techniques and approaches that prevent negative impacts on vulnerable habitats and allow recovery of these habitats where possible. This should include consideration of the use of environmental impact assessment approaches to identify and mitigate possible impacts arising from the expansion of fishing into new areas.

Regional summary of environmental impacts from fishing

→ LEGEND: BACK-COVER FOLD-OUT

OSPAR Region	Status of commercial fish stocks	Fishing pressure 1998–2008	Outlook for pressures	Key issues
Region I	Some problems * * *	↓	↓	Damage to seabed habitats Deep-sea species
Region II	Many problems * * *	↓	↓	Status of cod stocks Improved assessment of whiting and other stocks needed Discards Damage to seabed habitats By-catch of marine mammals
Region III	Many problems * * *	↓	↓	Status of cod and sole stocks (Irish Sea) Improved assessment of herring and other stocks needed Discards Damage to seabed habitats By-catch of marine mammals
Region IV	Many problems * * *	↑	↓	Status of bluefin tuna and anchovy stocks Improved assessment of several stocks and mixed fisheries needed Discards Damage to seabed habitats By-catch of marine mammals IUU fishing
Region V	Some problems *	↑	?	Status of bluefin tuna stocks and deep-sea species Damage to deep seabed habitats Discards

MARICULTURE

Mariculture is a growing activity with potential to cause substantial environmental damage if not properly managed. OSPAR Contracting Parties should cooperate to keep broader scale effects under review as the industry develops.

Key OSPAR assessment → Environmental impact of mariculture

Mariculture is the cultivation of marine organisms such as fish and shellfish for food and other products. In 2006, almost 1.5 million tonnes of farmed fish and shellfish were produced in the OSPAR area representing 4.2 % of world mariculture production → FIGURE 8.7. Since 1998, production of finfish in the OSPAR area has increased by 57 % mainly due to increased production in Regions I and II → FIGURE 8.8. Shellfish farming, which is most intensive to the south of Region II and in Region IV, remained stable over the same period.

There are many concerns linked to mariculture, both in relation to rearing practices and to the widespread exchange and movement of eggs, embryos and seed, especially when different eco-regions are involved. Examples of these concerns include genetic interaction between farmed fish and wild stocks, transfer of parasites and diseases, spread of non-indigenous species, and dependence on industrial catches of wild fish to feed fish in mariculture. There are also concerns over a number of site-specific impacts from mariculture facilities, including:

- Eutrophication as a result of nutrient enrichment from feeds and effluents.
- Competition between escaped farmed fish and wild stocks for spawning grounds in freshwater habitats.
- Release of chemicals used to prevent fouling of equipment or to treat parasites and diseases.
- Displacement of bird and seal populations as a result of the use of scaring devices to discourage predation of farmed fish.
- Impacts from the harvesting of shellfish and from seed collection for mussel farming.

Measures are in place to reduce impacts

OSPAR recommends best environmental practice (BEP) to reduce inputs of potentially toxic chemicals from aquaculture use. In addition, measures under OSPAR's Eutrophication, Hazardous Substances and Biodiversity and Ecosystems Strategies provide a means to monitor, assess and regulate the impacts of mariculture. Various national and EU measures address the pollution and biodiversity impacts of mariculture. There are also international risk assessment protocols developed by ICES for assessing the risks of using non-indigenous species in aquaculture.

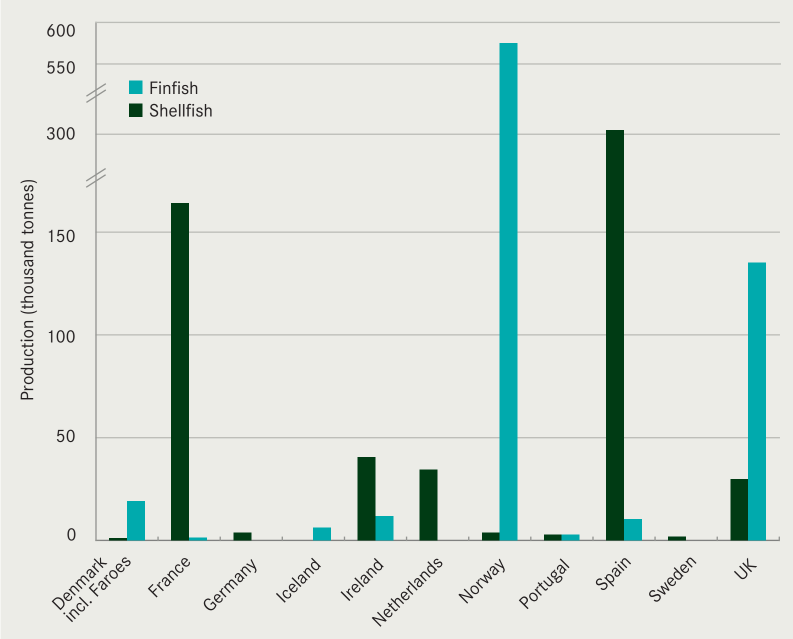


FIGURE 8.7 *Finfish and shellfish production in the OSPAR area in 2006.*

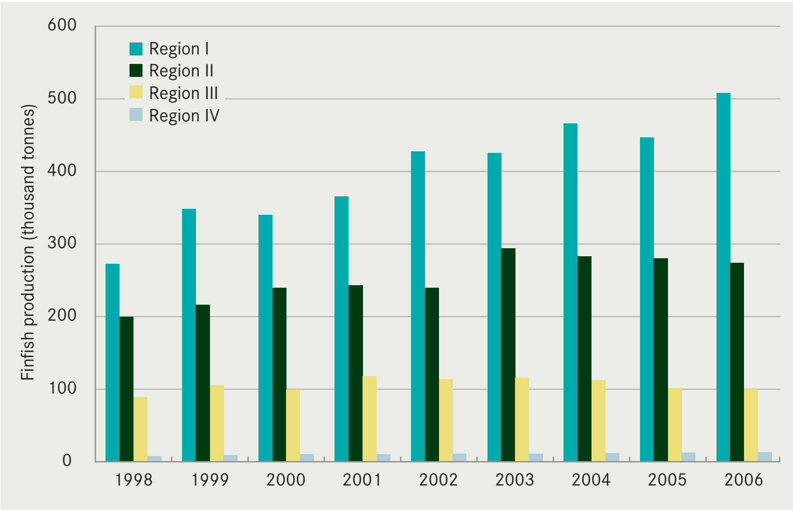


FIGURE 8.8 *Finfish production in the OSPAR Regions (1998–2006).*

Bouchots for mussel culture

Finfish farming cages

Oyster trestle culture

Use of hazardous substances has been reduced

Although OSPAR's recommendations on BEP for the reduction of inputs of potentially toxic chemicals from aquaculture use are not fully implemented in national legislation, the aims do seem to have been taken up by national or EU legislation. Increased use and development of vaccines has considerably reduced the application of antibiotics in mariculture. Tributyltin (TBT) in anti-fouling agents for mariculture equipment has been replaced by copper-based substances. Concern has been raised about possible increases in the release of copper, especially in Regions I and II. It is likely, however, that apparent increases are actually an artefact of better monitoring and reporting and that the actual usage of copper may have even reduced.

Effects on wild populations need better understanding

Lice from farmed salmon have been linked to the decline in wild salmon and sea trout near salmon farms, but further evidence is needed to make a direct association. In 2007, the contribution of escaped salmon from mariculture to national catches in the North-East Atlantic was around 15% in Norway, but less than 2% in most other OSPAR countries. The main risks associated with escape of farmed fish are the displacement of wild fish and genetic interactions. An expansion of mariculture with a focus on carnivorous fish species is likely to increase demand for feed derived from industrial fishing of wild stocks. These issues show the need for a better understanding of interactions between fish farming and wild fish stocks.

Climate change may increase introduction of non-indigenous species

Increased sea temperatures have the potential to change the areas where introduced species can become established. Pacific oysters, introduced into the OSPAR area as a mariculture species, have established wild populations in France and as far north as Denmark and Sweden – areas previously thought too cold for them to reproduce. These introductions can lead to displacement of indigenous species with consequences for associated fauna.

Wider impacts should be kept under review

Mariculture activities are very diverse and impacts are site-specific. Regulation and control therefore need to be focused on a case-by-case approach. OSPAR countries should continue to implement the measures that are already in place to mitigate impacts from mariculture. OSPAR needs to keep under review the wider impacts, such as non-indigenous species, impacts of sea lice, escaped fish and increased demand for industrial fisheries, especially in the event of substantial increases in mariculture activities. If necessary, coordinated management may then be required. The need to adapt mariculture management approaches to climate change should also be reviewed.

Regional summary of past trends and outlook for mariculture

→ LEGEND: BACK-COVER FOLD-OUT

Change of activity in 1998–2008					Outlook for change in activity					Main pressures
I	II	III	IV	V	I	II	III	IV	V	
↑	↓	←→	↓		↑	↑	↑	↑		Introduction/spread of non-indigenous species, genetic modification, habitat damage, habitat loss, contamination

HUNTING OF MARINE MAMMALS

Hunting of marine mammals is carried out only by northern OSPAR countries (Norway, Iceland, Faroe Islands, Greenland) and the Russian Federation, and is subject to management measures and monitoring. There is no evidence of major environmental problems, if these activities are properly carried out within the relevant management plans.

Local subsistence hunting as well as commercial whaling and sealing have a long history in the OSPAR area, especially in Region I. In the 17th century, hunting for bowhead and northern right whales brought these species to very depleted levels, with only occasional bowhead whales now being seen east of Cape Farewell in Greenland. Modern whaling, which began off the coasts of northern Norway during the 1860s targeting fast-swimming fin whales, was based on bringing killed animals to land stations for processing. This industry declined at the beginning of the 20th century as stocks of the large whales, and in particular the blue whales, in the OSPAR area were depleted and the focus on large whaling moved to the Southern Hemisphere.

Management aims at a sustainable yield

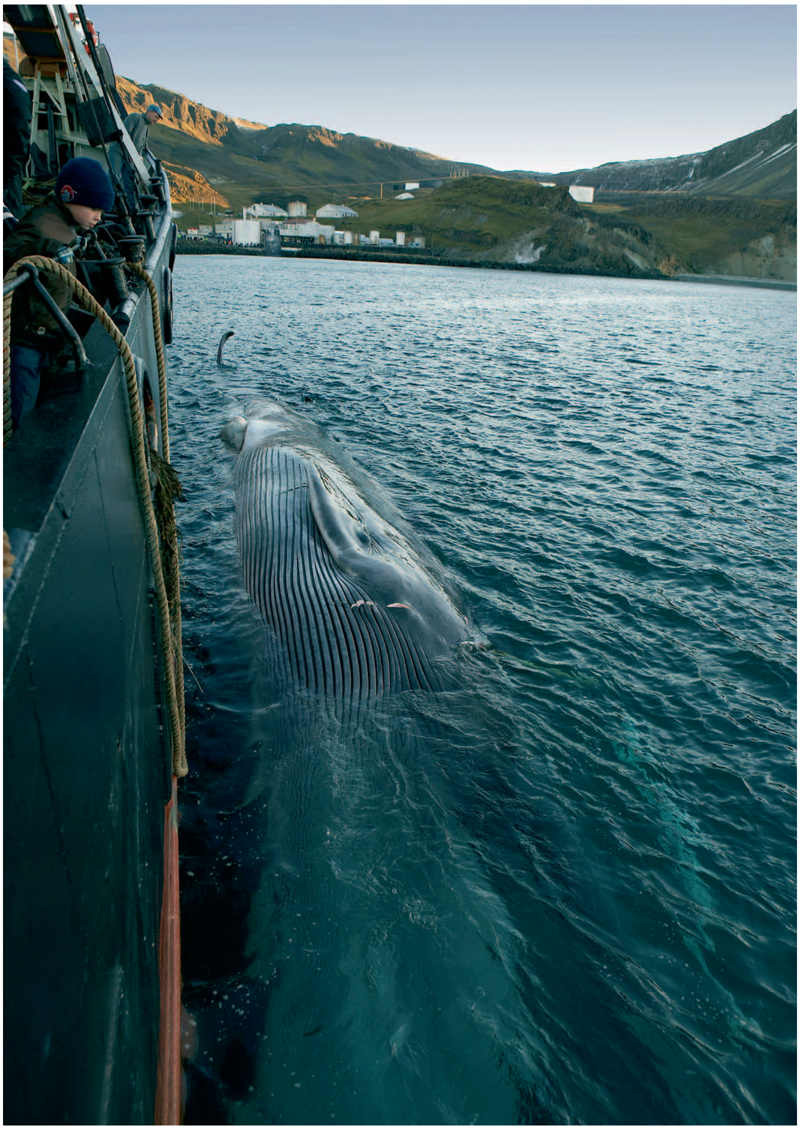
Today's hunting for marine mammals in the North-East Atlantic is limited to participation by Norway, Iceland, Faroe Islands, Greenland, and the Russian Federation. National monitoring programmes are in place for most hunted populations. Results from these programmes are reviewed by international bodies which recommend quotas and management actions as appropriate: the International Whaling Commission (IWC) for large whales, the North Atlantic Marine Mammal Commission (NAMMCO) for cetaceans and seals, and ICES for the ice-breeding seal species, harp and hooded seals. All current commercial hunting of marine mammals within the OSPAR area is under a management scheme which aims at sustainability and low risk of depletion of populations. Species for which no quotas are set are protected. Current hunting practices are therefore not thought to be a threat to marine mammal populations in the area, however, environmental problems such as by-catch in fishing gear, pollution and disappearing habitats may be a challenge for future management.

Commercial sealing is well within quota

Commercial sealing is carried out by Norway and the Russian Federation in the Jan Mayen area of the Greenland Sea (the West Ice) and in the south-eastern Barents Sea (the East Ice), including the White Sea. These areas play important roles in the breeding and moulting annual cycle of harp seals (both areas) and hooded seals (West Ice only). Stocks are subject to monitoring programmes and recommended catch quotas are based on advice provided by ICES. Currently, the harp seal stock in the West Ice is increasing, while the East Ice harp seals have shown a decrease in pup production since 2003. Actual catches taken from these stocks in recent years are only 3% to 7% of the recommended quotas, indicating a decreased interest in participation. The West Ice stock of hooded seals has experienced a continuous decline in abundance since the Second World War, and from 2007 onwards the commercial catch quota for this species has been zero. A small number have been taken for scientific purposes. Harbour seals and grey seals are exploited on the Norwegian and Icelandic coasts (Regions I and II) by local hunters. In Norway, quotas are set by national authorities, usually at 5% of the current abundance estimates.

Commercial whaling is carefully managed

Minke whales and fin whales have been harvested in Regions I and II by Norway and Iceland for many decades. After the IWC introduction of a moratorium (zero catch quota) on all commercial whaling after 1985, a period of high research activity followed to develop management procedures and monitoring programmes to establish a common basis for management decisions. The Scientific Committee of the IWC has developed a Revised Management Procedure (RMP) which is designed to balance long-term yield with an acceptable risk of depletion, combined with a protection level below which all quotas are set to zero. The RMP has been implemented for North Atlantic minke whales and used for quota calculations since Norway resumed minke whaling in 1994 and Iceland in 2006. A survey programme ensures that the North-East Atlantic is covered by partial surveys over a six-year period, thus supplying abundance estimates of minke whales for use in RMP catch quotas on a regular basis. The most recent abundance estimate (survey period 2002–2007) in the areas harvested by Norway is 108 000 minke whales, which is similar to previous estimates (1995: 118 000; 1996–2001: 107 000). The RMP catch quota for 2009 was set at 885 minke whales. Iceland has set a catch quota of 150 fin whales each year for the period 2009–2013.



Fin whale alongside catcher boat, Hvalfjordur, Iceland

Local hunting in Greenland and the Faroe Islands

In addition to the commercial hunting activities described above, there is also traditional or local hunting in some parts of the OSPAR area. This is of particular importance off East Greenland where subsistence hunting for ringed, harp and bearded seals, walruses and small cetaceans takes place. Catch and species are monitored and minke whales are managed under the aboriginal subsistence scheme of the IWC. On the Faroe Islands, long-finned pilot whales have been caught in a traditional drive fishery for centuries, with annual catch records dating back to around 1600. The Faroe Islands are at the northern range of long-finned pilot whales, and the catch statistics indicate widely fluctuating availability with a long-term mean annual catch of around 900 animals. A best estimate of the North Atlantic stock of pilot whales is 778 000 animals and is based on survey data from around 1990.

9 OTHER HUMAN USES AND IMPACTS

Human uses are concentrated in the coastal waters of Regions II, III and IV and have increased in intensity since 2000. Some new uses, such as offshore wind farms, are part of efforts to mitigate climate change. The relative and cumulative environmental impact of these pressures is not fully understood. The needs of different users of the sea must be balanced to ensure environmental protection and sustainable use of marine resources.

OSPAR Contracting Parties should cooperate

→ to improve international coordination on integrated management of human activities, including marine spatial planning, building on existing experience in some OSPAR countries and in conjunction with the EU Marine Strategy Framework Directive;
→ to monitor the impacts from growing human uses of the sea and to agree on methods for cumulative impact assessment and socio-economic evaluation;
→ to promote international action on marine litter and underwater noise.

Key OSPAR assessments

→ Environmental impacts of human activities
→ Marine beach litter
→ Marine litter in the North-East Atlantic Region
→ Environmental impacts of underwater noise
→ Collective impact of human activities on the OSPAR maritime area

A range of other human uses of the sea provide goods and services for OSPAR countries. These include: shipping; tourism and recreational activities; wind farms; cables; land reclamation, coastal defence and other structures; artificial reefs; mineral extraction; and dredging and dumping (including dumped munitions). These activities exert physical, chemical and biological pressures on marine ecosystems which need to be carefully managed so as to avoid unwanted impacts. Some of these impacts have been covered in Chapters 4 and 5. Under the Biodiversity and Ecosystems Strategy OSPAR has been considering the impacts from these activities to determine whether any specific measures are needed to ensure the protection of ecosystems and biodiversity. Many of these activities are regulated through national procedures, including licensing and the application of environmental impact assessments (EIA). Shipping is regulated largely through the International Maritime Organization (IMO). OSPAR is developing tools to help with the socio-economic evaluation of these activities, as a basis for valuing ecosystem services. There are also specific impacts which result from more than one activity, such as marine litter, microbiological contamination, non-indigenous species and underwater noise. Integrated management based on an ecosystem approach to management is essential for balancing the demands of different uses of the sea and nature conservation interests → **BOX 9.1**.

OSPAR Strategy objective for biodiversity and ecosystems
To protect and conserve the ecosystems and the biological diversity of the maritime area which are, or could be, affected as a result of human activities, and to restore, where practicable, marine areas which have been adversely affected.

The Strategy includes the following actions:
→ Assessment of the impact of human activities on the marine environment.
→ Drawing up of programmes and measures for controlling human activities that have an adverse impact on species and habitats that need to be protected or conserved where this is necessary.
→ Drawing the attention of the IMO to questions concerning maritime transport on which OSPAR considers that action is desirable.

Ria de Vigo, Spain

BOX 9.1 Integrated management strategies and integrated tools

OSPAR is revising its structure and activities in line with recent legislative efforts to set in place instruments for the integrated management of the marine environment based on the ecosystem approach. In 2008, the EU adopted the Marine Strategy Framework Directive and Norway has agreed integrated management plans for several large marine areas. Overall integrated management strategies such as these should be developed in close coordination with a range of specific tools for the management of human activities: environmental impact assessment (EIA), marine spatial planning and integrated coastal zone management. Marine protected areas (MPAs) are a further tool for integrating the management of human uses with environmental protection. These are often complemented by sector-specific actions and measures.

Environmental impact assessment identifies the potential impacts of a project or activity on the environment and develops mitigation measures to reduce these to acceptable levels. The EU EIA Directive supports a common approach in applying EIA to major projects such as wind farm development, land reclamation, coastal defence works and the placement of structures. An EIA aims to identify a series of discrete, auditable measures to eliminate or reduce impacts, set out in an environmental management plan. The EU Strategic Environmental Assessment Directive aims to contribute to sustainable development by ensuring that environmental consequences of certain plans and programmes, including for fisheries, energy, industry, transport and tourism, are identified and assessed in consultation with the public during their preparation.

Marine spatial planning. In 2003, OSPAR agreed to pursue strategies that would promote cooperation in spatial planning and to develop spatial planning tools for the OSPAR area. Marine spatial planning is a public process of analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that are usually specified through a political process. While some of the objectives of spatial planning are to facilitate the orderly development of maritime activities, this tool can also be useful for ensuring that they are carried out within sustainable boundaries applying the ecosystem approach. Its development should therefore be closely coordinated with overall integrated management strategies designed to achieve good status of marine waters.

Integrated coastal zone management is a multi-disciplinary process designed to promote sustainable management of coastal zones. It seeks to balance environmental, economic, social, cultural and recreational objectives within the limits set by the environment. The complexity of the coastal zone means that marine, littoral and terrestrial issues are all involved.

Marine protected areas are areas for which protective, conservation, restorative or precautionary measures have been put in place to protect and conserve species, habitats, ecosystems or ecological processes of the marine environment on a temporary or permanent basis. MPA management plans set out how human activities within an MPA should be managed to meet conservation objectives. A joint network of MPAs is being developed through OSPAR and the Natura 2000 network under the EU Habitats Directive → CHAPTER 10.

SHIPPING

Several measures addressing impacts from shipping have been introduced recently and their effectiveness is not yet clear. Air emissions have increased with growing ship traffic. Illegal discharges of oil and wastes, including litter and sewage, continue.

OSPAR Contracting Parties should cooperate

→ to monitor and assess the development of shipping, the effectiveness of measures and the impacts on the OSPAR Regions;

→ within IMO on reducing air pollution from ships as a priority, and should ratify, implement and enforce existing instruments while applying the 'clean ship' approach;

→ with the IMO, the Bonn Agreement and regional organisations on the prevention of oil spills and on risk response, including for the Arctic.

Key OSPAR assessment → Environmental impact of shipping

The North-East Atlantic has some of the world's busiest shipping routes. The OSPAR area handles 90 % of EU external trade and around 35 % of trade between EU countries. There is also a huge amount of through-traffic. Ship traffic in Regions II and IV has been increasing over the past 20 years as trade has grown and alternatives to road transport have been promoted → FIGURE 9.1. This includes increases in the number of ships, the cargo carried and the size of ships. Transport by sea is considered more environmentally friendly than transport by air or road, but shipping has clear impacts on the marine environment.

What are the problems?

Shipping exerts a number of pressures

The main pressures associated with maritime shipping in the OSPAR area include the following:

- Pollution by oil and hazardous or toxic substances from incidental, operational and illegal discharges.
- Air pollution through emissions and particulate matter from engine exhaust gases and cargo tanks, which may be carried over long distances.
- Discharge and disposal of wastes from ships including sewage and litter.

- Release of toxic chemicals used in anti-fouling paints and anodes.
- Introduction of non-indigenous organisms through ships' ballast water and associated sediments, and fouling on ships' hulls.
- Pollution and physical impact through loss of ships and cargo.
- Physical and other impacts including noise and collision with marine mammals.

What has been done?

OSPAR cooperates with other international bodies

The IMO is the competent international body regulating international shipping to protect the marine environment. OSPAR can refer to the IMO any shipping-related concerns regarding environmental protection within the OSPAR area.

OSPAR is following up commitments made at the North Sea Conferences. The North Sea Ministerial Meeting on the Environmental Impact of Shipping and Fisheries in 2006, resulting in the 'Gothenburg Declaration', reinforced the commitment of North Sea states to the 'clean ship' approach. This is a concept whereby vessels are designed, constructed and operated in a way that aims to eliminate harmful discharges and emissions during their working life. The clean ship approach has been followed up by some OSPAR countries through 'green ship label' initiatives.

OSPAR also works closely with the Bonn Agreement. This is the mechanism by which the North Sea states and the EU work together to detect and combat pollution from maritime disasters and chronic pollution from ships and offshore installations.

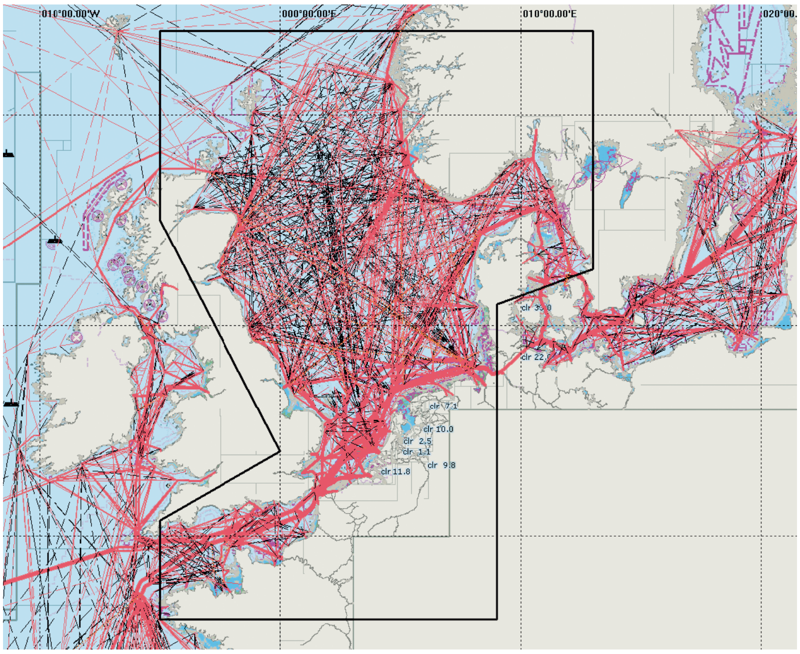


FIGURE 9.1 *Shipping traffic in Region II and connections with the Baltic Sea.*

Recent international measures target impacts from shipping

The main international convention covering the prevention of pollution from ships is the MARPOL Convention and its thematic annexes I to VI. Annex II on noxious liquid substances carried in bulk was revised with effect from January 2007 to reduce the impact of cargo tank cleaning. Annex VI, relating to the prevention of air pollution, was amended in October 2008 to further reduce harmful emissions from ships. The International Convention for the Safety of Life at Sea (SOLAS) sets technical minimum standards for vessels and so reduces the risk of shipping accidents and thus accidental pollution.

Several priorities identified in the QSR 2000 are now addressed through legislation developed at the international level by the IMO. This includes the Convention on the Control of Harmful Anti-fouling Systems on Ships (2001) and the Convention for the Control and Management of Ships' Ballast Water and Sediments (2004). OSPAR and the Helsinki Commission (HELCOM) have developed guidelines for managing ballast water, based on those of the IMO, which can be used on a voluntary basis, pending the ratification and entry into force of the IMO Ballast Water Convention.

In 2008, the IMO Marine Environmental Protection Committee developed a programme of work for minimising incidental noise from commercial shipping. It also began work on guidance for minimising the risk of ship strikes with marine mammals.

Following the loss of the *Erika* off the French coast in 1999, the EU adopted several Directives aimed at preventing accidents at sea and established the European Maritime Safety Agency (EMSA). The EU Blue Book on an Integrated Maritime Policy provides the framework for an integrated approach to managing marine activities, including shipping, and the environment.

Many of these measures have only been taken recently and it is too early to judge their effectiveness. In some cases, information is too limited to quantify the contribution of shipping to impacts such as oil spills or litter and to evaluate progress made since 1998. Improved monitoring of the development of impacts is therefore a priority.

Efficient surveillance, investigation and prosecutions are essential for the protection of the marine environment from pollution by shipping. The North Sea Network of Investigators and Prosecutors, a body associated with the OSPAR Commission and closely cooperating with the Bonn Agreement, was set up in 2002 to help enforce international pollution rules and standards in the North Sea. This is achieved through promoting effective use of evidence in the different national legal systems, comparable levels of penalties and exchange of information on convictions of offenders.

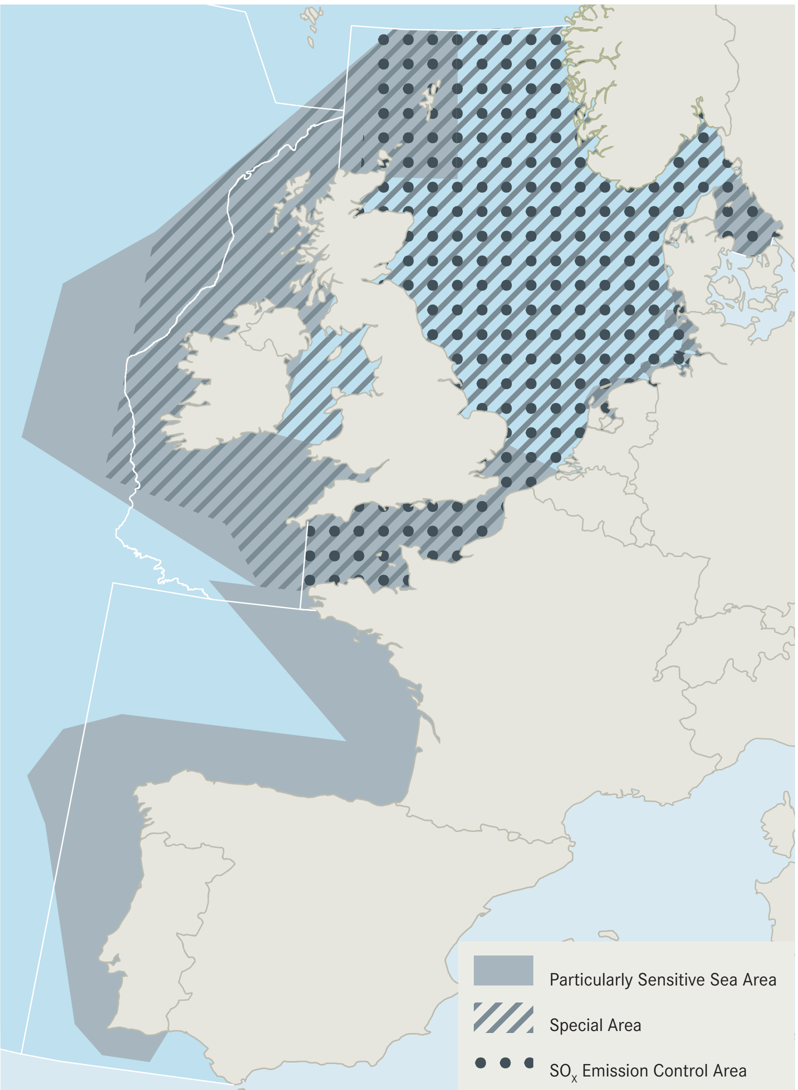


FIGURE 9.2 *Areas of the North-East Atlantic recognised as MARPOL Special Areas, MARPOL SO_x Emission Control Areas (SECA) or Particularly Sensitive Sea Areas (PSSAs). The Kattegat has been recognised under those regimes as part of the Baltic Sea.*

Special Areas and Particularly Sensitive Sea Areas

The IMO recognises that particular areas require a stricter regulatory regime for pollution from ships and management of shipping routes → **FIGURE 9.2**:

- The North Sea was designated a Special Area under MARPOL Annex V in 1991. More stringent restrictions for discharges of garbage apply in this area.
- The North West European Waters were designated a Special Area under MARPOL Annex I in 1999 leading to more stringent restrictions on the discharge of oil and oily waste in this area.
- The North Sea was designated a Sulphur Oxides (SO_X) Emission Control Area (SECA) under MARPOL Annex VI in 2007. Ships must comply with more stringent emission and fuel quality requirements if they want to pass through this area. Ships in the area are only permitted to burn low sulphur content fuel.
- The Wadden Sea and the Western European Waters were designated Particularly Sensitive Sea Areas (PSSAs) in 2002 and 2004, respectively, in recognition of their ecological, socio-economic or scientific importance.

Did it work?
How does this affect the quality status?

Some signs of decreasing oil pollution in the North Sea

Because the North Sea has been designated a Special Area under MARPOL Annex I, the discharge of oil or oily waste is more stringently regulated. Nevertheless, aerial surveillance conducted under the Bonn Agreement suggests that illegal discharges of oil or oily wastes are still occurring → FIGURE 9.3. Limited data are available to quantify how much oil has been spilt in the OSPAR area since 2000 as a result of incidental and illegal discharge. For around 80 % of slicks detected using aerial surveillance it is not possible to identify the polluter. This means it is not possible to quantify how many of the slicks are attributable to shipping. Monitoring for the North Sea Ecological Quality Objective (EcoQO) on oiled guillemots suggests that oil pollution at sea has been decreasing → BOX 9.2.

Incidental spills can cause severe damage

Incidents involving spills from ships carrying oil and other hazardous or toxic substances can have severe effects on the marine ecosystem. The effects may be short- or long-term depending on climatic and environmental conditions at the time of the spill and the sensitivity of the area. The *Prestige* oil spill demonstrates the importance of enforcement of IMO ship standards, appropriate risk response and management of shipping lanes in ecologically sensitive areas to reduce risks of incidents and impacts of oil spills → BOX 9.3. Since 1998, a number of incidents have occurred in the OSPAR area involving loss of cargo (e.g. chemicals, timber, containers) and of ships. In most cases, there is limited information to assess the environmental impact of these losses. Improved controls on the securing of cargoes could work to minimise cargo loss.

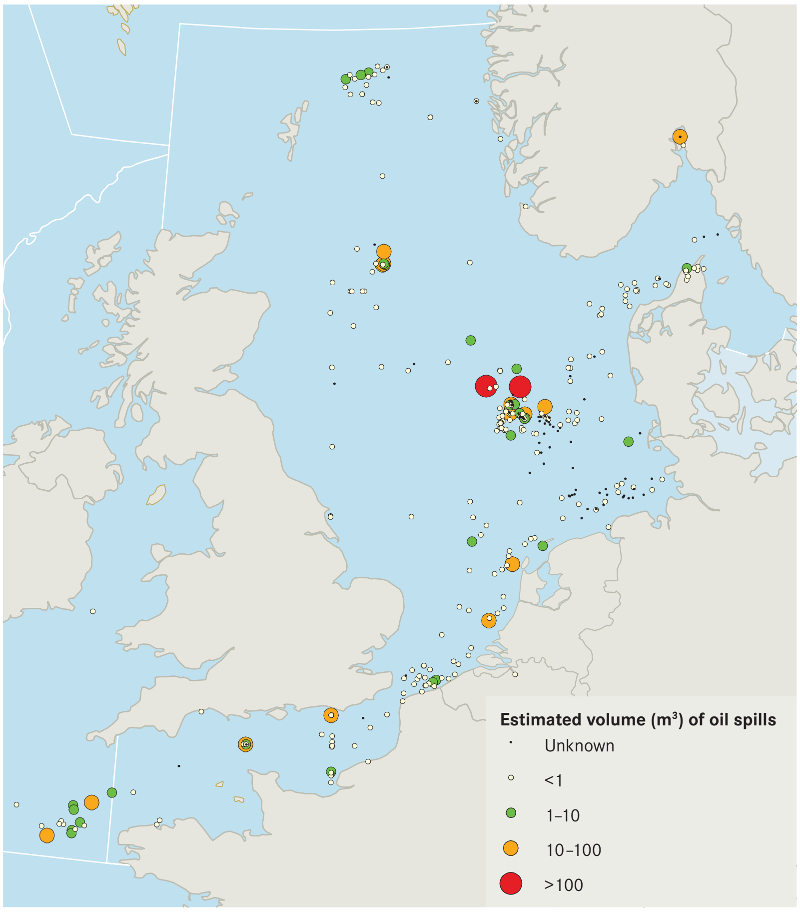


FIGURE 9.3 *Oil spills detected using aerial surveillance in the North Sea in 2008. Based on observations by Belgium, Denmark, France, Germany, Netherlands, Norway, Sweden and the UK. Data source: Bonn Agreement.*

BOX 9.2 Reduced rate of oiled guillemots indicates decreasing oil pollution in the North Sea

North Sea EcoQO: The average proportion of oiled common guillemots in all winter months (November to April) should be 10 % or less of the total found dead or dying in each of 15 areas of the North Sea over a period of at least 5 years.

Guillemots are deep-diving seabirds that are common and widespread throughout the OSPAR area. They are very sensitive to oil pollution. A guillemot will soon die once it is oiled, due to hypothermia and because it is unable to forage and feed. These dead birds wash ashore and the proportion of stranded guillemots that are oiled can be used as an indication of oil pollution in specific areas.

In some parts of the North Sea, over 90 % of all stranded common guillemots were oiled until only a few decades ago. Since then rates of oiled birds have declined substantially in most areas. This is thought to be the result of better enforcement of measures, improved awareness and the introduction of port reception facilities for waste oil. However, the EcoQO is achieved in very few parts of the North Sea. Current rates of oiled birds in the North Sea vary significantly from over 50 % in the southern North Sea (the Netherlands, Belgium and south-east England) to approximately 4 % in Orkney in the northern North Sea.

The main inputs of mineral oil originate from operational discharges from ships, land-based sources and, to a lesser extent, from the offshore oil industry. This partly explains why higher bird oiling rates are seen near busy shipping lanes (southern North Sea, Channel). Accidents at sea are a less frequent source.

Since the discharge of oil or oily mixtures that cause slicks is prohibited in the North Sea, management measures need to focus on the further enforcement of current regulations and raising awareness among operators of vessels to reduce illegal oily discharges.

BOX 9.3 The long-term effects of the *Prestige* oil spill are not yet known

In 2002, the 26-year old, single-hull tanker *Prestige* started leaking heavy fuel oil from its 77 000 tonne cargo following an incident 50 km off the Galician coast of northern Spain. The *Prestige* was towed out to sea. During this operation it broke in two in a storm and sank some 200 km off the coast coming to rest at 3600 m depth on the slopes of the Galicia bank seamount where the wreck continued leaking oil.

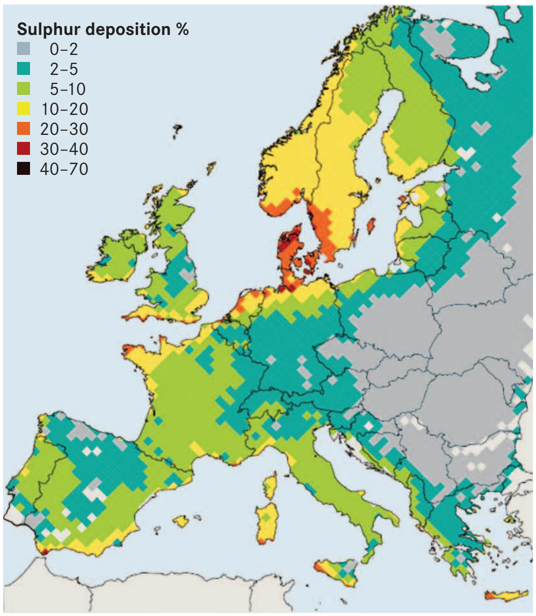
An estimated 64 000 tonnes of oil were spilled and polluted the seabed and more than 1000 km of coastline in Spain and France. The immediate area affected off Galicia is an area of ecological importance supporting cold-water coral reefs and deep-sea sponges. The area is also important for the fisheries on which 60 % of the Galician population depends.

Initial effects on seabirds were profound. Of the 20 000 oiled birds collected, 75 % were dead and few of those collected alive were able to recover. The last remaining Iberian populations of the guillemot were among the worst affected. Given the widespread and long-term impact of the oil spill on the Atlantic coast, estimates suggest that the total number of birds affected was much higher, up to some hundred thousand.

Biomarker measurements in fish showed that large areas of the northern Iberian shelf were affected by oil from the *Prestige* and that measurable effects decreased over the period 2002 to 2005 indicating a recovery of the water quality. Little is known about the effects of the oil pollution on the deep seabed and its biological communities and the rate of recovery.

Air pollution from ships is increasing

Emissions of nitrogen oxides (NO_X), SO_X and particulate matter from engine exhaust gases and cargo tanks may be carried long distances. Most emissions in EU sea areas are from cargo ships over 500 gross register tonnage. Around 45 % of all emissions are from EU-flagged ships and around 20 % of emissions are emitted within 12 miles of the coast. The total contribution of NO_X from international ship traffic in the North Sea and the Atlantic was 1850 kt in 2007. This is an increase of more than 20 % since 1998. Without the strict standards of the revised MARPOL Annex VI adopted in 2008, emissions from international shipping would have been expected to increase substantially. Models predict that by 2020 emissions of sulphur dioxide, NO_X and particulate matter from international shipping in all EU seas would have increased from their 2000 levels by 40 % (3200 kt), 45 % (4800 kt) and 55 % (400 kt) per year, respectively → **FIGURE 9.4**. Implementing the more stringent emissions standards in the amended MARPOL Annex VI will help target air pollution and should be given high priority, particularly in light of the expected increase in ship traffic. Even stricter standards apply in designated NO_X and SO_X Emission Control Areas. As a SECA, the North Sea currently profits from the more stringent ship fuel regulation for SO_X, but this still allows sulphur contents in fuels 15 000 times that



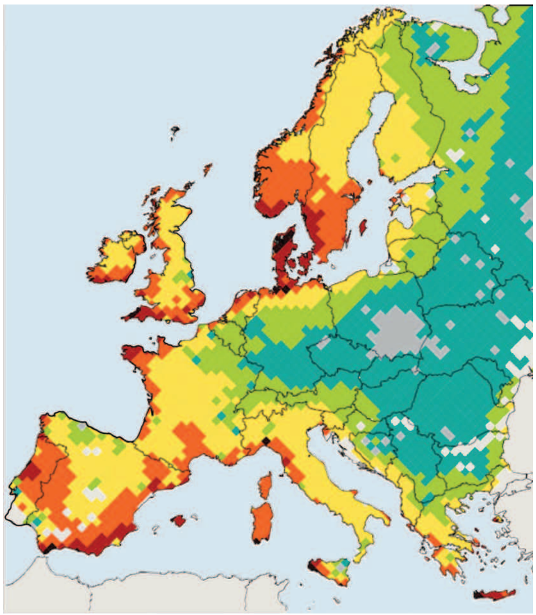


FIGURE 9.4 *Percentage of atmospheric deposition of sulphur originating from international shipping in 2000 (left) and projected for 2020 if no action is taken (right). Emission controls as a result of revisions to MARPOL Annex VI adopted in 2008 are expected to progressively reduce deposition. Source: IIASA, 2007.*

of fuel for road vehicles. Moreover, fuel regulations under MARPOL Annex VI address only sulphur and not other polluting substances. This is a gap that needs to be closed. Despite a large amount of information on inputs via the atmosphere, there is limited understanding of the contribution of shipping to environmental impacts.

Ships also emit ozone-depleting gases (e.g. from incinerators and cooling installations) and greenhouse gases from engine exhausts and so contribute to global emissions. A recent IMO study estimates that shipping emitted 1046 million tonnes of carbon dioxide (CO_2) globally in 2007, which is 3.3% of total world-wide CO_2 emissions in 2007. Most of these emissions (870 million tonnes or 2.7% of global CO_2 emissions) have been attributed to international shipping.

The IMO is currently working towards measures to reduce greenhouse gas emissions from shipping. The EU also targets air emissions from shipping through its 2005 Thematic Air Strategy. OSPAR countries support these initiatives.

Illegal discharges and disposal of waste are still occurring

Illegal disposal of waste (litter) from ships can be as detrimental to marine life as oil or chemicals. The greatest danger comes from plastics. Discharge of garbage is regulated through MARPOL Annex V. This prohibits the disposal of plastics anywhere into the sea, and severely restricts discharges of other types of garbage from ships to coastal waters and Special Areas. While shipping is acknowledged as a major source of marine litter it is difficult to quantify the exact amount as many litter items can be attributed to more than one source.

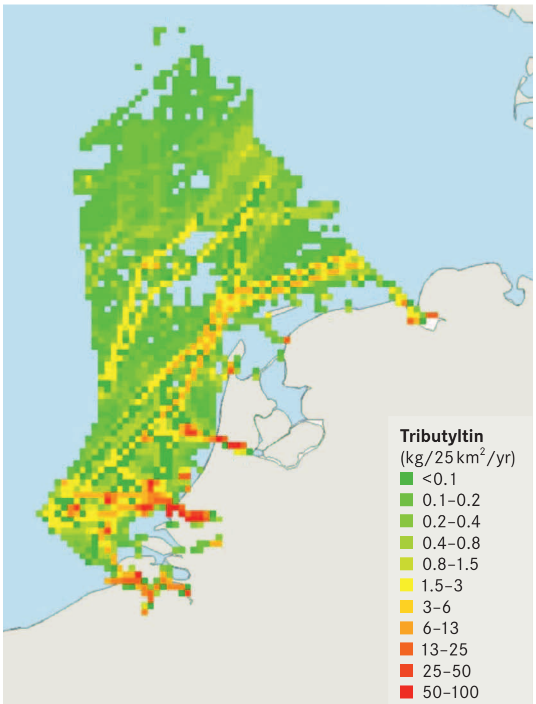
The effects of sewage discharges on water quality and in relation to eutrophication are thought to be minimal provided they comply with MARPOL Annex IV. In the open sea, raw sewage is assimilated through natural bacterial action, but illegal sewage discharges near the coast may be a problem locally.

Lack of data prevents assessment of port waste reception facilities

According to MARPOL, oily ballast and tank washing water, oily bilge water and wastes should be retained on board until they can be delivered to port waste reception facilities. It is difficult to identify improvements brought about by the introduction of port waste reception facilities because there are few data on the amounts and types of wastes handled. Prior to the implementation date of measures there was no reporting system in place and most waste operations in ports are contracted out to private operators which rarely report to port authorities.

TBT losses are expected to cease

There has been much progress towards the phasing out of tributyltin (TBT) → **CHAPTER 5**. Following the global ban on TBT in anti-fouling systems through the IMO, the release of TBT from ships' hulls is expected to cease with an associated decline in effects on marine species from TBT. However, losses of TBT substitutes (such as copper and Irgarol) are expected to increase. It has been estimated that ships in the Netherlands' Exclusive Economic Zone (EEZ) collectively release up to 30 tonnes of copper into the North Sea each year, both in transit and at anchor → **FIGURE 9.5**. There has been some progress in the development of non-biocidal



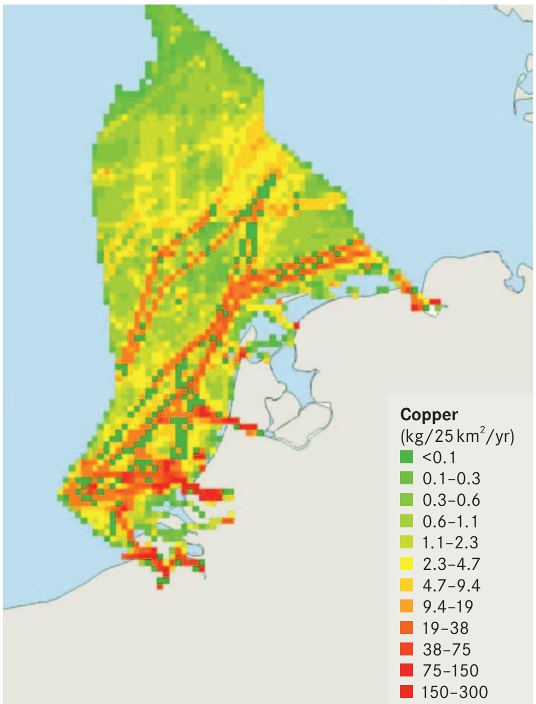


FIGURE 9.5 *Estimated losses of TBT and copper from ship coatings at sea (excluding fishing vessels) in the EEZ of the Netherlands in 2007.*

alternatives to TBT and copper such as self-polishing surfaces and non-sticky paints.

Introductions of non-indigenous species through ballast water continue

Over 160 non-indigenous species have been identified in the OSPAR area, as reported later in this chapter. Some of the main routes for these unintended introductions are through the discharge of ballast water (and the sediments that it carries) and fouling on ships' hulls. The risk of new species introductions is related to the amount of ballast water discharged, the frequency of ship visits and the match between environmental conditions where ballast water originated and where it is discharged. With increasing ship traffic there is a higher risk that new species will be introduced. Faster ships and shorter journey times mean that organisms have a greater chance of surviving the voyage.

Non-indigenous species can severely affect the structure of ecosystems. For example, the comb jelly (*Mnemiopsis leidyi*) which feeds on zooplankton and fish eggs was introduced to the Black Sea through ballast water in the 1980s and has been associated with dramatic changes in the pelagic food web and the collapse of commercial anchovy fisheries. The species was first recorded in the Netherlands, Norway and Sweden in 2006. So far, effects on the North Sea trophic structure and on fish stocks are unknown. Milder winters due to climate change are expected to favour its expansion. There is a need for OSPAR countries to ratify and implement the IMO Ballast Water Convention and to assess the risk of new species introductions.

Comb jelly

Increasing concern over noise and ship strikes

There are growing concerns over pressure on marine mammal populations due to noise from shipping and the risk of ship strikes, especially along migration routes in Regions I, IV and V. Ship traffic has been shown to be a dominant source of low frequency noise in many, if not most, coastal zones with high ship traffic. It is estimated that there has been an approximate doubling (3 dB increase) of background noise per decade since the 1950s in some sea areas. Commercial shipping is the most probable source of this increase. The development of faster and larger ships, and growth of ship traffic have increased concern about the risks associated with ship strikes. Collisions with ships are known to be fatal for whales, especially larger species, and may be a threat to vulnerable populations in waters with high levels of shipping.

Pressures on the environment are expected to increase

Predictions for shipping for the period to 2020 are difficult, due to confounding economic factors such as oil price and geopolitical issues. However, through-traffic of oil tankers is predicted to increase with higher environmental risks in the busier shipping lanes especially in Region II. Shipping is expected to increase in Region I, where sea-ice retreat and new technology are expected to afford new opportunities for exploiting Arctic resources (hydrocarbons, minerals, fisheries). The most significant threats from Arctic shipping are oil discharges.

With growing ship traffic and vessel size, increasing pressure can be expected from dredging and dumping of sediments from shipping channels, land reclamation and the construction of port facilities. These pressures are mainly concentrated on coastal areas where increasing pressures may conflict with nature conservation objectives for areas of particular ecological value.

Fin whale showing marks of ship strike in the Mediterranean Sea

What happens next?

Implementing and enforcing existing measures are the priorities

There has been significant progress in the development of measures to address pressures from shipping on the marine environment. The implementation of these measures, especially MARPOL Annexes I to VI, and their enforcement is essential to reducing pollution from ships.

OSPAR should promote the strict implementation of existing measures and, where appropriate, should seek to influence those international organisations with the competence to improve enforcement of shipping regulations at sea. OSPAR should assess the effectiveness of these measures through improved data collection on, and continued monitoring of, key pressures and impacts of shipping on the marine environment.

OSPAR should promote action by OSPAR countries within the framework of the International Maritime Organization (IMO):

- To implement the 'clean ship' approach agreed under the Gothenburg Declaration in maritime and environmental policies.
- To develop improved practices and innovative technologies for ships in port and at sea to help reduce current and future emissions of greenhouse gases, NO_x, SO_x and particulate matter, taking into account the relevant IMO regulations.
- To provide effective port reception facilities for litter and oily waste and apply best practice as recommended by the IMO.
- To implement the global ban on the use of organotin compounds in anti-fouling systems in ships.

OSPAR should further assess effects of ship noise and ship strikes on marine mammals in cooperation with the relevant international organisations, and work with the IMO in developing and implementing mitigation strategies.

A range of initiatives is needed to mitigate effects

OSPAR countries should undertake the following range of initiatives to mitigate the effects of shipping in the North-East Atlantic:

- Cooperate in the field of oil spill prevention and implement, as soon as possible, the IMO regulations aiming at reducing the risk of collisions and grounding, and the associated impacts from accidental spills and losses of cargo.
- Cooperate in contingency planning and counter-pollution responses. This should be done through the Bonn Agreement in Region II; through the development of response capacities and international cooperation agreement(s) in the Arctic; and, once entered into force, through the Lisbon Agreement (Cooperation Agreement for the Protection of the Coasts and Waters of the North-East Atlantic against Pollution) in Region IV and some adjacent areas of Region V.
- Apply the global and regional measures for preventing the spread of non-indigenous species via ballast water. The D1 Ballast Water Exchange Standard should be applied in the North-East Atlantic in the interim period before the more stringent D2 Standard comes into force.
- Ratify the IMO Ballast Water Convention and work to promote its entry into force. OSPAR countries should also assess the risk of introducing non-indigenous species so that appropriate regional and national preventive measures can be implemented.
- Consider the development of systems to collect and store accurate and comparable data that can be used to assess the impact of shipping on the marine environment.
- Cooperate closely with respect to shipping in the Arctic and promote related work by other international forums, particularly the IMO and the Arctic Council. Priority issues include the update and mandatory application of the IMO Guidelines for ships operating in Arctic ice-covered waters (the 'Arctic Guidelines') and, where necessary, the designation of 'Special Areas' or 'Particularly Sensitive Sea Areas', and better passenger ship safety.

TOURISM AND RECREATIONAL ACTIVITIES

Tourism is leading to increasing demand for space and increasing pressures on species and habitats. Special attention should be given to growing pressure from tourism in remote areas.

Key OSPAR assessment → Environmental impact of tourism and recreational activities

Many coastal areas in the North-East Atlantic are popular holiday destinations. Since the 1990s, the total number of tourists visiting the OSPAR Regions has increased steadily, growing from around 100 million in 1998 to around 146 million in 2007 → FIGURE 9.6. There are continued increases in coastal infrastructure, including for accommodation and service, and an increasing demand for resources, especially in Region IV, the southern part of Region II and parts of Region III.

The growth of tourism has increased pressure on natural areas and fragile ecosystems, such as dunes, cliffs and wetlands. Tourism also contributes to pollution, marine litter and coastal erosion. Beach tourism and recreational boating are widespread forms of coastal or sea-based tourism and have direct effects on marine species and habitats. Cruise tourism has steadily increased and is expected to continue growing. Other recreational activities that can put pressure on the marine environment include scuba-diving, angling and whale-watching.

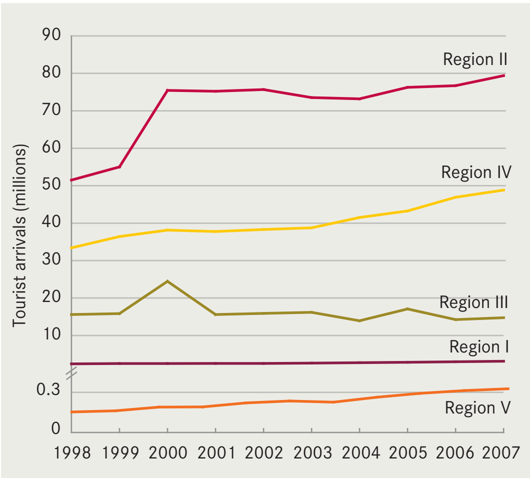


FIGURE 9.6 *Tourist arrivals to coastal areas in the OSPAR Regions (1998–2007). Data source: Eurostat.*

A particular concern is habitat fragmentation caused by tourism-related development, especially along the coasts of Regions II and IV. Another concern is the disturbance of beach-dwelling species by tourists during the breeding season. For example, the little tern has suffered reduced breeding success in the southern North Sea. Seagrass meadows (*Zostera* sp.), which OSPAR has identified as a habitat in need of protection, are impacted by recreational boating, both from frequent anchoring and from dredging to increase water depth. The growing attraction of remote areas as tourist destinations, including in the Arctic → BOX 9.4, puts these relatively pristine areas under pressure.

OSPAR is working to address some of the main impacts from activities associated with tourism, such as nutrient inputs from sewage → CHAPTER 4, effects of dredging and marine litter. Efforts to comply with the EU Bathing Water Directive provide a focus for water quality in coastal areas. OSPAR countries have also undertaken various actions to preserve their coasts from excessive development. These have been supported by the designation of Natura 2000 sites, OSPAR marine protected areas (MPAs)

BOX 9.4 Cruise tourism in the Arctic

Arctic cruising has seen significant growth in recent years. The Svalbard archipelago (Norway), often referred to as Spitsbergen, is one of the most popular destinations in the Arctic. The number of sites visited has increased from 64 in 1996 to 160 in 2008. In 2008, 97 704 tourists visited Svalbard. All recreational ships coming to Svalbard are required to notify the Governor of Svalbard and obtain approval for their travel plans in advance of their trip.

Cruise ships represent a source of disturbance and pollution in areas that are not otherwise affected. The biggest single threat posed by ship-based activities on Svalbard is from a major oil spill. Other environmental threats include degradation of regularly-visited sites, air pollution, discharges of sewage and waste water and introduction of non-indigenous species.

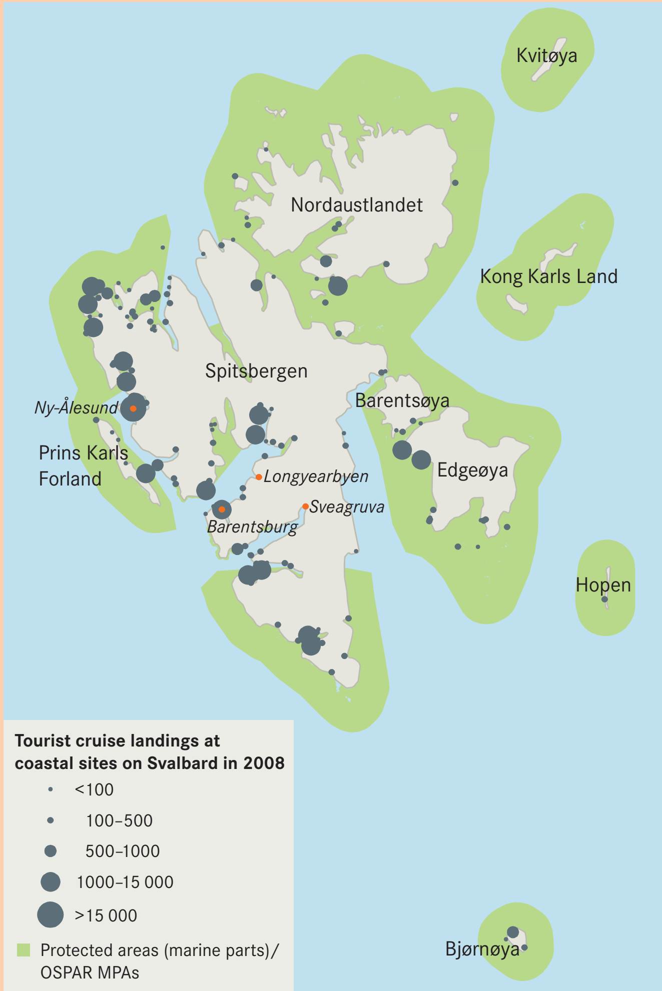
Norway has established a number of protected areas to conserve the archipelago's natural and cultural values. Where national parks and nature reserves border the sea, their boundaries extend 12 nautical miles out from shore. These marine areas have been included in the OSPAR network of MPAs. Voluntary guidelines, such as the 'Ten Principles' for Arctic Tourism developed by WWF International together with local communities, tour operators and other stakeholders, help to reduce negative impacts.

Ny-Ålesund, a scientific community on the west coast, is the world's most northerly permanent settlement and is popular with cruise ships. The annual influx of 15 000 to 20 000 tourists has forced the development of a code of conduct for tourists to reduce their impact on the local environment and research programmes.

Tourist pressure is also managed by restricting access to land areas. In addition, there are time limits imposed on anchoring by ships at Ny-Ålesund.

It is likely that Svalbard will continue to be a popular cruise destination. There is also a possibility that more remote areas of the archipelago will be impacted as larger ice-class vessels are commissioned and the extent of summer sea ice is reduced due to climate change.

Text based on WWF (2004); map based on data from the Governor of Svalbard.



and national marine parks → **CHAPTER 10**. The European Commission's proposed strategy on Integrated Coastal Zone Management (ICZM) and the recommendation of the European Parliament and the Council concerning the implementation of ICZM could contribute to minimising impacts on the marine environment while supporting sustainable tourism, if effectively implemented. In this context, implementing marine and coastal spatial planning policies, the use of guidelines and principles for sustainable tourism, and the designation and management of protected areas should be encouraged. OSPAR should keep under review the extent of impacts from tourism-related pressures as the industry develops further.

WIND FARMS

Offshore wind energy production is projected to increase rapidly. Careful planning and site selection is needed. Operators should follow OSPAR guidance to minimise environmental impacts. OSPAR Contracting Parties should cooperate to monitor these impacts and address gaps in knowledge.

Key OSPAR assessment → Environmental impact of offshore wind farms

Over the past ten years, energy production by offshore wind farms has emerged as a new use of coastal and shallower offshore waters → FIGURE 9.7. Operation and proposed development of offshore wind farms is currently limited to Regions II and III. In 2009, 17 wind farms with a total of 713 turbines were either operational or under construction covering an area of over 500 km². These will have a combined capacity of almost 1900 MW. Around 800 turbines are expected to be operational by 2010. The development of large-scale offshore wind farms is being driven by demands for increased renewable energy production as a result of policies to reduce reliance on fossil fuels and to mitigate the effects of climate change. The EU is committed to having 20% of its energy production from renewable sources by 2020. By the end of 2009 a further 50 wind farms (2490 turbines) had been authorised, but construction work for most was still to start. Applications had been submitted for another 74 (2463 turbines).

Impacts arise throughout the life cycle of wind farms, including: site selection, construction, operation, decommissioning and removal. Impacts include the effects of noise on marine mammals and fish, disturbance and loss of habitats, bird collisions and visual intrusion. Wind farms can also interfere with other uses of the sea – causing hazards to shipping and the servicing of the offshore industry, and displacing fishing activities and recreational boating. There may also be conflict with marine conservation objectives.

Knowledge of the wider effects of offshore wind farms on environmental quality is limited and mainly based on data from monitoring at specific sites, similar activities, government sponsored research and development, and predictions from EIAs. Monitoring of bird abundance in the vicinity of the *Horns Rev* and *Nysted* offshore wind farms off Denmark shows a statistically significant decrease in numbers of some seabird species up to 2 km from the wind farms. Such displacement could potentially give rise to a loss of feeding grounds. Marine mammals have been disturbed by noise from pile driving up to 20 km from the *Horns Rev* wind farm. As with other construction on the seabed, wind farms may also have positive impacts, for example,

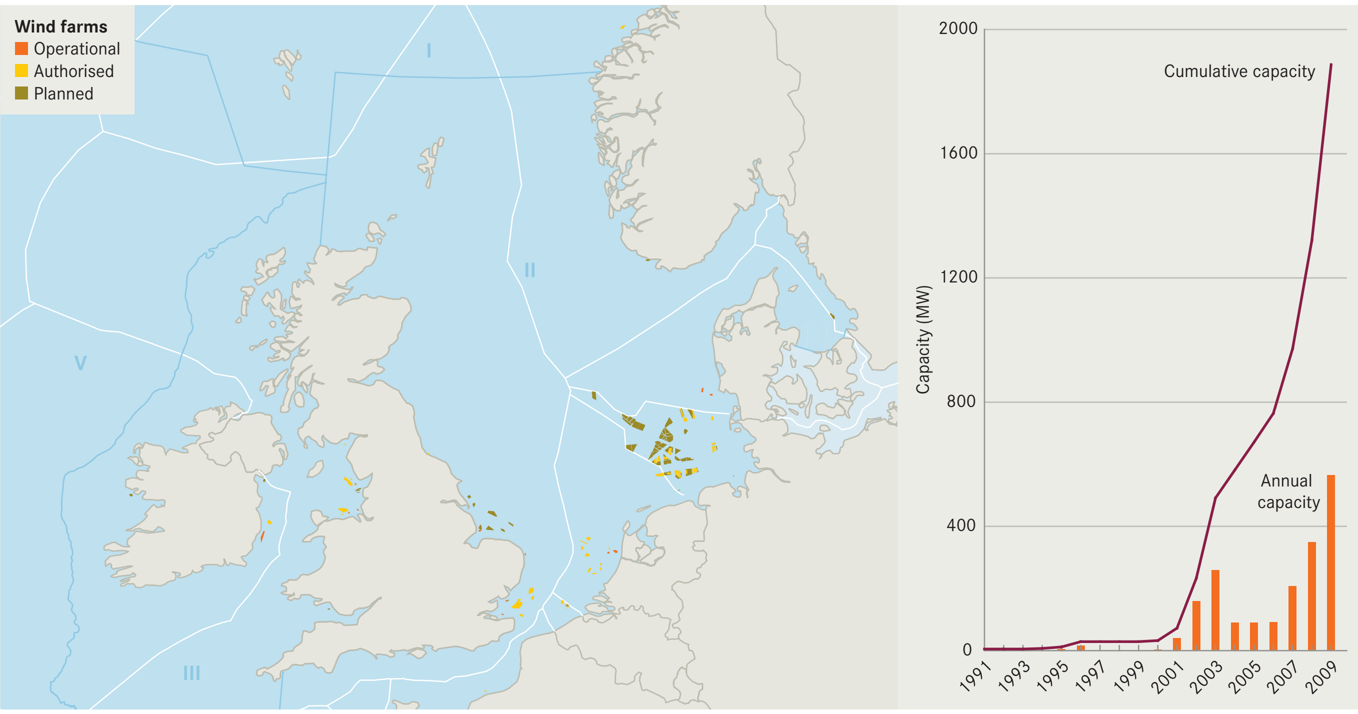


FIGURE 9.7 *Location of operational, authorised and planned wind farms in the OSPAR area in 2009. The graph shows trends in the development of wind power since the 1990s. Data source: OSPAR database on offshore windfarms and development of offshore wind power in the OSPAR maritime area (1998–2009). Source: European Wind Energy Association, offshore statistics 2009.*

Horns Rev offshore wind farm, Denmark

by restricting other human activities, such as fishing. The degree and extent of these benefits is still being established.

Currently, the location, size and separation of the relatively few operational offshore wind farms in the OSPAR area are such that population-scale impacts on marine organisms have not been found. However, many proposed wind farms are more extensive than those in operation and in some cases several hundred turbines are planned per farm. The potential for cumulative and transboundary effects (particularly on migratory species) will increase as more wind farms are developed.

OSPAR has developed guidance on environmental considerations for the development of offshore wind farms. This recommends best practices to assess, minimise and manage the potential impacts of wind farms. All OSPAR countries have national approval procedures for marine developments; Germany, the Netherlands and the UK have specific guidance for offshore wind farms. OSPAR has a database on operational and proposed sites and promotes the exchange of information through its website.

Many of the environmental impacts associated with offshore wind farms can be mitigated through national licensing procedures. These should ensure that the OSPAR guidance is followed, in particular, that sites are selected to avoid important seabird feeding areas, construction is timed to minimise effects on spawning fish, and routes taken by construction vessels are positioned to minimise disturbance to seabirds. Monitoring at operational wind farms will provide the basis for better management at future wind farms.

With the expected increase in the number and scale of offshore wind farms beyond 2010, OSPAR will need to address the gaps in knowledge about the effects of wind farms on the marine ecosystem. Information from monitoring of operational wind farms should be exchanged and assessed. Impacts from wind farms need to be kept at acceptable levels in relation to reference populations of species that are affected. These could be populations that are functionally or regionally significant or populations within biogeographic regions or flyways. Where appropriate, consideration of cumulative and transboundary effects should become a more critical part of the national assessment and consenting process. OSPAR will need to keep under review the need for measures or guidance to address these aspects. In the interim, existing approaches to wind farm management should be followed to ensure that impacts are minimised. These approaches should be supported by measures to mitigate effects such as underwater noise (e.g. from pile driving during construction), electromagnetic fields, bird displacement and physical changes to the seabed.

CABLES

Power cables are regarded as having localised impacts, but there is limited knowledge on their effects on marine organisms, particularly from heat emission and electromagnetic fields.

Key OSPAR assessment	→ Environmental impact of cables

Submarine cables have a long history in telecommunication services and are increasingly important for transmission of electric power. Most telecommunication cables are located in the southern parts of Region II, Region III and in a transatlantic corridor in Region V → FIGURE 9.8. Almost all power cables are located in Regions II and III. Submarine cables are usually buried, but in areas of exposed bedrock they are laid directly on the seabed and may be covered by a protective structure. The development of offshore power generation and transnational energy networks will require new power cables and the need for new communication links is likely to remain high in some areas.

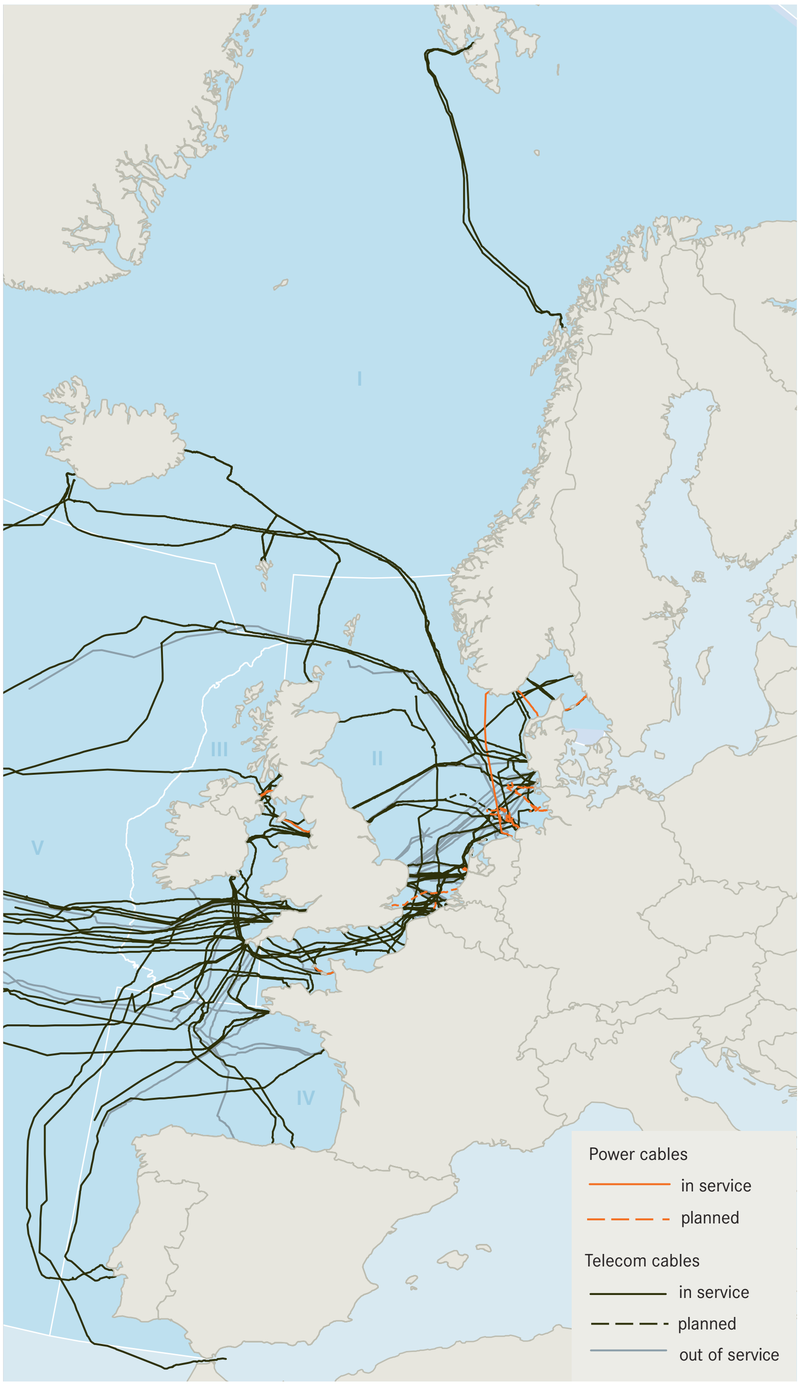


FIGURE 9.8 *Subsea cables in the OSPAR area (data incomplete). Composed from different sources by the German Federal Agency for Nature Conservation.*

Placement and removal of power cables causes temporary local disturbance of the seabed. There are also a range of permanent environmental effects. These include the settling of non-indigenous hard-substrate species on unburied cables or protective structures. During operation, electromagnetic fields from power cables may affect the behaviour and migration of fish and marine mammals that use electric fields or the Earth's magnetic field for orientation. Heat from power cables may affect bottom-dwelling species and biogeochemical processes. These effects need further study.

So far, no common programmes or measures for the placement of subsea cables have been developed either by OSPAR or by other organisations, but some OSPAR countries subject the placement and operation of cables to licensing procedures.

Mitigation measures should be used, such as the choice of cable type, appropriate selection of burial or surface laying and scheduling placement according to the sensitivity of local habitats. OSPAR should develop guidelines to help OSPAR countries assess the environmental effects of cables. Research is needed on the effects of heat emission and electromagnetic fields and the impact of burial and removal operations on marine organisms.

LAND RECLAMATION, COASTAL DEFENCE AND OTHER STRUCTURES

There are increasing demands for coastal defence in Regions II and III. Local management needs to take into account regional-scale effects, such as sediment balance.

Key OSPAR assessments

→ Environmental impact of land reclamation
→ Environmental impact of coastal defence structures
→ Environmental impact of construction or placement of structures

Various artificial structures have been constructed within the OSPAR area. Land has been reclaimed to extend ports and provide associated industrial zones and various sites have been proposed for future land reclamation projects. Coastal defence structures have been installed to prevent erosion and protect against flooding at vulnerable sites. Many ports, marinas, piers and other infrastructure have been created. It is estimated that over 13 000 individual structures have been placed in the OSPAR area → FIGURE 9.9.

Construction activities can have a range of impacts on the marine environment. They may cause loss or damage of coastal habitats and changes to the physical nature of the seabed, which in turn cause erosion, sedimentation and physical and chemical disturbance of ecosystems. While the structures are under development there may be more underwater noise, water pollution (e.g. higher turbidity), and air pollution. Foraging or breeding seabirds and marine mammals are affected by visual or noise disturbance. There may be a loss of space for human activities, such as coastal fishing.

Since 1998, OSPAR countries have reported on the reclamation of around 145 hectares from the sea and coastal wetlands, mainly in the form of small-scale developments. Most sites, including the largest, are located in Region II. Typical habitats affected by land reclamation and the construction of other structures include sandbanks, estuaries, mudflats and salt marshes. Long-term growth in world trade is likely to lead to more development of shipping-related infrastructure.

Extensive lengths of coastline in the OSPAR area are protected against erosion by coastal defence structures. Techniques employed include dykes, groyne fields, seawalls, and beach nourishment schemes to replace sand lost from beaches. The almost unbroken line of coastal defence schemes protecting the southern coast of the North Sea and parts of its west coast has caused extensive fragmentation of habitats. Hard-engineered coastal defence structures, such as seawalls and dykes, change ecosystems and create new hard-bottom habitats. Soft-engineering coastal structures, such as dunes and salt marshes, are increasingly being

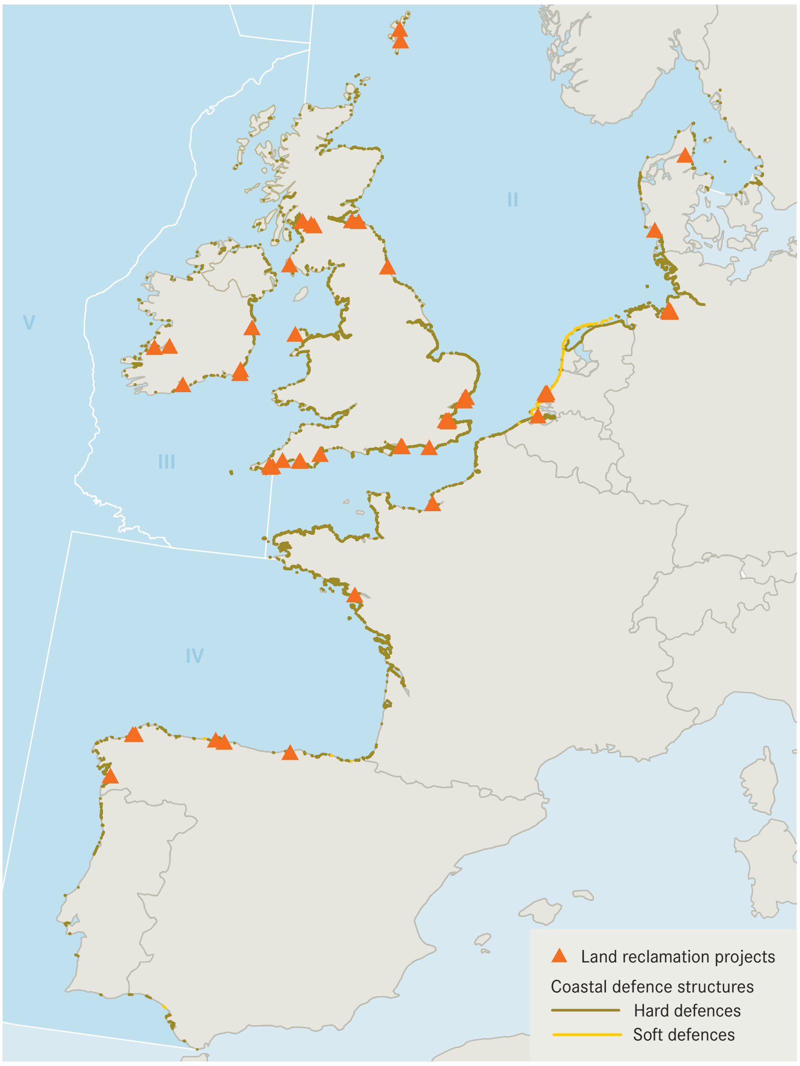


FIGURE 9.9 *Location of land reclamation and coastal defence structures.*

BOX 9.5 Extension of Rotterdam harbour

Artist's impression of the Maasvlakte extension to the harbour of Rotterdam (Source: Port of Rotterdam Authority)

The Maasvlakte extension to the harbour of Rotterdam built in 1970 is one of the largest land reclamation projects in the OSPAR area to date, covering 2000 hectares. An extension to this site, *Maasvlakte 2*, was proposed in 1997 comprising a further 2000 hectares to provide port facilities and deep water wharfs for container ships, chemical carriers and other large vessels. Reclamation began in September 2008 with the aim that the new facility would be operational from 2013 onward and completed in 2033.

A series of environmental assessments were published in 2007 to comply with national and EU regulations. The studies concluded that, although the project design minimises environmental impact as far as possible, there were unavoidable environmental impacts on water quality from the increased levels of shipping. This is mostly due to the use of organotin compounds in anti-foulants on vessels from outside the EU. *Maasvlakte 2* is sited in and near an EU Natura 2000 area (Voordelta), which is also an OSPAR MPA, and will result in important ecological values and habitats being lost. There will be a loss of 2.8% (2455 ha) of shallow sandbanks (a habitat of community interest under the EU Habitats Directive). This will be compensated by improving shallow sandbank habitat quality in the Voordelta in an area ten times larger than the affected area (24 550 ha). The significant loss of feeding and/or living area for the sandwich tern (1.7%), common tern (5.9%) and common scoter (3.1%) will be compensated by measures that guarantee extra quiet areas for birds. Permits requiring the compensation scheme are based upon worst-case scenarios, but acknowledge uncertainties in the prediction of longer-term impacts. An extensive monitoring programme is required to identify additional compensation measures that may be necessary.

employed to act as natural buffers against rising tides. These work with the coastal sediment balance to ensure coastal stability. Beach nourishment means more marine sand and gravel extraction. The projected rise in sea levels, storm frequencies and wave loads is likely to increase the need for coastal protection measures, especially in the southern North Sea.

OSPAR countries regulate land reclamation, coastal defence works and the construction of other structures through national legislation. The aim is to minimise and put right any adverse environmental effects. National regulations for coastal defence often prioritise natural and soft techniques. This is supported by EU legislation, such as the Environmental Impact Assessment Directive, the Habitats Directive, the Birds Directive and the Recommendation on Integrated Coastal Zone Management.

EIAs for land reclamation, coastal defence works and other structures have identified various effects on marine ecosystems. Although the regulatory system appears adequate for controlling impacts on a site by site basis, in most cases monitoring data are not available to evaluate the actual changes in environmental quality. For the recently started expansion of the port of Rotterdam in the Netherlands (*Maasvlakte 2* project → BOX 9.5) an extensive monitoring programme will be carried out to investigate the recovery of benthic fauna, concentrations and spread of suspended matter, physical effects and underwater noise. In developments where negative effects are expected or observed, compensation is often more feasible than remediation.

To help address gaps in knowledge of cumulative and wide-scale effects, a coordinated system is required for collecting and reporting information on land reclamation, coastal defence structures and other artificial structures. This will help improve the effectiveness of regulations and other measures for managing impacts.

OSPAR countries should promote a shift to a sediment management approach and modern methods of soft coastal engineering, which reinforce natural coastal defences (such as salt marshes and dunes) and protect key sources of sediment. OSPAR guidelines should be updated to include best options and practices for use of marine sand and gravel for coastal defence. The updates should reflect the experience of OSPAR countries, strategies under the EU Water Framework Directive and the need to adapt to rising sea levels and increased flood risk.

ARTIFICIAL REEFS

Environmental impacts from artificial reefs should remain localised provided the relevant OSPAR guidelines are followed.

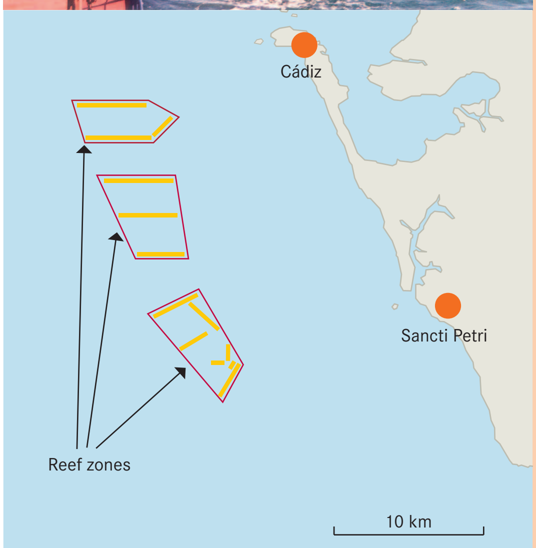
Key OSPAR assessment → Environmental impact of artificial reefs

There are around 50 artificial reefs in the OSPAR area. These are located at various sites within Regions I to IV. There are no artificial reefs in Region V. Most have been created in the past two decades and are purpose-built and made of concrete → BOX 9.6. Their purpose ranges from improving marine resources, compensating for, and protecting against, habitat loss, to providing recreational dive sites. Effects on the general biodiversity are unclear and opinions differ as to whether artificial reefs increase the productivity of fish species or whether they serve to concentrate them. Localised impacts on the marine environment are possible, for example, changes to waves and currents and displacement and changes to biological communities. Monitoring confirms that environmental impacts around artificial reefs are local and of limited intensity.

The design, choice of material and placement of artificial reefs in the OSPAR area are mostly subject to national authorisation, supported by EIAs. OSPAR has developed guidelines for artificial reefs that are specifically built for protecting, regenerating, concentrating and/or increasing the production of living marine resources. These recognise that negative impacts are possible at the local scale. The United Nations Environment Programme (UNEP) and the London Convention have prepared guidelines covering artificial reefs built for a wider range of purposes.

Because most of the impacts from artificial reefs are relatively local, as long as there is not a massive increase in the number of reefs and the OSPAR, UNEP and London Convention guidelines are followed, the development of artificial reefs is not expected to have major negative effects in the OSPAR area. However, monitoring the extent of this activity will assist further consideration of its impacts. To facilitate this, OSPAR should establish an inventory of artificial reefs.

BOX 9.6 Sancti Petri artificial reef in the Gulf of Cadiz (Spain)



The Sancti Petri artificial reef is situated off the coast of Cadiz at a depth of between 15 and 40 m (see map). The area attracts a high level of artisanal fishing activity. In 2000, the Spanish Ministry of Agriculture, Fisheries and Food started to develop a reef to protect fish populations from the action of illegal bottom trawlers, thereby reducing catch pressure, avoiding damage to artisanal fishing gear and reducing social conflicts. The reef was completed in 2005.

The reef complex comprises three reef zones, each with three barrier structures placed perpendicular to the favoured trawling routes. The barriers are separated by one nautical mile of free area. The barriers are rectangular structures between 2 and 4 km long and 200 m wide, comprising modular units (see photo).

Each artificial reef unit is a 5.5 tonne reinforced concrete cylinder with a 3 m foot to prevent it from sinking into the seabed. Units are typically placed 75 to 200 m apart to form the barriers. A total of 569 units have been placed creating 2845 m^2 of reef within an overall protected area of 4818 ha.

The performance of the reef is monitored in several ways. Every two years, a structural and functional survey is carried out using side scan sonar. In addition, the artisanal fishing catches are regulated and the fishermen are consulted using opinion polls. The results show a dramatic decrease in illegal trawling activity in the area and an increase in artisanal catch.

The limited spatial extent and inherent physical and chemical stability of the reef mean that no significant impacts have been detected. Entanglement of trammel nets occurs occasionally, but does not appear to result in 'ghost fishing'.

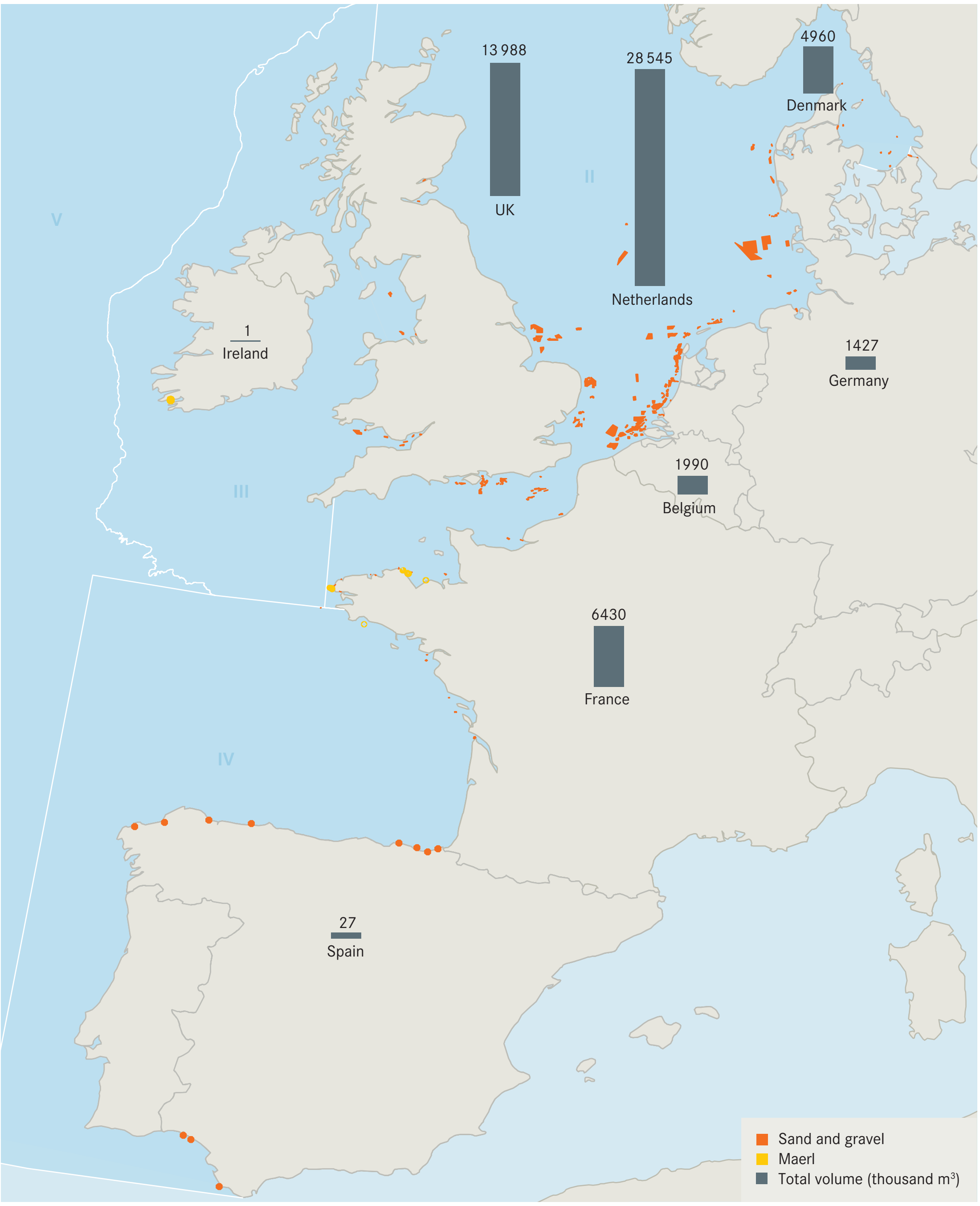
MINERAL EXTRACTION

Sand and gravel extraction can have a range of impacts, such as habitat damage and noise. Existing regulations and guidelines provide a framework for management of impacts. OSPAR Contracting Parties should cooperate to keep under review the impacts from any increases in mineral extraction and give special attention to avoiding damage to OSPAR priority habitats.

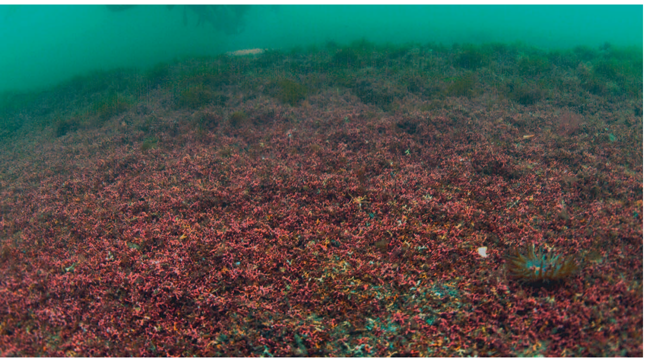
Key OSPAR assessment → Environmental impact of sand and gravel extraction

Around 50 to 60 million m^3 of marine mineral deposits are extracted each year, mainly for the construction industry, for use as fill sand on land, or for beach nourishment. Sand and gravel are the main materials extracted, but maerl (calcareous seaweed) is also extracted in France and to a lesser extent in Ireland to improve agricultural soils and as a filtering material in water treatment. Small amounts of shell are extracted in the Netherlands, for example, for paving hiking trails. The greatest amounts of sand and gravel are extracted in Regions II and III, with smaller amounts extracted in Regions I and IV → FIGURE 9.10. About 80 % of the total volume extracted in the OSPAR area is

FIGURE 9.10 *Extraction sites for sand, gravel and maerl in the OSPAR area and volumes extracted in 2007.*



extracted in Region II. The biggest extractors are the Netherlands, the UK, France and Denmark. There is no mineral extraction currently in Region V, but the deep seabed is being explored for possible mineral resources, which may be extracted by new technology. Regulation of mineral extraction in the area beyond national jurisdiction is in the exclusive competence of the International Seabed Authority.



Maerl bed

The total quantity of marine sand and gravel extracted has increased by around 30% over the past decade. However, the total geographical extent of extraction areas has been relatively stable as new concessions have been offset by extraction activity ceasing in some areas.

The main impacts from the extraction of mineral deposits are the removal of substrate and associated organisms, which can affect the stability of the seabed and lead to changes in food webs. Areas from which sand and gravel have been extracted may start to re-colonise quite quickly. Biomass is restored two to four years after short-term extraction activities. Recovery after intensive or protracted periods of extraction takes longer or may not occur at all depending on local conditions. There are also transitory plumes of suspended material, but the impacts, including lowered dissolved oxygen and interference with foraging fish and seabirds, are considered negligible. Extraction also causes underwater noise.

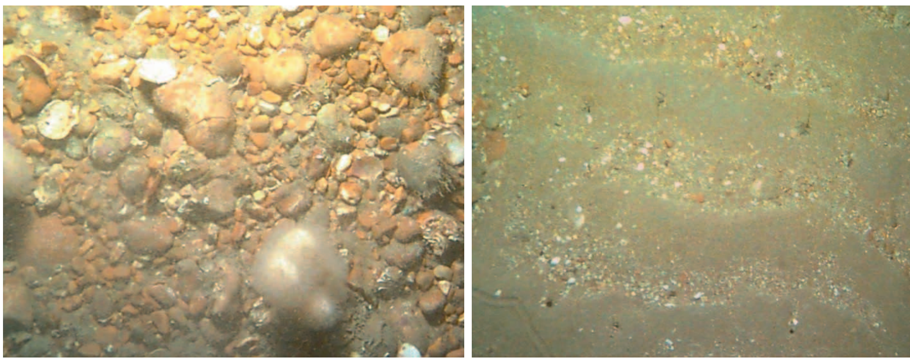
EIAs should ensure that damage or loss of habitats that OSPAR has identified as threatened or in decline, for example, maerl beds or *Sabellaria spinulosa* reefs, is minimised or avoided. Because it forms very slowly, maerl is considered a non-renewable resource and even extracting dead material can have major ecological effects. Sand and gravel extraction often takes place in areas of mixed sediment where *Sabellaria spinulosa* reefs occur and so there is a risk of damage to reefs, although they are known to exist close to extraction sites without any harm. The EU Habitats Directive requires Member States to take appropriate management measures to ensure that any exploitation of maerl is compatible with maintaining the habitat at a favourable conservation status. Maerl beds are included in several protected areas in Region III.

All OSPAR countries undertaking large amounts of sand and gravel extraction have legislation in line with the EU EIA and Habitats Directives. OSPAR countries have agreed to apply guidelines developed by the International Council for the Exploration of the Sea (ICES) for managing the extraction of marine sediments. These also address nature conservation and conflicts over space between different users. Belgium, Denmark, Germany, the Netherlands and the UK have required sand and gravel extractors to use black-box recorders to monitor changes in the geographical extent of extraction activities in real time.

The use of ICES guidelines and EIAs has proved successful for managing extraction of sand and gravel in some areas, for example the Channel (UK). The stable, or in some areas decreasing, geographical extent of extraction has reduced conflict between different coastal users, but this has been offset by an increase in the intensity of extraction, potentially slowing the recovery of affected areas. Comprehensive extraction data are not reported by all OSPAR countries. Also, the threshold at which countries require EIAs and the quality of the assessments themselves are very variable. Without accurate data, it is difficult to assess whether regulation has improved the protection of benthic ecosystems.

Demand for marine sand and gravel in coastal protection schemes is likely to increase as sea level rise and the growth in infrastructure projects drive requirements for marine sand and gravel for construction purposes. Efforts to reduce the negative impacts from sand and gravel extraction will therefore be required. These should include stringent implementation of the ICES guidelines, harmonised and accurate reporting on the extent and impact of extraction, and follow-up activities to EIAs. OSPAR should promote research to address gaps in knowledge on the impacts of sand and gravel extraction on fish and small benthic fauna, on long-term recovery of the seabed and on the feasibility of restoring the seabed, taking into account other activities that may impact the seabed. Regional approaches for managing sand and gravel extraction should be considered. These may require cooperation between different countries if a resource is on or near a national boundary.

Gravel seabed before dredging (left) and after extraction of gravel (right)



DREDGING AND DUMPING

Dredging and dumping of wastes or other matter at sea is a well-regulated localised activity. OSPAR Contracting Parties should cooperate to promote the development of regional sediment management plans and encourage research into the effects on the wider ecosystem.

Key OSPAR assessments

→ Environmental impact of dredging for navigational purposes
→ Environmental impact of dumping of wastes at sea

Sediment is an essential, integral and dynamic part of the ecosystem. Over 99 % of sediment dumped at sea is locally-generated and results from dredging of harbours and their approaches to ensure they are navigable. Most dredged material is dumped at established sites → FIGURE 9.11. It is also used for purposes such as beach nourishment or land reclamation. Fish wastes and inert material of natural origin, for example rock and mining wastes, may also be dumped at sea. Fish waste is only dumped in small amounts and at a few sites (fewer than 1000 tonnes per year). The phasing out of several types of waste disposal has reduced pressure on the marine environment. Dumping of sewage sludge and of vessels or aircraft has been banned by OSPAR since 1998 and 2004, respectively. Dumping of radioactive wastes has been prohibited since 1999.

Dredging and dumping operations and techniques have changed little over the past ten years. About 90 % of all sediments dumped each year are dredged and dumped in the southern North Sea. This is largely from maintaining navigation channels to major seaports such as Hull, Antwerp, Rotterdam, Hamburg and Esbjerg. In 2005, there were around 350 dumpsites in the OSPAR area → FIGURE 9.11. Between 1990 and 2007 the total annual amounts dumped at sea varied from 80 to 130 million tonnes (dry weight) with much of the variation due to capital dredging associated with port expansion and deepening of navigation channels. The level of dumping and dredging activities has been relatively stable over the past decade and is unlikely to fall. The need for dredging may be increased in coming years by a growth in ship size, requiring deeper and wider navigation channels, or a greater frequency and intensity of storm events, and thus sediment movement by waves and currents.

One of the main concerns over dumping and dredging is the release of contaminants to the water column (such as heavy metals and TBT), which is associated with temporary increases in turbidity. This can lead to increased availability of contaminants to the food chain. Contaminants in dredged material are monitored and assessed against action levels to help reduce pollution at dumpsites. There was a clear fall in contaminant concentrations in dredged material from the southern North Sea throughout the 1990s. This trend has since stabilised. In the Netherlands, TBT concentrations in dredged material have fallen since monitoring began in 1998. A further decrease in TBT concentrations is likely following the global ban on TBT-based anti-foulants. Nutrients released from dumped dredge spoil may contribute to eutrophication, but this will generally be of minor significance.

Knowledge about the effects of dredged material disposal on the wider environment is mainly from studies at individual dumpsites and from EIAs. Sediments are part of the marine environment and relocation of non-contaminated sediments to the sea supports the natural processes of the sediment balance. Increased turbidity may also lead to short-lived effects on organisms that are light-dependent, but these are generally considered to be negligible. Dumping sediments on the seabed may smother and crush organisms living on the seafloor and may cause changes in benthic habitats and biological communities. Changes in community structure are restricted to within 5 km of the dumpsite. Continuous maintenance dredging often takes place where navigation channels to ports have high sedimentation rates, such as in estuaries. Areas that are frequently dredged have a permanently changing benthic environment. Dredging in estuaries to create a new harbour, berth or waterway, or to deepen existing facilities, can affect tidal characteristics which may affect sensitive habitats. Dredging and dumping activities also contribute to underwater noise.

Dredging and the dumping of waste and other matter have been well-regulated since the Oslo Convention came into force in 1974. OSPAR guidelines specify best environmental practice (BEP) for managing dredged material. National authorities use these guidelines to manage dredging and dumping and to minimise effects on the marine environment. The main management tools are licence and control systems. These require assessments of the environmental impact of planned disposal activities in relation to a specific dumpsite, sediment characteristics and contamination load. Since the QSR 2000, assessment and licensing procedures for dredged materials in most OSPAR countries have included action levels for contaminant loads based on the OSPAR guidelines. Since 1998, OSPAR has also had guidelines for the dumping of fish wastes.

Management of dredged material should respect the natural processes of the sediment balance. Selecting the appropriate location for a dumpsite is essential to minimise environmental impact. Several dumpsites have been relocated by applying the OSPAR guidelines. A planned site in the Weser estuary was relocated after a site survey detected a mussel bank. Dumpsites have also been relocated or closed to avoid impacts on MPAs, fisheries and shipping. The ban on dumping vessels or aircraft has been implemented successfully.

Existing regulations, including EU legislation, need to be fully implemented and their effectiveness evaluated before additional OSPAR measures are developed. Improved understanding of the effects of dredging and dumping activities on marine ecosystems, including in combination with other pressures, is needed. OSPAR should promote the development of local or regional sediment management plans focusing on maintaining sediment balance, particularly in relation to sensitive marine areas such as OSPAR MPAs and Natura 2000 sites. Greater use should be made of dredged material for beneficial purposes, such as for protecting the stability of coastal and shelf systems.

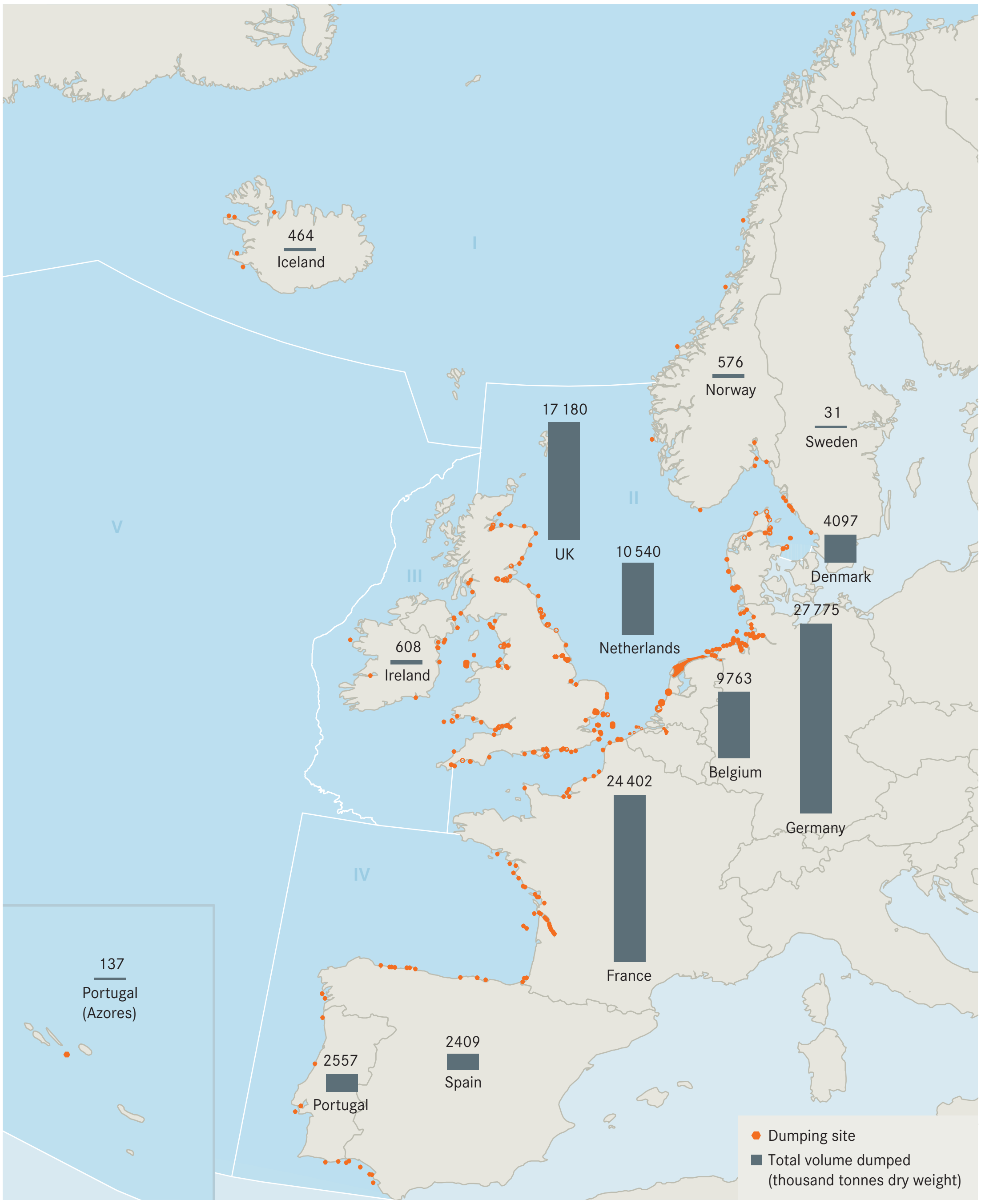


FIGURE 9.11 *Dumpsites for dredged material and volumes dumped in 2007.*

DUMPED MUNITIONS

The vast amounts of dumped munitions in the sea are a historical legacy representing a risk to fishermen, other coastal users and marine species.

Key OSPAR assessment → Environmental impact of dumped conventional and chemical munitions

Vast amounts of munitions were dumped at designated sites or randomly jettisoned into the sea following the First and Second World Wars. These included conventional munitions such as bombs, grenades, torpedoes and mines, as well as incendiary devices and chemical munitions.

The presence of munitions in the sea is a risk to fishermen and coastal users. As recently as 2005, three fishermen were killed in the southern North Sea when a Second World War bomb exploded on their fishing vessel after having been caught in their nets. There are also concerns over the many chemicals used in the munitions, which may be released as the munitions degrade with the possibility of risks for the marine food chain. However, there is no evidence of this in the OSPAR area at present. The few data that are available indicate little or no contamination of fish, shellfish or sediments near the dumpsites. A study at the *Beaufort's Dyke* dumpsite in the Irish Sea (Region III) in 1996 found no evidence of chemicals from conventional and chemical warfare agents in sediments, fish or shellfish. Levels of naturally occurring metals used in munitions, such as arsenic and heavy metals, were within the range expected around the UK. Belgian studies have shown that contamination of sediment with mustard gas from a Second World War shell is limited to 3 cm from the shell. Explosion of munitions may be a greater environmental concern both through release of hazardous substances and the impacts of noise. The high sound pressure generated by spontaneous or controlled explosions of munitions can injure or kill marine mammals and fish. Harbour porpoises have been reported killed within 4 km of explosions and suffering permanent hearing damage up to 30 km away.

Information on the amounts and locations of dumped munitions is recognised to be incomplete, but the existence of dumped munitions should be a consideration in marine spatial planning.

In 2004, OSPAR began a programme to establish the extent of munitions dumping and to monitor the frequency of encounters → FIGURE 9.12. This has revealed that munitions were dumped at 148 sites and that 1879 encounters with munitions have occurred since 2004. Around 58 % of reported munitions were encountered by fishermen and 29 % found on the shore. Most (76 %) were removed from the sea or neutralised; 11 % were returned to the sea for safety reasons.

To reduce risk to fishermen and coastal users, OSPAR prepared a framework for the development of national guidelines on what to do when munitions are encountered. There are serious safety risks associated with the clean-up of dumpsites, as well as increased risk of dispersing hazardous substances. The most common management practice is to leave munitions on the seabed and allow them to disintegrate naturally. If munitions must be removed from the seabed, the potential of new techniques which allow neutralisation without explosion should be considered.

Although knowledge has increased, OSPAR should continue to collate data on encounters with dumped munitions and keep under review new techniques for managing the risks from munitions. Planning and management of marine activities should take into account the risks from dumped munitions. Explosions should be avoided due to concerns over underwater noise and the spread of hazardous substances. National guidelines should be issued for fishermen and other coastal users on what to do when munitions are encountered. National authorities should consider supplying fishermen with sub-surface marker buoys to use in the case of encounters. OSPAR should encourage the development of techniques for safe removal and neutralisation without explosion and promote the monitoring of possible effects of dumped munitions in the North-East Atlantic.

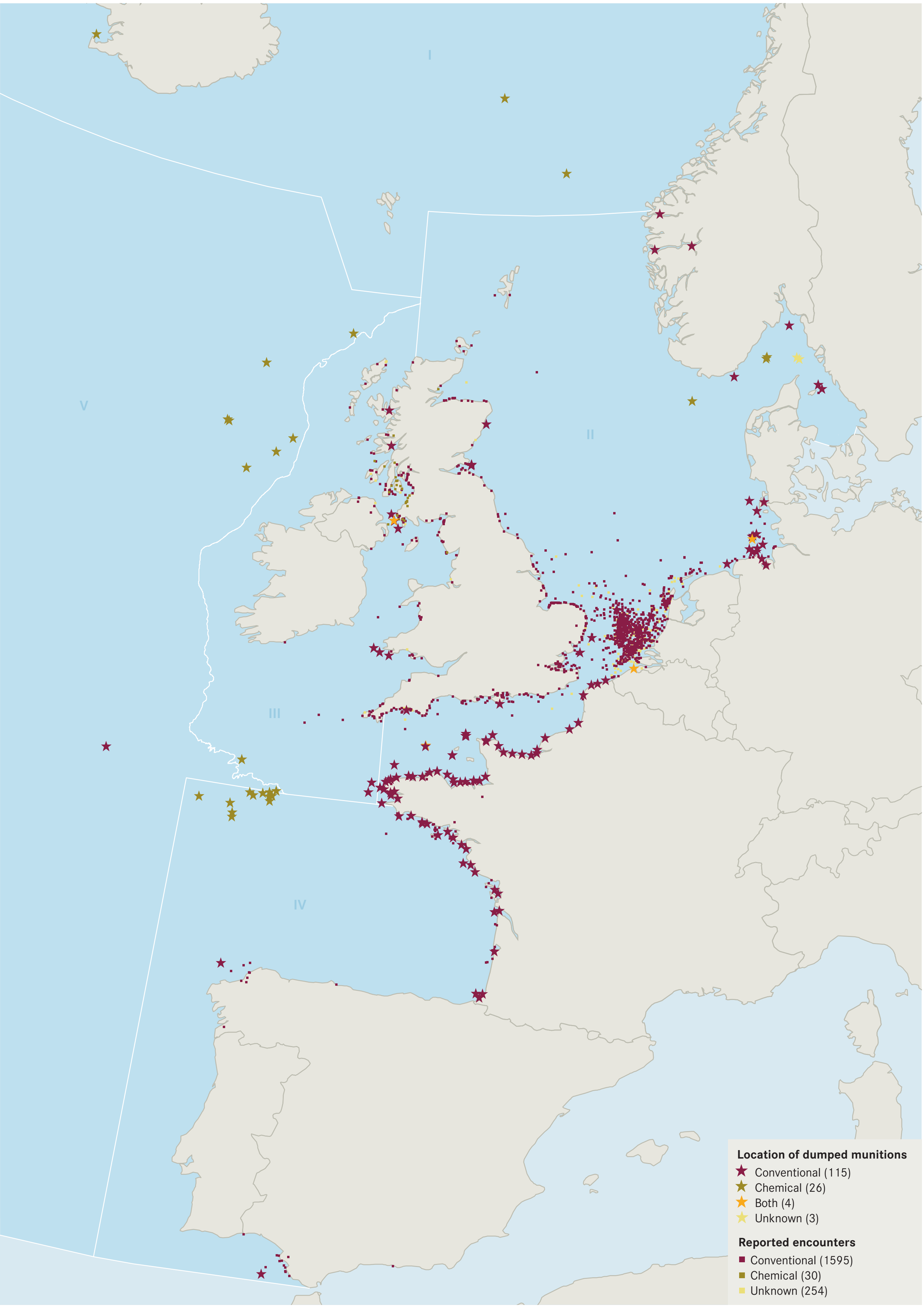


FIGURE 9.12 *Location of dumped munitions and reported encounters between 1999 and 2008.*

MICROBIOLOGICAL CONTAMINATION

Microbiological contamination from humans and animals presents a risk for recreational activities and shellfish quality. National legislation has driven improvements. OSPAR Contracting Parties should cooperate to further identify and control sources.

Key OSPAR assessment → Environmental impact of microbiological contamination

Pollution with germs from faecal material is of concern in coastal zones. Sources include treated and untreated sewage discharges from land or ships and animal excrement (e.g. from wildlife and farm animals in coastal catchments), storm water discharges and other diffuse sources. Bathers, pets and contaminated marine sediments also contribute. Impacts depend on weather, turbidity and hydrodynamics.

Bacteria and viruses from humans and animals can affect water quality and marine organisms. Their accumulation in shellfish is a major concern. Gastroenteritis and Hepatitis A are the most important microbial diseases transmitted to humans through shellfish. Contaminated water can also transmit diseases to bathers. Over the past 15 years the quality of bathing waters has improved significantly in most OSPAR countries as a result of increasing compliance with EU requirements. In 2006, around 5 % of Europe's bathing waters did not meet the mandatory level of microbiological quality, in some cases despite sewage treatment. This shows that diffuse pollution is a problem which is difficult to manage.

Limited information prevents an overall assessment of trends in water quality in shellfish areas, but there are examples of improvement following better urban waste water treatment → BOX 9.7. Recently, outbreaks of shellfish disease have been detected in shellfish that met bacteriological standards. One explanation is that existing indicators are not good at detecting viruses.

Since the QSR 2000, European legislation has been reinforced to address the sanitary risk to humans. This has been achieved by setting quality standards for bathing waters (Bathing Water Directive) and shellfish growing areas (Shellfish Water Directive), as well as requiring better urban waste water treatment. The Water Framework Directive and the Marine Strategy Framework Directive are also driving improved water quality.

OSPAR should promote international actions to improve detection of pathogens in seawater and seafood and the assessment of associated risks through expanded monitoring, modelling and development of suitable molecular tools. OSPAR countries should fully identify and quantify sources of microbial pollution. Further reductions in faecal inputs to coastal waters are needed, such as through better sewage collection and treatment and best practices for agricultural uses of sewage and manure. Early warning systems based on the latest technological standards need to be implemented.

BOX 9.7 Improved quality of shellfish areas in the Morlaix estuary

The Bay of Morlaix is a major shellfish harvesting area in northern Brittany (France), producing 5000 tonnes of oysters from 100 mariculture farms each year. Microbiological contamination occurs in the southern part of the catchment. In the early 1990s, poor water quality led to the risk of farm closures. Modelling studies clearly identified the Morlaix waste water treatment plant as one of the main sources of pollution. Water treatment has since been progressively improved. An upgraded treatment plant began operation in 1996. Lower levels of suspended matter alone resulted in a decrease in *E. coli* numbers at the outfall by two orders of magnitude and microbiological contamination has been reduced even further since 1996. The quality of the shellfish areas has improved significantly. Since 1999, they have been classified A (highest quality) under the EU Shellfish Water Directive and have enabled the sustainable use of the bay for oyster farming.

UNDERWATER NOISE

Levels of underwater noise are thought to be increasing internationally. Regions II and III seem to be the most affected by noise-generating human activities and there are signs of effects on marine life. Levels of noise in Regions II and III are likely to increase. OSPAR Contracting Parties should cooperate to monitor and investigate these effects and develop guidance on options for mitigation of noise and its effects.

Key OSPAR assessments
→ Overview of underwater noise
→ Environmental impact of underwater noise

Marine mammals, many fish species and even some invertebrates use sound in communication – to find mates, to search for prey, to avoid predators and hazards, and for navigation. Many of the human activities described in previous sections generate sound and contribute to the general background level of noise in the sea. For example, offshore construction, sand and gravel extraction, drilling, shipping, use of sonar, underwater explosions, seismic surveys, acoustic harassment devices and scarers (pingers).

Underwater sound from anthropogenic sources has the potential to mask biological signals and to cause behavioural reactions, physiological effects, injuries and mortality in marine animals. Impacts depend on both the nature of the sound and the acoustic sensitivity of the organism. There are difficulties in quantifying the extent and scale of the impacts as there is great variability in the characteristics of the sounds, the sensitivities of different species and the scale of noise-generating activities. Ambient or background noise is not range-dependent and remains constant irrespective of location. The perception of localised noise sources reduces with increasing distance from each source, eventually becoming indistinguishable from ambient noise → **FIGURE 9.13**. Data on all these aspects are generally scarce, but with the relatively intense concentrations of human activities in some parts of the OSPAR area, especially in Regions II and III, and the probability that these will increase, it is important that the effects of increased levels of underwater sound are fully considered. Studies show that noise does affect marine organisms, but so far there is a lack of knowledge on specific effects and possible cumulative effects, which makes understanding of dose-response relationships difficult.

OSPAR is working with other international organisations (e.g. the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas, ASCOBANS) to investigate the problems and identify future actions to address underwater noise. Guidelines and regulatory controls are already used in several OSPAR countries, such as noise reduction measures during pile driving (UK), a ban on pile driving during key reproductive periods for particular species (Netherlands) or the mandatory use of thresholds to limit man-made emissions with certain acoustic characteristics (Germany).

Research is needed on the propagation and effects of underwater sound on marine life, as well as behavioural and auditory studies, programmes to monitor the distribution of sound sources and the relevant marine species, and anthropogenic sound budgets. There is an urgent need to standardise methods for assessing the impacts of sound on marine species and to address the cumulative effects of different sources. OSPAR should facilitate the sharing of information, the coordination of data and measures specific to the Regions, and the standardisation of measurements. OSPAR should increase efforts to develop, review and apply mitigation measures to reduce the impacts of underwater noise and develop guidance on best environmental practices (BEP) and best available techniques (BAT) for mitigating noise emissions and their environmental impacts.

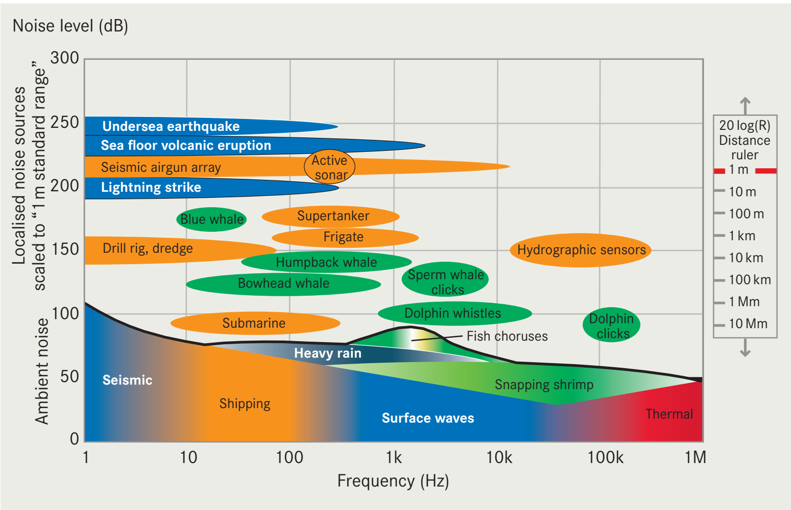


FIGURE 9.13 *Levels and frequencies of anthropogenic and naturally occurring sound sources in the marine environment. Spectrum Noise Level ("Acoustic Intensity per Hertz") versus Frequency (measured in Hertz or "cycles per second"). The vertical axis is expressed in decibels (dB; the reference for the dB calculation is the acoustic intensity of a sound wave, in water, of root-mean-square pressure 1 µPa). While ambient noise sources do not need to be corrected for range, localised noise sources are all scaled to "1 m standard range". The scaling ruler on the right-hand side of the figure may be used to gauge the loss corresponding to the distance from any localised noise source assuming spherical spreading. Colour scheme: anthropogenic (man-made) noise sources are depicted in orange, biological underwater noise sources in green and environmental noise sources in blue. Source: Coates, 2002 © Seiche Ltd. 2006*

MARINE LITTER

Marine litter is a persistent problem that affects the entire marine environment and its ecological effects are not fully understood. OSPAR should extend marine beach litter monitoring to all Regions.

Key assessments

→ OSPAR pilot project on monitoring marine beach litter
→ OSPAR/UNEP/KIMO report on marine litter in the North-East Atlantic Region

Marine litter is a collective term for any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment. It includes a wide variety of slowly degradable items. The main sources from land include tourism, sewage, fly-tipping, local businesses and unprotected waste disposal sites. The main sea-based sources are shipping and fishing, including abandoned and lost fishing gear.

Marine litter is a persistent problem affecting the seabed, the water column and coastlines. It poses risks to a wide range of marine organisms, such as seabirds, marine mammals and turtles, through ingestion and entanglement, and has economic impacts for local authorities and on a range of sectors, for example aquaculture, tourism, power generation, farming, fishing, shipping, harbours, and search and rescue. Sixty-five percent of items monitored on beaches are plastic. These degrade very slowly over hundred-year time scales and are prone to breaking up into small particles. The widespread presence of microscopic plastic particles and their potential uptake by filter-feeding organisms is of increasing concern given the capacity of plastic particles to absorb, transport and release pollutants.

International and EU legislation addressing sources of litter includes the MARPOL Convention Annex V, and the EU Port Waste Reception Facilities Directive. In 2007, OSPAR published Guidelines for the implementation of Fishing for Litter projects in the OSPAR area → BOX 9.8.

Since 1998, OSPAR has monitored levels of beach litter, initially through a pilot project and then through a voluntary monitoring programme. Despite initiatives to reduce the amount of marine litter in the OSPAR area, overall levels in areas monitored are frequently unacceptable. Beaches in the OSPAR area have an average of 712 litter items per 100 m. Levels have remained relatively constant, but with a slight increase in input from the fishing industry. Region III and the northern part of Region II have more litter than Region IV and the southern part of Region II → FIGURE 9.14.

There are limited data on seabed and floating litter, but those studies that do exist show that the amounts of litter on the seabed can vary widely and that litter may accumulate in certain areas. Marine litter also finds its way to the deep sea, and is regularly observed by scientists studying the seabed with submersibles or remotely operated vehicles.

BOX 9.8 Fishing for Litter

Fishing for Litter (FFL) is one of the most innovative and successful initiatives to tackle the problem of litter in the sea. FFL aims to reduce marine litter by involving one of the key stakeholders, the fishing industry. FFL not only involves the direct removal of litter from the sea, but also raises awareness of the problem inside the industry as a whole.

Participating vessels are given large (1 m^3) hard-wearing bags to store marine litter that collects in their nets during normal fishing activity. Operational or galley waste generated on board, which is the responsibility of the vessel, continues to go through the established harbour waste management system. Full bags of litter are deposited on the quayside where the participating harbours monitor the waste before moving the bag to a dedicated skip for disposal. Bags are provided and waste costs need to be met, but fishermen and harbours volunteer their time. FFL has two main aims: first, the physical removal of marine litter that sinks to the seabed and, second, to raise awareness within the fishing industry that it is no longer acceptable to dump litter overboard. The concept of FFL has received a lot of support within the fishing industry. The number of vessels involved has increased over the past seven years. Around 190 vessels participate in Regions II and III, removing 240 tonnes of waste per year. Other stakeholders also support the FFL initiative.

The FFL initiative has demonstrated that the objectives and aims of the scheme can gain the support of the fishing industry, port authorities and local authorities. This has helped contribute to changing practices and culture within the fishing sector, while providing a means for removing litter from the sea and seabed.

An Ecological Quality Objective (EcoQO) for the North Sea on plastic particles in seabirds' stomachs has helped to identify the extent of floating litter at sea. Associated studies have shown that 94 % of birds have small pieces of plastic in their stomach and a high percentage have more than the level set for the EcoQO → BOX 9.9

Additional efforts are needed to stop litter entering the marine environment both from sea-based and land-based sources. Efforts to address sea-based sources include environmental education for professional seafarers, methods to prevent abandoned fishing gear, cooperation on enforcement and awareness-raising, as well as FFL initiatives. For land-based sources, improved waste management, including waste reduction and recycling, will help reduce the problem. OSPAR should extend its marine litter monitoring on beaches to all Regions and consider including it in its Coordinated Environmental Monitoring Programme, taking into account the monitoring requirements of the EU Marine Strategy Framework Directive. This may result in a requirement to monitor the water column and the seabed. OSPAR should support the implementation of international and EU legislation, initiatives such as UNEP's (Regional Seas Programme) work on marine litter, and ongoing research into litter in the deep sea and the ecological effects of microplastics.

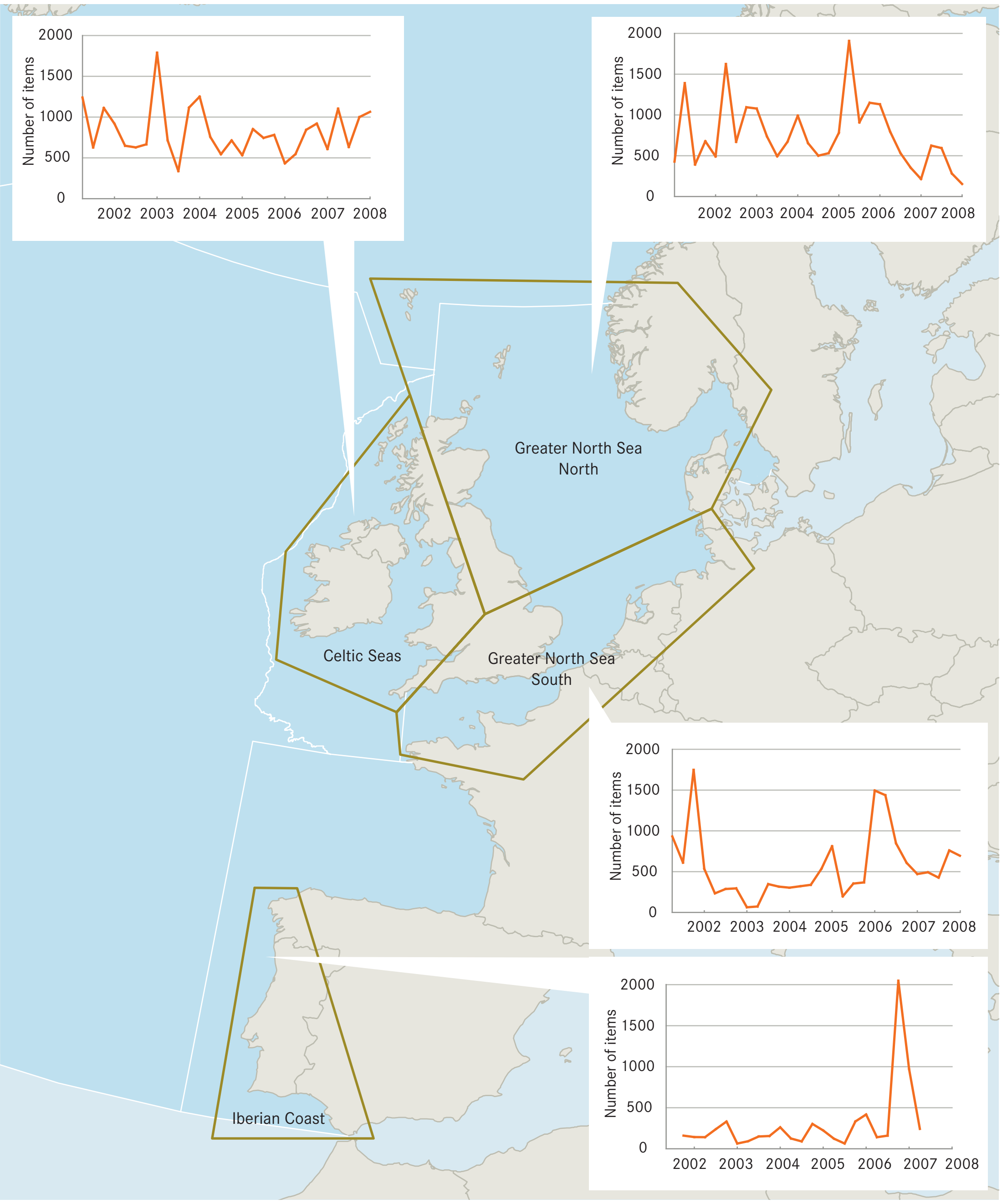


FIGURE 9.14 *Trends in the average number of items of marine litter collected on reference beaches in three-month periods in Regions II, III and IV.*

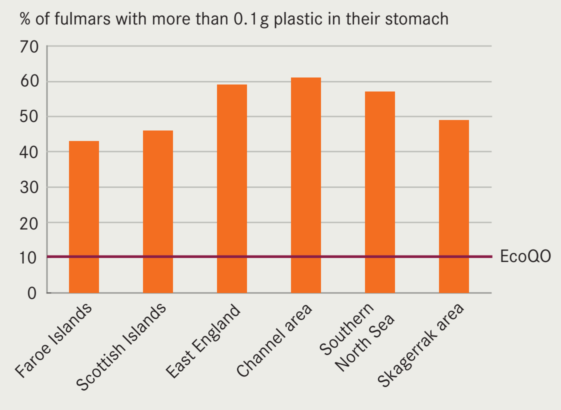
BOX 9.9 OSPAR EcoQO on plastic particles in seabird stomachs

North Sea EcoQO: There should be less than 10 % of northern fulmars having more than 0.1 g of plastic particles in the stomach in samples of 50 to 100 beach-washed fulmars found from each of four to five areas of the North Sea over a period of at least five years.

The northern fulmar is distributed throughout the northern part of the OSPAR area, including Region II. Fulmars forage exclusively at sea, capturing prey from the sea surface. They frequently ingest floating litter, including plastic items, presumably confusing them with food. Because fulmars do not regurgitate these small plastic items, the amount in their stomachs indicates the abundance of litter encountered at sea. Ingested plastics may reduce food intake and the birds' ability to process food, leading to a deterioration in body condition, increased mortality and reduced breeding success.

Over the period 2002 to 2006, the stomachs of 1090 beached fulmars from the North Sea were analysed. The percentage of fulmars with more than 0.1 g of plastic in the stomach ranged from 45 % to over 60 % (see figure). The Channel area is the most heavily polluted area while the Scottish Islands are the 'cleanest' with a mean mass for plastics in fulmars of about a third of the level encountered in the Channel. Data from the Faroe Islands (Region I) are included for comparison. The EcoQO is probably only achieved in Arctic populations. A long monitoring series from the Netherlands shows a significant reduction in plastic abundance from 1997 to 2006, mainly through a reduction in raw industrial plastics.

To meet the EcoQO, refinements may be needed on the implementation of the EU Directive on Port Reception Facilities and MARPOL Annex V, as well as specific measures on lost fisheries materials.



NON-INDIGENOUS SPECIES

Non-indigenous species, mainly introduced by shipping and mariculture, have economic and ecological effects on the OSPAR area. OSPAR Contracting Parties should cooperate in support of current international efforts to prevent further introductions.

Key assessment → ICES assessment of non-indigenous species in the OSPAR area

Non-indigenous species may cause unpredictable and irreversible changes to marine ecosystems, such as predation or competition for indigenous species, modification of habitats and trophic impacts. A variety of economic or human health impacts are possible through, for example, fouling, harmful non-indigenous algal blooms or damage to structures. Over 160 non-indigenous species have been identified in the OSPAR area, but the actual number of introduced species is likely to be greater. This is because long-term monitoring and recording data are limited and identifying the species taxonomically can be difficult. Some species are currently misidentified.

ICES has identified 30 non-indigenous species that have had adverse impacts on ecosystems or human health within the OSPAR area → TABLE 9.1. Most of the non-indigenous species identified are present in two or more Regions (especially Regions II, III and IV). Data for Region V are mainly absent. The main vector for the initial introduction of these species has been mariculture, followed by ballast water from ships, hull fouling and fishing. The most important and widespread impacts are changes to habitats and competition for food and space with indigenous organisms. Many of these species also have economic impacts → BOX 9.10. Almost all the species concerned were introduced before current measures, some as much as several hundred years ago.

The risk of introductions by ballast water has been addressed by OSPAR and HELCOM taking action to ensure the early application of standards consistent with the IMO Ballast Water Convention. Environmental risks related to movements of non-indigenous aquatic species are addressed within the EU by the Regulation concerning use of alien and locally absent species in aquaculture. There are also international risk assessment protocols for assessing the risks of using non-indigenous species in aquaculture.

Ratification and implementation of the IMO Ballast Water Convention should be expedited and followed up with effective enforcement. There is a need to monitor the effectiveness of this and other recently implemented measures on reducing introductions of non-indigenous species. Work under the EU Marine Strategy Framework Directive will provide a focus for this in seeking to ensure that non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.

TABLE 9.1 *Non-indigenous species in the OSPAR area that have been identified as problematic.*

Group	Taxonomic group	Common names	Regions affected	Vector	First reported	Probable impacts
Plants, algae and phytoplankton	*Spartina anglica*	Common cord-grass, Townsend's grass or ricegrass	I, III, IV	Planting; Secondary spread	France 1906	Habitat modification
	Sargassum muticum	Wireweed, Japweed, Strangleweed	II, III, IV	Secondary spread; Importation for aquaculture	UK 1973	Habitat modification; Competition; Fouling
	Undaria pinnatifida	Wakame, Japanese kelp	II, IV	Importation for aquaculture; Secondary spread; Ballast water	France 1972 France 1983	Competition; Fouling
	Gracilaria vermiculophylla	Asian red alga	II, III	Importation for aquaculture; Secondary spread; Fishing nets	France 1996	Competition; Fouling
	Codium fragile ssp. *fragile*	Green sea fingers	I, II, III, IV	Secondary spread; Ballast water	Netherlands ~1900	Competition; Habitat modification; Fouling
	Bonnemaisonia hamifera	Red alga	I, II, III, IV, V	Importation for aquaculture; Fouling	UK 1893	Competition; Habitat modification
	Coscinodiscus wailesii	A centric diatom	II, III, IV	Ballast water	UK 1977 Norway 1979	Algal blooms
Invertebrates	*Mnemiopsis leidyi*	A comb jelly	II	Ballast water	Netherlands, Sweden, Norway 2006	Food web impacts; Competition
	Marenzelleria spp. (complex)	Red gilled mud worm	II, III	Ballast water	UK 1979	Nutrient regeneration; Competition; Biodiversity loss
	Crepidula fornicata	Slipper limpet	II, III, IV	Aquaculture	UK 1872	Competition; Habitat modification
	Ensis americanus (=*directus*)	Jackknife clam, razor clam	II	Ballast water	Germany 1979	Competition; Habitat modification
	Crassostrea gigas	Pacific oyster	II, IV	Aquaculture	France 1980s	Competition; Habitat modification; Biodiversity loss
	Mya arenaria	Soft-shelled clam, soft clam, long-necked clam	I, II, III, IV	Ballast water	1245	Competition
	Rapana venosa	Rapa whelk, veined whelk	IV	Importation for aquaculture	France 1997 North Sea 2005	Competition
	Venerupis philippinarum	Japanese clam, Manila clam	II, IV	Importation for aquaculture	UK 1992	Competition
	Teredo navalis	Ship worm	II, III, IV, V	Fouling	Netherlands >1730	Damage to structures; Habitat modification
	Eriocheir sinensis	Chinese mitten crab, Mitten crab, Chinese freshwater edible crab	II, III, IV	Ballast water; Secondary spread	Germany 1912	Habitat modification; Predation; Competition
	Hemigrapsus sanguineus	Asian shore crab	II, IV	Ballast water; Fouling	France 1999	Competition; Habitat modification
	Hemigrapsus takanoi	Asian shore crab	II, IV	Ballast water; Fouling	France 1994	Competition; Habitat modification
	Paralithodes camtschaticus	Red king crab	I	Secondary spread	Norway 1976	Competition; Predation; Habitat modification
	Marsupenaeus japonicus	Kuruma prawn	IV	?	Portugal 1985	Competition
	Ficopomatus enigmaticus	A tubeworm	II, III, IV	Fouling	France 1921	Competition; Habitat modification
	Austrominius (=*Elminius*) *modestus*	An acorn barnacle	I, II, IV	Fouling	UK 1945	Competition; Habitat modification
	Caprella mutica	Skeleton shrimp	II, III, IV	Fouling	Belgium 1998	Competition; Habitat modification
	Telmatogeton japonicus	A chironomid (insect)	II, III	Fouling	Germany 1963	Competition; Habitat modification
	Bugula stolonifera	A bryozoan	II, IV, V	Fouling	Netherlands 1993	Competition; Habitat modification
	Styela clava	Leathery sea squirt, Asian sea squirt	II, III, IV	Fouling	France 1968	Competition; Habitat modification
	Didemnum vexillum	A sea squirt or tunicate	I, III	Fouling	Netherlands 1991	Competition; Habitat modification
	Tricellaria inopinata	A bryozoan	II, IV	Importation for aquaculture; Secondary spread; Fishing nets	Spain 1996 UK 1998	Competition; Habitat modification
Protozoa	*Bonamia ostreae*	None	II, III, IV	Aquaculture	France 1976	Competition; Predation

Vectors for introduction have been classified as: Planting; Secondary spread; Importation for aquaculture; Ballast water; Fishing nets; Fouling; Aquaculture; ? Not known **Probable impacts have been classified as:** Habitat modification; Damage to structures; Biodiversity loss; Competition; Food web impacts; Predation; Fouling; Nutrient regeneration; Algal blooms

BOX 9.10 Examples of non-indigenous species known to have adverse effects

The **Pacific oyster** was introduced throughout Europe in the 1970s for cultivation purposes to replace declining populations of the native oyster and the Portuguese oyster. It was assumed that Pacific oysters would not spread to higher latitudes (such as the UK, the Netherlands and Germany) because the waters would be too cold for reproduction. However, the species can tolerate a wide range of temperatures and the free-swimming planktonic larvae can spend up to three weeks in the water column before finding a suitable substrate to settle on. This gives Pacific oyster a wide dispersal range. It is now established or has been detected in Belgium, Denmark, France, Germany, Ireland, the Netherlands and the UK and established populations are reported as far north as Norway and Sweden. In the Wadden Sea, where hard substrate is rare except for mussel beds and oyster shells, blue mussel beds are declining, while populations of reef-habitat building Pacific oysters appear to be increasing. Community structure differs between habitats created by oysters and mussels, with implications for their overall function in the marine environment.

From top: Pacific oyster, red king crab, leathery sea squirt

The **red king crab**, a native of the northern Pacific, was intentionally introduced into Russian waters in the 1960s and by 1976 had migrated to Norway. It is now found in coastal waters throughout northern Norway, where it competes with local predators, modifies habitats and may affect the shellfish industry.

The **leathery sea squirt**, native to the Pacific coast of Asia, was probably introduced to Europe through fouling on warships during the Korean War. Once introduced to Europe, it was reported on the hulls of ships and leisure craft and may have been spread through movements of oyster stocks and floating port structures on which it is a fouling organism. This species can create a high biomass in sheltered areas that result in competition with other filter-feeders. Young individuals often attach to larger specimens (up to 200 mm) to form clusters and thus the long-lived sea squirt may serve as substrate for other non-indigenous species. Economic impacts arise as a result of fouling, for example on artificial structures in ports or mariculture installations. Some people develop respiratory problems from sprays produced from damaged tissues when removing sea squirts from oysters.

TOWARDS INTEGRATED MANAGEMENT

The multiple pressures on the marine environment are increasing. Understanding the relative and cumulative environmental impact of human activities and their integrated management remains a challenge.

The demand for marine resources and space is increasing and there is a growing necessity to balance the needs of different sectors and conservation. New activities, such as offshore wind farm development, alongside increased demands for marine sand and gravel, and growing marine transport, tourism and leisure activity, mariculture and fishing are the main forces driving these demands. OSPAR needs to keep under review the development of pressures from these different activities and the extent of their impacts. Understanding of cumulative impacts is needed. Effective implementation of integrated management, including marine spatial planning, is required to avoid or minimise negative effects on the marine environment and conflicts between different users.

More efforts are needed to move towards integrated management, building on existing achievements

Although integrated management of human activities has not yet been achieved throughout the North-East Atlantic, there are examples of good practice in some parts of the OSPAR area (e.g. Norway → BOX 9.11, Germany and the Netherlands) and this has led to substantial expertise in marine spatial planning. OSPAR should promote transboundary and cross-sectoral cooperation on integrated management by the following:

- Developing and implementing a regionally-based integrated approach to the management of human activities, which meets the requirements of the OSPAR Convention and the EU Marine Strategy Framework Directive. This should apply the ecosystem approach, making best use of tools such as marine spatial planning, integrated coastal zone management, cumulative impact assessments, adaptive management and economic and social analysis.
- More coherent implementation of measures across the OSPAR area. Special attention should be given to the assessment and management of human activities in Regions I and V, particularly in areas beyond national jurisdiction, in cooperation with other competent authorities.
- Intensifying cooperation and communication on the management of the marine environment with other competent authorities, such as the International Maritime Organization (IMO), the International Seabed Authority and the North

East Atlantic Fisheries Commission. Where appropriate, close cooperation on monitoring and assessment should be developed, for example with the Arctic Council.
- Cooperating with the IMO and other international organisations to reduce further the environmental impacts of shipping and to promote maritime safety. In particular, to implement further the commitments from the Gothenburg Declaration 2006 and work towards an integrated approach to sustainable shipping.
- Supporting actions and measures on activities or pressures that are not yet adequately covered by other international bodies and/or legislation and have been assessed as requiring such measures. Issues that need such consideration include litter and noise.

Gaps in knowledge make a comprehensive assessment difficult

In spite of progress made in scientific research and more comprehensive assessment and monitoring programmes, some of the gaps in knowledge on the effects of human activities recognised in the QSR 2000 still remain. Key shortcomings are as follows:
- Data on spatial and temporal trends of some human activities and their effects on the marine environment are incomplete or lacking.
- Much effort has been put into developing approaches for assessing cumulative effects, but standard methods have yet to be agreed and only very few data on cumulative effects of human activities are available.
- Limited transboundary and cross-sectoral cooperation, for example, on site selection and mitigation measures for wind farm development.
- Information from EIAs and related monitoring programmes is often inaccessible to the public. Its use for sub-regional or OSPAR-wide assessments of human activities is also hampered by limited comparability of the data.

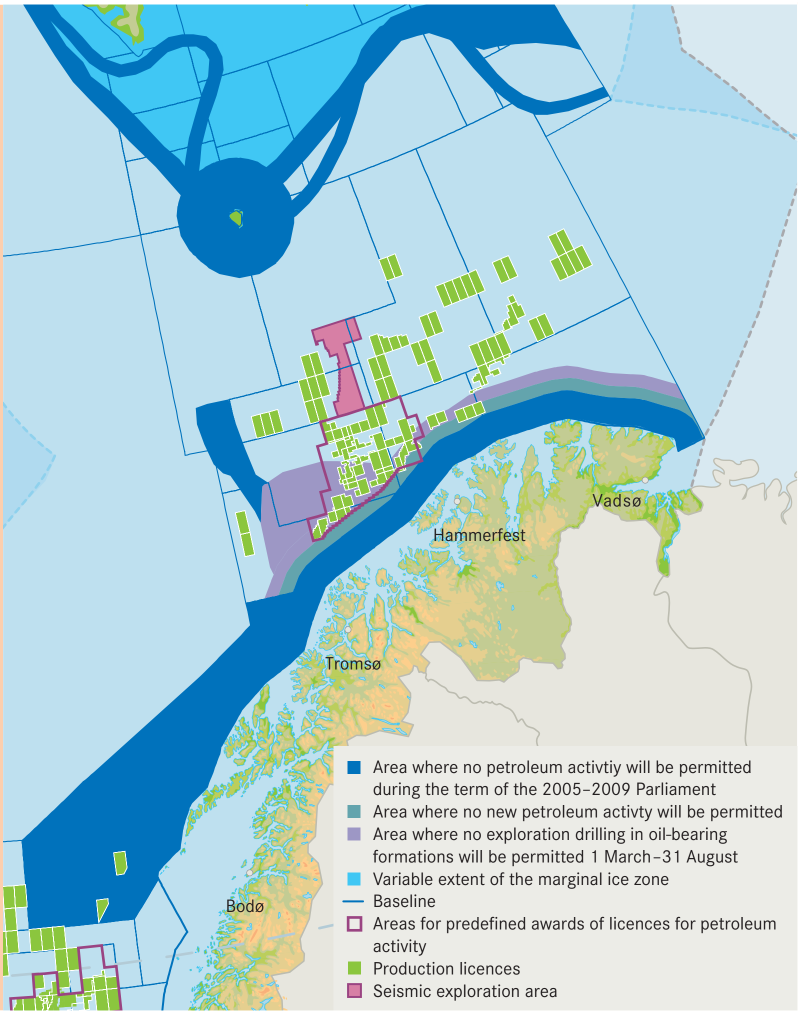
OSPAR should intensify efforts to achieve harmonised, comprehensive assessment and monitoring of human activities as a basis for implementation of the EU Marine Strategy Framework Directive and its concept of good environmental status by EU Member States. Gaps in knowledge should be filled, particularly concerning effects of human activities on biodiversity.

BOX 9.11 Integrated management and marine spatial planning in the Barents Sea

In 2006, the Norwegian government endorsed a plan for 'Integrated Management of the Marine Environment of the Barents Sea and the sea areas off the Lofoten Islands'. A similar plan for the Norwegian Sea was endorsed by the parliament in 2009.

These management plans provide the political basis for managing these important sea areas. The areas include a variety of vulnerable habitats as well as valuable marine living resources and petroleum resources. Indicators with reference values and action thresholds have been developed. Extensive co-ordinated monitoring will ensure a scientific base for management according to the defined action thresholds.

The management plans give the overall framework for both existing and new activities and facilitate co-existence between different sectors, in particular the fisheries, maritime transport and the offshore petroleum industry. Spatial planning is a core element in the integrated management plans. In order to reduce potential conflicts between activities and the protection of vulnerable habitats and species, special restrictions are set for the use of geographically defined areas and zones. These include areas and zones with restrictions on petroleum activities (see figure), mandatory shipping lanes, and areas with coral reefs where fishing with gear able to harm the corals is prohibited. The management plans will be rolling plans and will be updated at regular intervals. The Barents Sea plan will be revised in 2010.



Continued use of the precautionary approach is required

Protection of the marine environment must take into account uncertainties in understanding the effects of new activities and the ability of ecosystems to adapt and respond to changes. OSPAR should promote the following:

- Continued application of the precautionary approach to ecosystem based management of human activities.
- Adaptation of management of human activities to climate change, taking into account additional pressure on species and habitats from expected consequences such as warmer and more acidic seawater, rising sea level and more extreme weather conditions → CHAPTER 3.
- Further investment in the development and application of best available techniques (BAT) and best environmental practices (BEP). This will help safeguard sustainable use of marine resources as well as the promotion of technological progress and development.
- Continued review of developing activities, such as tidal stream and wave energy production.

Regional summary of past trends and outlook for human activities discussed in Chapter 9

Activity	Change of activity in 1998–2008					Outlook for change in activity					Main pressures
	I	II	III	IV	V	I	II	III	IV	V	
Artificial reefs	↑	↑	↑	↓		← →	↑	← →	↑		Habitat loss; Organic enrichment; Local hydrological changes
Cables	⇧	↑	↑	↑	⇧	⇧	↑	↑	↑	⇧	Habitat damage; Habitat loss; Siltation rate changes; Underwater noise; Electromagnetic changes; Temperature changes
Coastal defence		↑	↑	↑			↑	↑	↑		Habitat damage; Habitat loss; Local hydrological changes; Siltation rate changes; Non-indigenous species; Underwater noise; Wave exposure changes
Construction of structures	⇧	↑	↑	↑		⇧	↑	↑	↑		Habitat damage; Habitat loss; Local hydrological changes; Siltation rate changes; Underwater noise
Dredging	⇦ ⇨	← →	← →	⇦ ⇨		⇧	↑	↑	⇧		Habitat damage; Habitat loss; Siltation rate changes; Underwater noise; Hazardous substances
Dumping of wastes and other matter	⇦ ⇨	← →	← →	⇦ ⇨		⇧	↑	↑	⇧		Habitat damage; Habitat loss; Siltation rate changes; Hazardous substances; Organic enrichment; De-oxygenation
Land reclamation	← →	← →	← →	← →		⇧	↑	↑	↑		Habitat damage; Habitat loss; Barrier to species movement; Siltation rate changes; Local hydrological changes
Munitions	← →	← →	← →	← →		← →	← →	← →	← →		Habitat damage; Hazardous substances
Sand and gravel extraction		← →	← →	⇦ ⇨			↑	↑	⇧		Habitat damage; Siltation rate changes; Underwater noise; De-oxygenation
Tourism	↑	↑	← →	↑	↑	↑	← →	← →	↑	↑	Habitat damage; Habitat loss; Underwater noise; Litter; Organic enrichment
Wind farms		↑	↑			↑	↑	↑			Habitat damage; Habitat loss; Barrier to species movement; Underwater noise; Electromagnetic changes; Visual disturbance
Shipping	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	Non-indigenous species; Underwater noise; Litter; Hazardous substances; Microbial pathogens

Direction of change: ↑ Major activity increasing; ↓ Major activity decreasing; ← → No change in major activity; ⇧ Minor activity increasing; ⇩ Minor activity decreasing; ⇦ ⇨ No change in minor activity; Blank field: no relevant activity

Main pressures: Temperature changes; Local hydrological changes; Wave exposure changes – regional/national; Hazardous substances; O_2↓ De-oxygenation; Organic enrichment; Electromagnetic changes; Litter; Underwater noise; Barrier to species movement; Siltation rate changes; Habitat damage; Habitat loss; Visual disturbance; Microbial pathogens; Non-indigenous species

10 PROTECTION AND CONSERVATION OF BIODIVERSITY AND ECOSYSTEMS

OSPAR is working to protect vulnerable species and habitats and ecological processes in the North-East Atlantic. Fishing is a key pressure leading to declines in some species and loss of vulnerable seabed habitat. Climate change will increase the pressure on biodiversity. Progress has been made in establishing marine protected areas (MPAs) in coastal waters and in protecting cold-water corals from destructive fishing practices. The target of reducing the rate of loss of biodiversity has not yet been reached.

OSPAR Contracting Parties should cooperate

- → to ensure that biodiversity protection is fully taken into account in the management of human activities and in marine spatial plans;
- → to develop targeted measures to support the protection and conservation of all threatened and declining species and habitats;
- → to establish additional MPAs, particularly beyond the coasts and in areas beyond national jurisdiction, and ensure that OSPAR MPAs are effectively managed;
- → to develop a scheme for assessing and monitoring biodiversity status at the ecosystem scale.

Key OSPAR assessments

- → Background Documents for the OSPAR List of threatened and/or declining species and habitats
- → Report on progress in developing the OSPAR network of MPAs

Biological diversity – or biodiversity – is the term given to the variety of life on Earth and the natural patterns it forms. Biologically diverse oceans and seas are important for the proper functioning of marine ecosystems. They are also of high value to man in providing services, sustainable uses and as a basis for human health and livelihoods. Many marine species, habitats and ecosystems are sensitive to pressures from human activities and there is general agreement that marine biodiversity globally is facing unprecedented threats as a result of human activities in the marine environment, land-based inputs to the sea and climate change. Since 1998, OSPAR has been working under its Biodiversity and Ecosystems Strategy to identify, protect and conserve those species, habitats, and ecosystem processes in the North-East Atlantic which are most vulnerable to harm. This work complements the work under the Biodiversity and Ecosystems Strategy on human uses of the sea → CHAPTERS 8 and 9.

In 2002, both at the World Summit on Sustainable Development (Johannesburg) and in the context of the UN Convention on Biological Diversity, world governments committed to achieving a significant reduction in the rate of biodiversity loss at the global, regional and national level by 2010. OSPAR's work is one of the key regional processes for implementing the Convention on Biological Diversity in the North-East Atlantic, complementing work done under various EU Directives and measures under the Bern Convention on the Conservation of European Wildlife and Natural Habitats, the Bonn Convention on Migratory Species, and other relevant instruments → TABLE 10.1.

OSPAR Strategy objective for biodiversity and ecosystems
To protect and conserve the ecosystems and the biological diversity of the maritime area which are, or could be, affected as a result of human activities, and to restore, where practicable, marine areas which have been adversely affected.

The Strategy includes the following actions:

- → **Identify those marine species, habitats or ecosystems that need to be protected, conserved or restored.**
- → **Adopt measures within the sphere of competence of OSPAR for the protection of those species and habitats, or draw the attention of other competent authorities to the need for such measures.**
- → **Establish an ecologically coherent network of well managed marine protected areas by 2010.**

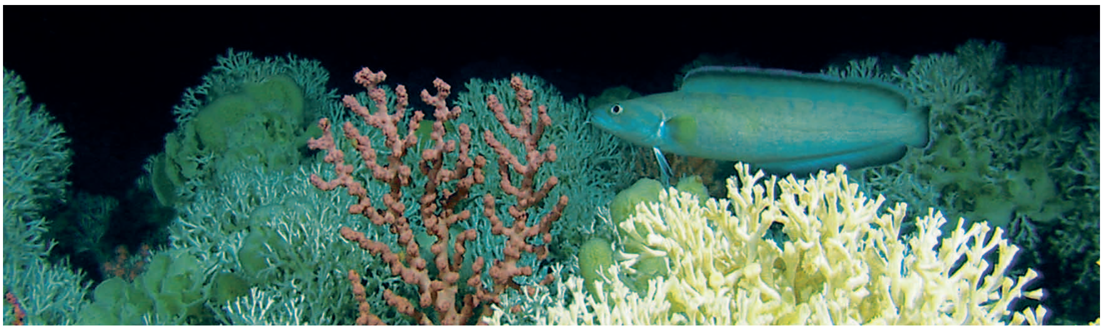
What are the problems?

Pressures are still present and even increasing

Pressures such as the removal of species (e.g. by fishing), loss of and damage to habitats, the introduction of non-indigenous species → CHAPTER 9, obstacles to species migration and poor water quality are still present. Some pressures are even increasing in parts of the OSPAR area and all can act in synergy or be exacerbated by climate change. These pressures result in loss of biodiversity, including declines in the abundance and variety of species and habitats. Interruption of ecological processes, such as spawning, migration, and biological communication, may also occur.

TABLE 10.1 *International and regional framework for protection and conservation of biodiversity.*

	Framework	Objective
Global	Convention on Biological Diversity (CBD)	To conserve biological diversity To use biological diversity in a sustainable fashion To share benefits from the utilization of genetic resources fairly and equitably
	Bonn Convention on Migratory Species (CMS)	To conserve terrestrial, marine and avian migratory species throughout their range
	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	To ensure that international trade in specimens of wild animals and plants does not threaten their survival
	International Whaling Commission (IWC)	To provide for the proper conservation of whale stocks and thus make possible the orderly development of the whaling industry
Europe and North-East Atlantic	OSPAR Convention	To protect the maritime area against the adverse effects of human activities so as to safeguard human health and to conserve marine ecosystems and, when practicable, restore marine areas which have been adversely affected
	EU Habitats Directive (92/43/EEC)	To promote the maintenance of biodiversity by requiring EU Member States to take measures to maintain or restore natural habitats and wild species at a favourable conservation status
	EU Birds Directive (79/409/EEC)	To conserve all species of naturally occurring birds in the wild state in territory of the EU Member States
	EU Marine Strategy Framework Directive (2008/56/EC)	To establish a framework within which EU Member States shall take the necessary measures to achieve or maintain good environmental status in the marine environment by the year 2020 at the latest
	EU Water Framework Directive (2000/60/EC)	To establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater
	Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention)	To conserve wild flora and fauna and their natural habitats To promote cooperation between states To monitor and control endangered and vulnerable species To assist with the provision of assistance concerning legal and scientific issues
Sub-regions of the North-East Atlantic	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS)	To promote close cooperation amongst Parties with a view to achieving and maintaining a favourable conservation status for small cetaceans
	Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS)	To reduce threats to cetaceans in Mediterranean and Black Sea waters and improve our knowledge of these animals
	Trilateral Governmental Cooperation on the Protection of the Wadden Sea	To achieve, as far as possible, a natural and sustainable ecosystem in which natural processes proceed in an undisturbed way
	The North Atlantic Marine Mammal Commission (NAMMCO)	To contribute through regional consultation and cooperation to the conservation, rational management and study of marine mammals in the North Atlantic
Adjacent regions	Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA)	To maintain migratory waterbird species in a favourable conservation status or to restore them to such a status
	Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea Area (HELCOM)	Viable populations of species Favourable conservation status of Baltic Sea biodiversity Thriving and balanced communities of plants and animals



Cold-water corals at 200 m depth off the coast of Norway

Northern right whale and calf (left); blue whale (right)

Severe decline in some species and habitats

The most sensitive features are those that are easily damaged and slow to recover. Some never recover. Reefs of the cold-water coral *Lophelia pertusa* are slow-growing and delicate and can be severely damaged by bottom trawl fisheries. The common skate is a long-lived species that has a slow rate of reproduction and is particularly vulnerable to capture by bottom-trawl fisheries. Species that are near extinction over their entire range include the Azorean limpet, the European sturgeon, and the northern right whale. Numbers of blue whales in the OSPAR area are still at a low level and recovering only very slowly, despite more than 40 years protection from commercial whaling.

Lack of attention to conserving biodiversity

Historically, the management of human activities in the marine environment has not paid enough attention to conserving biodiversity. One of the reasons is that clear evidence of the impacts on species, habitats and ecological processes has only developed in recent decades and still remains scarce in some instances, especially for deeper waters. Another reason is that long-term sustainability has not always been the focus of management. Furthermore, the importance of biodiversity to the proper functioning of habitats is still being debated. OSPAR is working with other international bodies to remedy this, but national management plans still pay too little attention to impacts on species and habitats. Scientific knowledge and practices for assessing biodiversity status are still evolving and an adaptive approach to management planning needs to be used, taking account of better scientific evidence as it becomes available.

Pressures at the coast differ from those offshore

Coastal waters contain feeding grounds, spawning and nursery areas, and feature on migration routes for seabirds and some fish species. These areas also host intense and varied human activities, which exert a wide range of pressures and can lead to the damage or loss of key habitats in estuaries and intertidal areas. Salt marshes and seagrass beds, which are highly productive and act as natural carbon sinks, are under pressure from relative sea-level rise and coastal development. Key areas of the shelf seas, including offshore banks and reefs, and frontal zones between different water masses, play important roles in pelagic productivity. Fishing is recognised as a key pressure on species and habitats in the shelf seas and there continues to be a need for information about ecologically important areas to guide improvements in management.

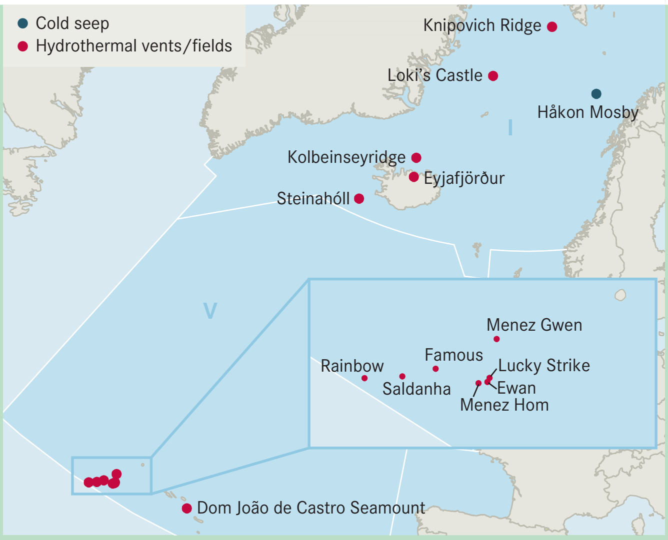
Areas deeper than 200 m cover about 83% of the OSPAR area. The protection of marine biodiversity from human activities such as fishing or the future development of seabed mining and bioprospecting in these vast deep-sea areas is particularly challenging. The full extent of some specialised deep-sea habitats, for example hydrothermal vent fields → BOX 10.1, is still being revealed.

Salt marsh

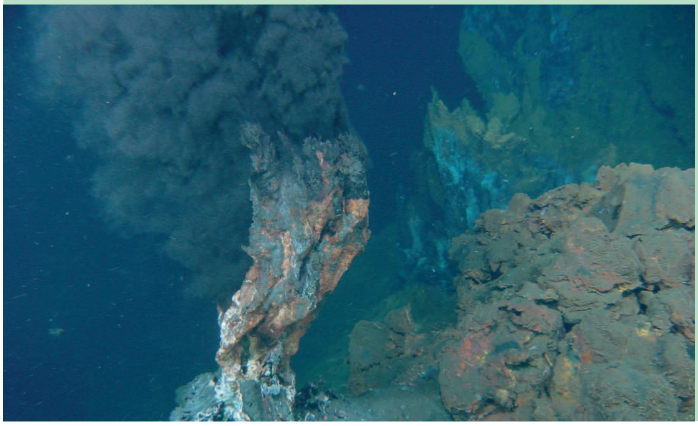
BOX 10.1 Deep-sea vents and seeps

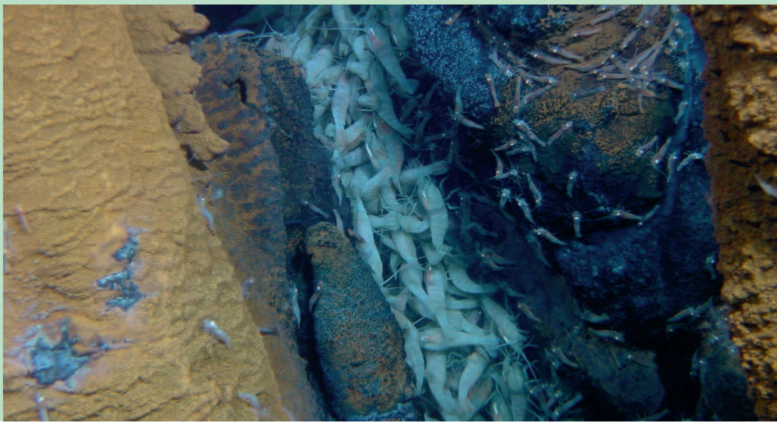
Hydrothermal vents occur around submarine hot springs or superheated jets. The mineral-rich water supports biological communities that derive their energy from dissolved chemicals, such as hydrogen sulphide (H_2S), rather than from solar radiation. One typical form of hydrothermal vent, a 'black smoker' is shown in the photo below (left). The plume consists of hot water escaping from the seafloor containing (black) metal sulphides. Chemotrophic bacteria metabolise the H_2S and support a unique community of animals that feed on them, or with which they have long-term interactions. The photo below (right) shows a specialised community of hydrothermal vent shrimps. Hydrothermal vent fields in the OSPAR area (see map) occupy small areas of the seabed at depths of 850 to 4000 m, associated with the Mid-Atlantic Ridge in Regions I and V. Vents are relatively short-lived, generally existing for only a few decades, thus the exact number and locations of vents are not known.

Cold seeps occur where methane and H_2S are released from the seabed at near-ambient temperatures and also provide energy for a bacterial-based food chain. They are common in European waters and can form a variety of large-scale to small-scale features on the seafloor. The Håkon Mosby mud volcano is one of the largest such features in the OSPAR area, measuring over 1 km across. The communities on different cold seeps frequently differ in terms of species composition. This indicates that there is a high variability in ecosystem processes and associated biodiversity at different spatial scales.



The physical structures of vents in particular may be at risk from activities such as mineral extraction, bioprospecting and, in future, tourism. Scientific research can also cause physical damage. Protected area designation is among the approaches being taken forward to manage human impacts on hydrothermal vents. OSPAR has agreed a code of conduct for responsible marine research in the deep seas and High Seas of the OSPAR area.





Marine biodiversity still poorly known and understood

While knowledge of biodiversity in shallow, coastal areas has much improved over the past few decades, there are still large gaps with respect to the organisms and communities living in areas deeper than 200 m. Bacteria and viruses are thought to play a crucial role as drivers of food webs and global biogeochemical cycles, but this is not sufficiently understood. There are especially gaps in understanding how they will respond to environmental change caused by human activities, including climate change. There are also major gaps in understanding of bottom habitats and their functions for benthic species and communities. There is an ongoing need for major exploratory research initiatives to address these various gaps and support efforts to protect and conserve ecosystems and biodiversity.

What has been done?

Species and habitats under threat and/or in decline

To help set priorities, OSPAR's work on protection and conservation of biodiversity has started from an identification of those species and habitats most in need of protection. The OSPAR List of threatened and/or declining species and habitats was agreed in 2003 and extended in 2008 → TABLES 10.2 and 10.3. It was based on agreed criteria for decline (expressed in terms of population, distribution and condition of species, and distribution, extent and condition of habitats) and threat (expressed in terms of there being a direct or indirect link to human activity). There has been no revision of the list associated with the present quality status assessment (i.e., the QSR 2010). Establishing trends for all species and habitats on the list is challenging, but recent information for some features is presented in the following sections and in the background assessments to this Chapter.

The key pressure affecting the species listed is the removal of target and non-target species, mainly as a result of fishing, while other key pressures include habitat loss or damage, and pollution. Large-scale oceanographic changes associated with climate change, including ocean acidification, rising sea level and increasing sea temperatures, are likely to become increasingly important in the coming decades. Other pressures include the introduction of non-indigenous species and litter. Some species suffer land-based pressures, such as predation at seabird breeding sites and barriers to migration through freshwater areas for those migratory fish species with life stages in both fresh and salt water. The three whale species listed were historically depleted as a result of commercial whaling until the 1960s.

The most important pressures affecting habitats are habitat loss, for example from coastal development or mineral extraction, and habitat damage, in many cases through bottom trawling.

Working to protect species and habitats

OSPAR has been working to identify and implement the best means of protection for these threatened and/or declining species and habitats, many of which are affected by multiple pressures from human activities, often acting cumulatively. Some species and habitats have benefited from improvements in the quality of the marine environment over the past 20 years achieved as a result of OSPAR's work on eutrophication, hazardous substances, offshore oil and gas production and the phasing out of several types of waste disposal.

OSPAR has collected and mapped available information on the distribution of threatened and/or declining habitats → **FIGURE 10.1** and has urged the relevant fisheries authorities to take this information into account in actions to protect these habitats from fisheries-related impacts.

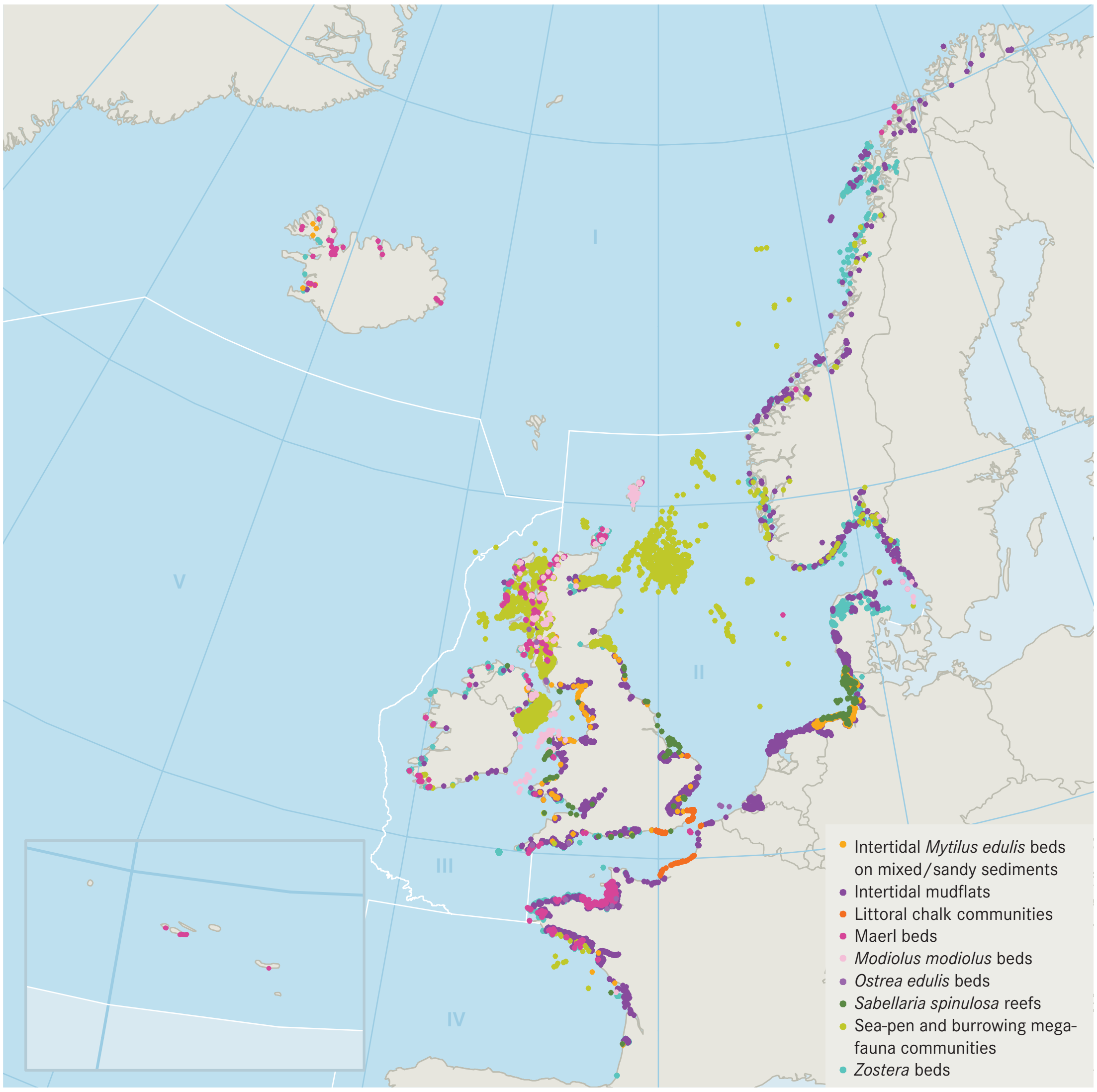


FIGURE 10.1 *Reported information on the distribution of threatened and/or declining coastal and shelf-sea habitats (January 2010). Progress has been made in collating information on the distribution of each habitat considered to be threatened and/or declining. To date, the habitat-mapping programme has mainly provided information on habitat distribution (i.e. geographical coverage). The programme is based on the supply of data by OSPAR countries, so information on habitats in areas beyond national jurisdiction is not targeted. Data for deep-sea habitats are shown in Box 10.3. Data for the coral gardens and Cymodocea meadows are not yet available.*

TABLE 10.2 *OSPAR List of threatened and/or declining species adopted in 2003 (¹species added in 2008) and the current key pressures with impacts on the species listed.*

	Species	Scientific name	Regions where species occurs (○) and has been recognised by OSPAR to be threatened and/or declining (●)					Key pressures
			I	II	III	IV	V	
Invertebrates	Ocean quahog	*Arctica islandica*	○	●	○	○		
	Azorean barnacle	*Megabalanus azoricus*					●	
	Dogwhelk	*Nucella lapillus*	○	●	●	●	○	
	Flat oyster	*Ostrea edulis*	○	●	○	○		
	Azorean limpet	*Patella aspera*					●	
Birds	Lesser black backed gull	*Larus fuscus fuscus*	●					
	Ivory gull[1]	*Pagophilia eburnea*	●					
	Steller's eider	*Polysticta stelleri*	●					
	Little shearwater	*Puffinus assimilis baroli*					●	
	Balearic shearwater[1]	*Puffinus mauretanicus*		●	●	●	●	
	Black-legged kittiwake[1]	*Rissa tridactyla*	●	●	○	○	○	
	Roseate tern	*Sterna dougallii*		●	●	●	●	
	Iberian guillemot	*Uria aalge – Iberian population*				●		
	Thick-billed murre[1]	*Uria lomvia*	●					
Fish	European sturgeon	*Acipenser sturio*		●	○	●		
	Allis shad	*Alosa alosa*		●	●	●		
	European eel[1]	*Anguilla anguilla*	●	●	●	●	●	
	Houting	*Coregonus lavaretus oxyrinchus*		●				
	Salmon	*Salmo salar*	●	●	●	●		
	Sea lamprey	*Petromyzon marinus*	●	●	●	●		
	Portuguese dogfish[1]	*Centroscymnus coelolepis*	●	●	●	●	●	
	Gulper shark[1]	*Centrophorus granulosus*				●	●	
	Leafscale gulper shark[1]	*Centrophorus squamosus*	●	●	●	●	●	
	Basking shark	*Cetorhinus maximus*	●	●	●	●	●	
	Common skate	*Dipturus batis*	●	●	●	●	●	
	Spotted ray	*Raja montagui*		●	●	●	●	
	Spurdog[1]	*Squalus acanthias*	●	●	●	●	●	
	Porbeagle[1]	*Lamna nasus*	●	●	●	●	●	
	Thornback skate/ray[1]	*Raja clavata*	○	●	○	○	○	
	White skate[1]	*Rostroraja alba*		●	●	●		
	Angel shark[1]	*Squatina squatina*		●	●	●		
	Cod	*Gadus morhua*	○	●	●	○	○	
	Orange roughy	*Hoplostethus atlanticus*	●				●	
	Bluefin tuna	*Thunnus thynnus*					●	
	Long-snouted seahorse	*Hippocampus guttulatus*		●	●	●	●	
	Short-snouted seahorse	*Hippocampus hippocampus*		●	●	●	●	
Reptiles	Loggerhead turtle	*Caretta caretta*				●	●	
	Leatherback turtle	*Dermochelys coriacea*	●	●	●	●	●	
Mammals	Bowhead whale	*Balaena mysticetus*	●					
	Blue whale	*Balaenoptera musculus*	●	●	●	●	●	
	Northern right whale	*Eubalaena glacialis*	●	●	●	●	●	
	Harbour porpoise	*Phocoena phocoena*	○	●	●	○	○	

TABLE 10.3 *OSPAR List of threatened and/or declining habitats adopted in 2003 ([1]habitats added in 2008) and the current key pressures with impacts on the habitats listed.*

	Habitat	Regions where habitat occurs (○) and has been recognised by OSPAR to be threatened and/or declining (●)					Key pressures
		I	II	III	IV	V	
Coastal habitats	Littoral chalk communities		●				Climate change; Hazardous substances; Oil pollution; Habitat damage; Habitat loss; Introduction of non-indigenous species and translocations
Coastal habitats	Intertidal *Mytilus edulis* beds on mixed and sandy sediments		●	●			Climate change; Hazardous substances; Oil pollution; Nutrient and organic enrichment; Habitat damage; Habitat loss; Removal of target and non-target species
Coastal habitats	Intertidal mudflats	●	●	●	●		Climate change; Hydrological changes; Hazardous substances; Oil pollution; Habitat damage; Habitat loss
Coastal habitats	*Ostrea edulis* beds		●	●	●		Hazardous substances; Habitat damage; Microbial pathogens; Introduction of non-indigenous species and translocations; Removal of target and non-target species
Coastal habitats	*Zostera* beds	●	●	●	●		Climate change; Hazardous substances; Nutrient and organic enrichment; Siltation rate changes; Habitat damage; Microbial pathogens; Introduction of non-indigenous species and translocations; Removal of target and non-target species
Coastal habitats	*Cymodocea* meadows[1]				●		Siltation rate changes; Habitat damage
Shelf sea habitats	*Modiolus modiolus* beds	●	●	●	●		Hazardous substances; Habitat damage; Habitat loss; Introduction of non-indigenous species and translocations; Removal of target and non-target species
Shelf sea habitats	*Sabellaria spinulosa* reefs	○	●	●	○	○	Hydrological changes; Habitat damage; Habitat loss; Removal of target and non-target species
Shelf sea habitats	Maerl beds	○	○	●	○	○	pH changes; Siltation rate changes; Habitat damage; Habitat loss
Shelf sea habitats	Sea-pen and burrowing megafauna communities	○	●	●	○		Habitat damage; Habitat loss
Deep-sea habitats	*Lophelia pertusa* reefs	●	●	●	●	●	pH changes; Siltation rate changes; Habitat damage; Habitat loss; Nutrient and organic enrichment
Deep-sea habitats	Coral gardens[1]	●	●	●	●	●	pH changes; Habitat damage
Deep-sea habitats	Carbonate mounds	○				●	Habitat damage
Deep-sea habitats	Deep-sea sponge aggregations	●		●	●	●	Habitat damage; Removal of target and non-target species
Deep-sea habitats	Oceanic ridges with hydrothermal vents/fields	○				●	Habitat damage; Removal of target and non-target species
Deep-sea habitats	Seamounts	●			●	●	Habitat damage; Removal of target and non-target species

KEY TO TABLES 10.2 AND 10.3: Climate change; **pH↘** pH changes; Hydrological changes; Hazardous substances; Oil pollution; Nutrient and organic enrichment; Litter; Underwater noise; Barriers to species movement; Death or injury by ship strikes; Siltation rate changes; Habitat damage; Habitat loss; Microbial pathogens; Introduction of non-indigenous species and translocations; Removal of target and non-target species; Predation; Loss of prey species; Threats outside the OSPAR area

OSPAR has identified a range of actions to be taken to protect particular species and habitats. These include:

- Raising awareness of the species and habitats and their key pressures among stakeholders and wider society.
- Taking into account threatened and/or declining species and habitats in environmental impact assessment processes.
- Supporting improved identification of threatened species (sharks, skates and rays, sturgeon) among key users of the sea (e.g. fishermen).
- Protection of breeding sites (seabirds, including roseate tern and thick-billed murre).
- Restoration of habitats and protection of migration corridors (diadromous fish).
- Reintroduction programmes (European sturgeon).
- Improved coordination of monitoring of species, habitats and pressures, and sharing of information, for example, on sightings (turtles, basking shark).
- Action to reduce by-catch (sharks, skates, rays, Balearic shearwater, harbour porpoise, turtles).
- Establishing marine protected areas (MPAs) to protect important functional areas for species and habitats, including key life stages (shark, skates and rays).

Thick-billed murres

Several other international organisations and frameworks contribute to protection and conservation of marine biodiversity → **TABLE 10.1**. OSPAR needs to coordinate its work with the efforts of these organisations and to provide a framework to harmonise and support consistent actions at national level. Conservation efforts for many species need to be supported by further research, especially on demographics and life history. Improved mapping of the distribution, extent and condition of seabed habitats is vital to support management. Better coordination of monitoring and information collection is also important.

A network of MPAs is under development

OSPAR is developing an ecologically coherent network of well-managed MPAs for the North-East Atlantic and has set the aim for this to be established by 2010. The network is intended to make a significant contribution to the sustainable use, protection and conservation of marine biodiversity including in areas beyond national jurisdiction. Both the network and the aims set for it → **BOX 10.2** add to, and complement, the system of Natura 2000 protected areas for the marine environment established under the EU Birds Directive and the Habitats Directive and other national measures. Specifically, the OSPAR network has extended geographical coverage and the ecologically based criteria used to select OSPAR MPAs are broader than the Natura 2000 criteria and include the need to represent a more extensive range of species and habitats. OSPAR's aim of an ecologically coherent network seeks to ensure that the MPAs interact with, and support, the wider marine environment as well as other MPAs. This is particularly important for highly mobile species so as to safeguard the critical stages and areas of their lifecycle (such as breeding, nursery and feeding areas). Appropriate management is vital to achieve good ecosystem health and functioning within and outside MPAs. The most appropriate management measures to achieve the objectives of each MPA need to be defined in a management plan. Zoning, seasonal closures, and restrictions on certain activities (e.g. fishing effort management, gear restrictions) are all management approaches that could be employed in MPAs.

BOX 10.2 Aims of the OSPAR MPA network

Marine protected areas are areas for which protective, conservation, restorative or precautionary measures have been put in place to protect and conserve species, habitats, ecosystems or ecological processes of the marine environment on a temporary or permanent basis.

The OSPAR network of MPAs has the following aims:
- To protect, conserve and restore species, habitats and ecological processes which have been adversely affected as a result of human activities.
- To protect, conserve and restore species, habitats and ecological processes which best represent the range of these features within the OSPAR maritime area.
- To prevent degradation and damage to species, habitats and ecological processes, following the precautionary principle.

The selection of areas for inclusion in the network takes into account the following criteria, based on best available scientific expertise and knowledge:
- Threatened or declining species and habitats/biotopes
- Important species and habitats/biotopes
- Ecological significance
- High natural biological diversity
- Representativity
- Sensitivity
- Naturalness

MPAs in areas beyond national jurisdiction

OSPAR has agreed that areas outside the jurisdiction of OSPAR countries will be considered for inclusion in the MPA network. Several ecologically significant and/or vulnerable areas have been identified in these areas beyond national jurisdiction. The mandates for regulatory measures to protect these areas are shared by a number of bodies under the United Nations Convention on the Law of the Sea (UNCLOS), including OSPAR. As a result, common principles for the protection of vulnerable marine ecosystems in these areas must be drawn up through international cooperation and collaboration.

EcoQOs provide tools for considering wider biodiversity status

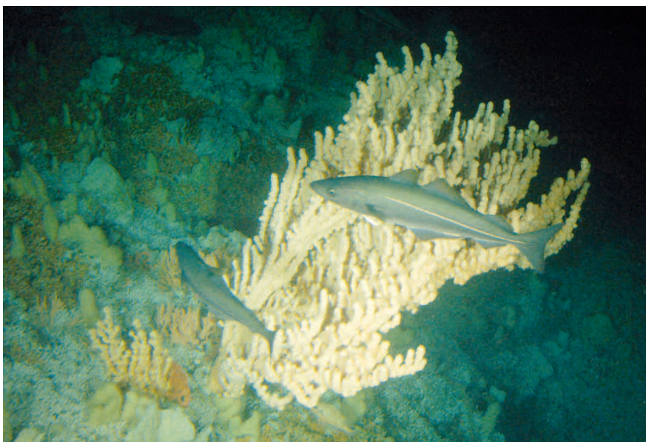
OSPAR's Ecological Quality Objectives (EcoQOs) for the North Sea provide a further tool to support the protection of biodiversity and ecosystems. EcoQOs on seals and seabird populations consider developments in biodiversity status beyond endangered species and habitats. Other EcoQOs provide a link between elements of biodiversity and human activities. EcoQOs are seen as an important component of an ecosystem approach to management → **CHAPTER 11**.

Did it work?

Progress on protecting some species and habitats

Work by OSPAR to raise awareness with key fisheries management authorities has contributed to the protection of cold-water coral reefs → **BOX 10.3**. Following similar efforts in relation to littoral chalk communities, protection and monitoring schemes for this habitat are now included in national and EU legislation. These coastal exposures of chalk are rare in Europe and large parts have been modified by coastal defence. This has led to the loss of micro-habitats on the upper shore and the removal of splash-zone communities (including unique algal communities) which have also been affected by poor water quality. As a result of the steps taken, the overall prognosis for preventing further deterioration in the current state of the habitat is good.

Lophelia pertusa corals off the Norwegian coast

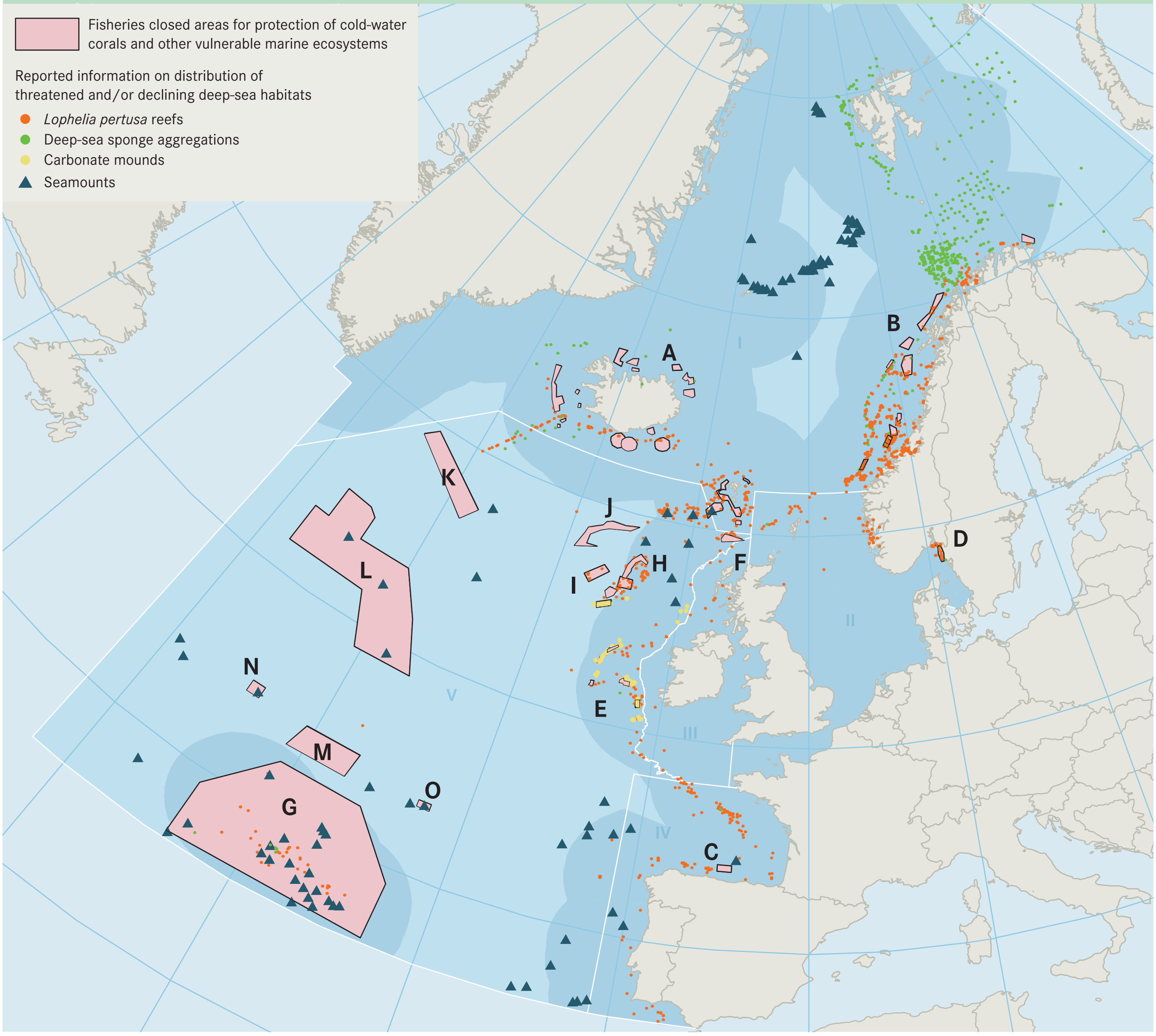


BOX 10.3 Protection of cold-water corals and other deep-sea habitats

Cold-water corals are very important in the deep-sea environment because the habitats they create are biologically rich and diverse. They may either form reefs of hard stony corals (*Lophelia pertusa*) or gardens of soft, non-reef building species. Cold-water coral reefs are widely recognised as threatened marine ecosystems because they are slow-growing habitats that are easily impacted by the mechanical effects of fishing gear. *Lophelia pertusa* has been documented in commercial by-catch in waters off Ireland, Iceland and northern Norway. Survey images reveal the extent of reef impacts including trawl door furrows and broken coral strewn on the seabed.

In 2003, OSPAR Ministers agreed to take immediate measures to protect cold-water coral reefs from further damage by fishing gear. OSPAR raised its concerns about the status of these reefs to the fisheries management authorities of the EU, Iceland and Norway and to the North East Atlantic Fisheries Commission (NEAFC). OSPAR raised particular concerns with NEAFC over the protection of corals on the western slopes of the Rockall Bank.

There has been significant progress in establishing closed areas to fisheries around known reefs, with almost 600 000 km^2 of the OSPAR area currently protected (see map). Protected areas within Icelandic (A), Norwegian (B), Spanish (C) and Swedish (D) waters have been included in the OSPAR MPA network and some fisheries closures have been introduced in Faroese waters. Certain reefs have been jointly designated by EU Member States under the Habitats Directive and the OSPAR network, including four areas in Irish waters (E) and the Darwin Mounds (F) in UK waters. Initial restrictions on fishing gear in these areas were introduced through provisions under the EU Common Fisheries Policy. This approach has also been used to protect reefs around the Azores (Portugal) (G) and on North-West Rockall Bank (UK) (H). The need to protect deep-sea habitats is one of the issues for cooperation under a memorandum of understanding between OSPAR and NEAFC established in 2008. One of the most significant conservation measures in the OSPAR area is the NEAFC temporary closure of an area comprising 330 000 km^2 to bottom trawling for the purpose of protecting vulnerable deep-sea habitats. This includes closure of three areas to the west and south of the Rockall Bank (I), parts of the Hatton Bank (J), three large areas on the Mid-Atlantic Ridge (K,L,M) and two isolated seamounts (N,O). The map below includes known distributions of four threatened deep-sea habitats on the OSPAR List based on the OSPAR habitat-mapping programme (*Lophelia pertusa* reefs, carbonate mounds, deep-sea sponge aggregations and seamounts). Knowledge of the distribution of cold-water coral reefs and other deep-sea habitats is still growing. In 2008, OSPAR recognised coral gardens, a further cold-water coral habitat, as being under threat and is now working to raise awareness of this habitat.



Littoral chalk communities

Intertidal mussel bed

Many of the species and habitats on the OSPAR List are affected by poor environmental quality. Work towards improved environmental quality under all OSPAR Strategies has had a positive influence on biodiversity. For example, threatened and/or declining species and habitats as well as wider ecosystems benefit from improvements in water quality. Dogwhelk populations, which were heavily affected by the use of tributyltin (TBT) as an anti-foulant in marine paints, are no longer declining and are re-colonising some sites from which they had previously disappeared → CHAPTER 5. Before the global ban on the use of TBT under the International Maritime Organization, some of the first international action on TBT was taken by OSPAR. The extent of further impacts of hazardous substances on sensitive marine species, including effects such as endocrine disruption, is still being revealed.

Implementing measures can be challenging

In the Azores, a number of measures have been introduced to protect the wild Azorean limpet following a dramatic collapse in the late 1980s, including closed seasons, closed areas and licensing of fishermen. The measures have not been effective in protecting the limpet population from illegal exploitation, because the extent of the coastline and its remoteness make enforcement difficult. Legal measures must be maintained for several years and supplemented by awareness raising.

In the Wadden Sea, intense exploitation of intertidal mussel beds removed almost the entire stock of blue mussels between 1988 and 1990. As a result, trilateral targets were adopted by Denmark, Germany and the Netherlands, and a management plan for the blue mussel fishery was laid down in 1997. However, despite considerable efforts in mussel management and the closure of extensive parts of the Wadden Sea to mussel fisheries, the area of intertidal mussel beds is only increasing in parts of the Dutch Wadden Sea. Long-term changes in climatic conditions and increasing numbers of non-indigenous species, such as Pacific oyster, are thought to be a contributory factor to this lack of success.

Azorean limpet

Situation is critical for other species and habitats

Progress on the protection of other species and habitats has been too slow. Many diadromous fish species (those that migrate between freshwater and marine habitats at different stages of their life-cycle) have been strongly declining. Five such species have been identified by OSPAR as under threat and in decline (European sturgeon, Allis shad, houting, sea lamprey and Atlantic salmon). The decline is attributed to direct impacts, such as uncontrolled commercial and recreational fisheries, and indirect impacts, such as degradation of spawning habitat, decreased water quality, impacts from aquaculture and barriers to migration. The European sturgeon is recognised as critically endangered by the International Union for Conservation of Nature (IUCN) → BOX 10.4. Stocks of the Atlantic salmon continue to be at low historical levels in spite of management measures aimed at reducing exploitation, mainly due to poor survival at sea. Efforts continue to fully understand the reasons for this, although it has been attributed to climate change.

Some commercially exploited fish stocks, particularly cod in Regions II and III, and orange roughy and bluefin tuna in Region V have undergone a strong decline, mainly due to poor management and overfishing.

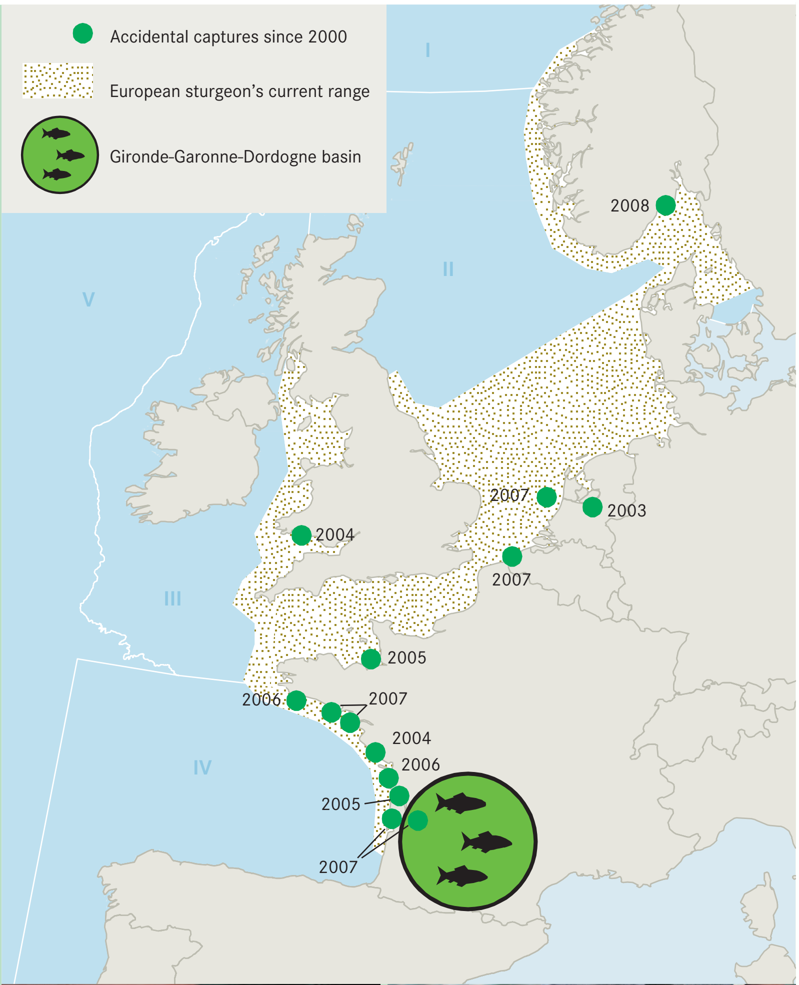
BOX 10.4 Protecting the last population of the European sturgeon

The European sturgeon is the largest freshwater fish in Europe and probably one of the most vulnerable species in OSPAR's waters. Its spawning grounds have dramatically declined since the 19th century and are presently restricted to one area in the Gironde-Garonne-Dordogne basin in France (see map) with one confirmed population, but even this may no longer be viable.

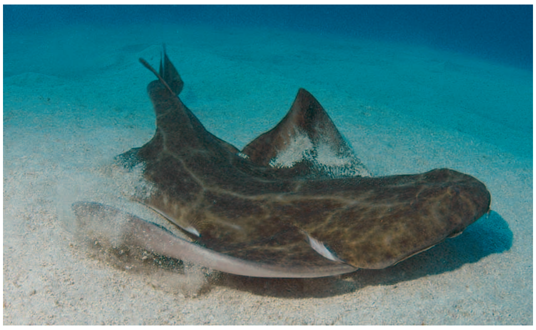
Although the sturgeon breeds in rivers, some adults spend time at sea. Their marine range is entirely confined to the coastal waters of Regions II, III and IV (see map). Loss of natural breeding and feeding habitat, through damming and gravel extraction, appears to have been responsible for the historical decline in sturgeon. The largest current threat to the few individuals remaining is from accidental capture, including as by-catch, and poaching. Water abstraction and pollution also pose problems.

Since its original inclusion in the OSPAR List in 2003, a variety of measures have been introduced in an attempt to reverse its decline. The sturgeon has full legal protection throughout the OSPAR area and awareness-raising campaigns for fishermen and anglers have been undertaken by environmental and fisheries organisations. A Europe-wide action plan for the restoration of this species was drafted under the Bern Convention in 2007.

This species has also been the subject of international scientific research and monitoring programmes aimed at understanding the reasons for its decline and at restocking with wild or artificially reared fish. Some 9000 wild fish were released into Europe's rivers in 1995. Over 100 000 reared alevins were released into the Garonne and Dordogne between 2007 and 2009. To date, there has been no evidence of an improvement in its conservation status. In 2008, a programme was started in Germany on experimental restocking of sturgeons in the rivers Oste, Stör and Elbe.



Elasmobranchs (sharks, skates and rays) are long-lived fish found in all European waters. Populations of many elasmobranch species have declined as a result of fishing pressure and in the past several species were targeted by fisheries until their numbers collapsed. An example is the common skate which, as the name implies, was historically one of the most abundant skates in the North-East Atlantic and was widely distributed in the seas off North-West Europe. It is now considered severely depleted in many areas and is no longer found in large parts of Region II (the North Sea) and Region III (Irish Sea). Several other pelagic and demersal shark, skate and ray species occurring in both deep-sea and shelf sea ecosystems are included on the OSPAR List and continuing declines in populations have been reported during the period 1998–2008. Some, such as the angel shark and the white skate, are considered severely depleted. By-catch in commercial fisheries is the main current threat affecting elasmobranchs.



Angel shark

Common skate

Sea-pen and burrowing megafauna community

The Balearic shearwater breeds in the Balearic Islands in the Mediterranean and occurs in Regions II, III, IV and V during summer (particularly June to October). Several breeding colonies have disappeared over the past few decades; threats in their offshore foraging areas in the Atlantic are also likely to have a significant effect on overall populations. The Balearic shearwater is increasingly threatened through overexploitation of its main prey species and changes in their distribution, with by-catch and oil pollution incidents also thought to be significant. At sea, censuses in the Mediterranean and the OSPAR area have both shown significant and rapid declines. This species has a very high risk of extinction (one study estimated the risk at 50 % within three generations) and is classified as 'critically endangered' by the IUCN.

Other species for which priority actions are required include the black-legged kittiwake → **BOX 10.5**, the leatherback turtle, the ocean quahog and the flat oyster.

Sea-pen and burrowing megafauna communities occur in soft muddy sediment and are very sensitive to seabed disturbance. They are found mainly in the shelf seas and deeper coastal waters of northern Region II and Region III, but also in parts of Regions I and IV. The high natural biodiversity of this habitat makes it very productive for fishing. The protection of this habitat in the North-East Atlantic has received little attention until now, with only limited protection provided through existing MPAs.

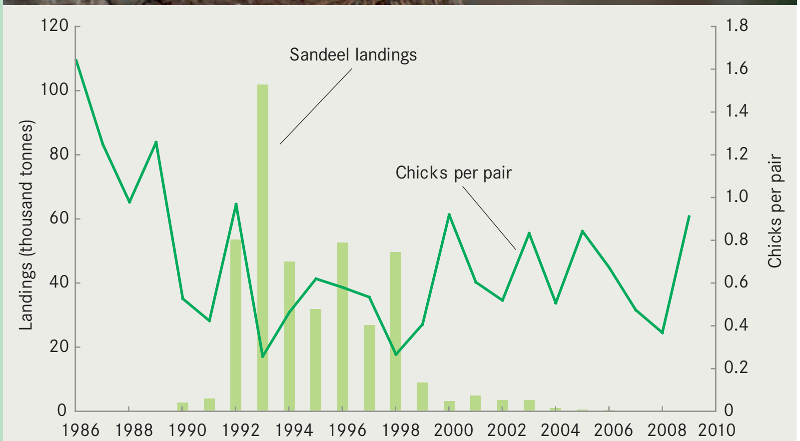
Other habitats for which priority actions are required include intertidal mudflats, *Zostera* beds, *Modiolus modiolus* beds, natural beds of oysters (*Ostrea edulis*), deep-sea sponge aggregations and seamounts.

BOX 10.5 Local sandeel availability to black-legged kittiwakes

Populations of several seabird species have declined in Region I and the northern part of Region II. More than 90 % of the North Sea's black-legged kittiwakes breed on UK coasts. Populations have declined by over 50 % since 1990, coinciding with a period of significant oceanographic change and increased commercial landings of the bird's main prey, lesser sandeels. The graph below compares breeding success of black-legged kittiwake along the east coast of Scotland between Troup Head and St. Abbs, and sandeel catch from the adjacent sea areas east of the Scottish coast (west of 1° W; south of 58° N). This apparent relationship contributed to the decision to close the sandeel fishery off the east of Scotland in 2000. It has remained closed since, apart from a small exploratory fishery.

Breeding success and adult survival for black-legged kittiwakes was also negatively correlated with winter sea temperature. This may relate to rises in sea surface temperatures in the 1980s reducing sandeel recruitment. If temperatures in the North Sea increase further, this may lead to population declines, even if the commercial sandeel fishery remains closed. OSPAR has paused work with ICES on the development of an EcoQO for local sandeel availability to black-legged kittiwakes due to the difficulties of establishing a clear linking mechanism with the catch in the sandeel fishery.

Although an improvement in breeding success was observed on the Isle of May (off the east coast of Scotland) from 2000 onwards, numbers of Arctic skuas, Arctic terns and black-legged kittiwakes in Shetland have continued to decline following poor breeding success between 2001 and 2004. It has been predicted that if sea temperatures in the North Sea increase in the future and the sandeel fishery resumes, the kittiwake population on the Isle of May and perhaps other nearby colonies would enter a 'catastrophic decline'.



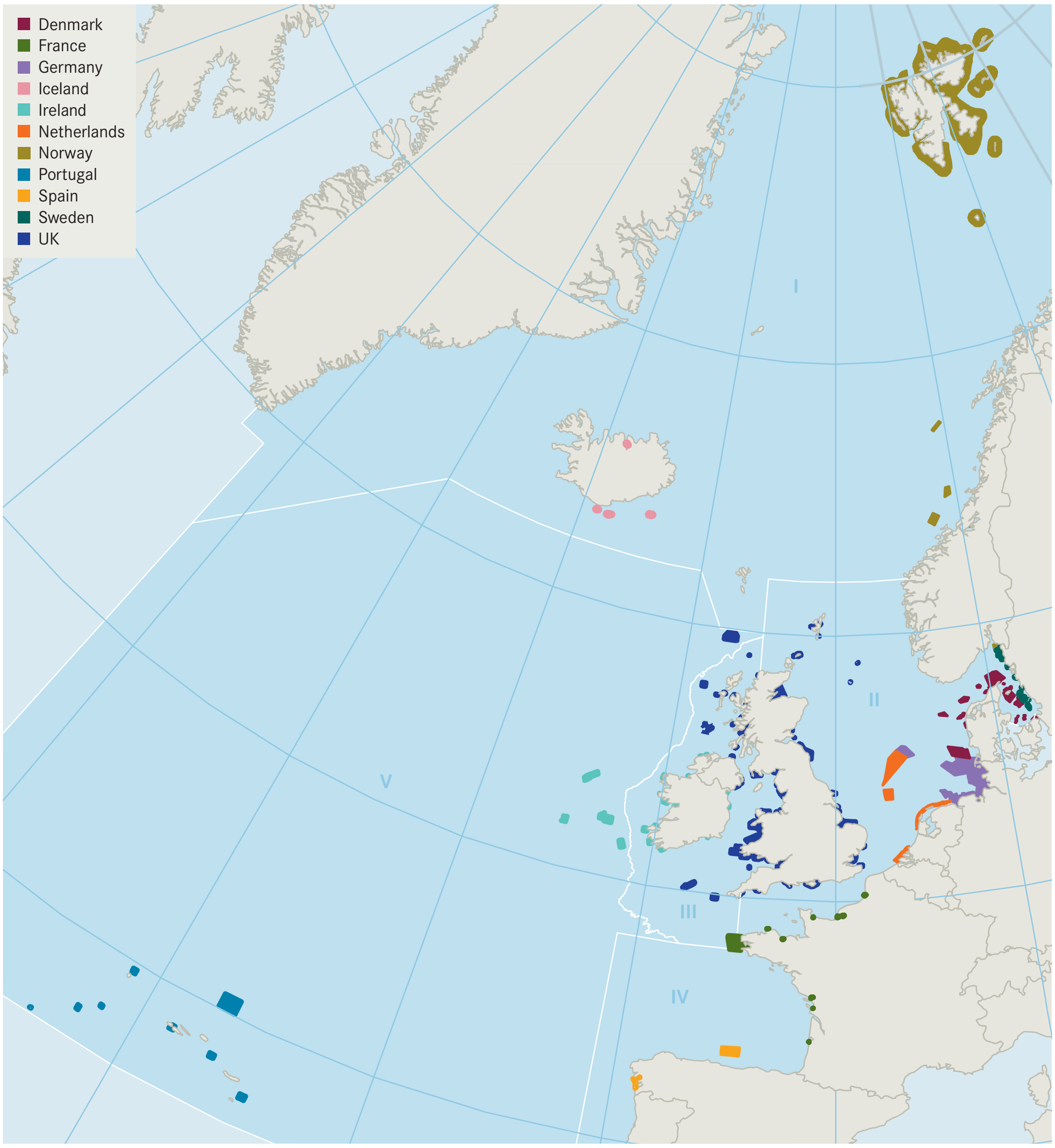


FIGURE 10.2 *The OSPAR network of marine protected areas (January 2010).*

OSPAR MPA network is developing from the Arctic to the Azores

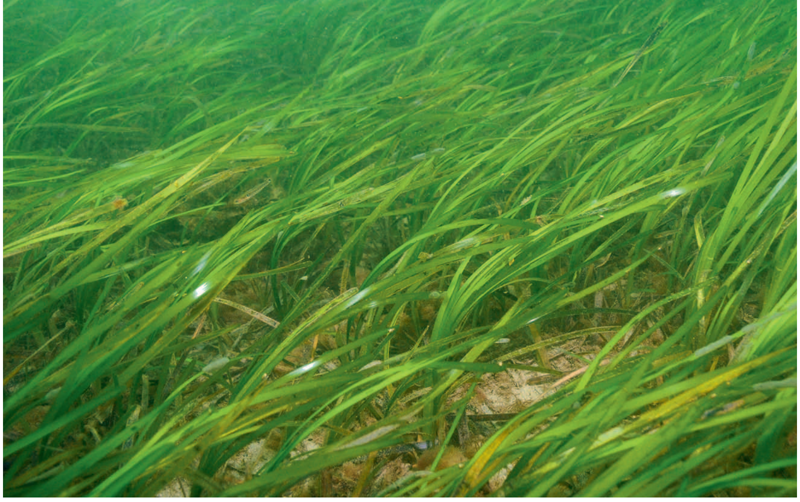
By January 2010, the MPA network comprised 159 MPAs that together covered 147 324 km^2 or 1.08 % of the OSPAR area → **TABLE 10.4** and → **FIGURE 10.2**.

Most MPAs are located within territorial waters, covering a substantial proportion of coastal waters (~ 13 %), while 46 are located at least partly within Exclusive Economic Zones (EEZ) (covering 0.52 %). Only one MPA is located on an extended continental shelf, which is claimed by Portugal. No MPA has yet been established entirely in areas beyond national jurisdiction.

The MPAs included in the OSPAR network offer protection for all invertebrates considered threatened and/or declining, three of the nine bird species listed, eight of the 22 fish species, both turtle species, three of the four mammal species, and all of the habitats listed. This is expected to improve as more MPAs are designated and management plans are developed and implemented → **FIGURE 10.3**.

TABLE 10.4 *Marine protected areas nominated to OSPAR (January 2010).*

OSPAR country	MPAs	Coverage, km²
Belgium	0	0
Denmark	24	8 403
France	9	3 598
Germany	6	16 889
Iceland	7	79
Ireland	19	4 137
Netherlands	5	8 316
Norway	8	80 598
Portugal	8	5 700
Spain	2	2 483
Sweden	8	1 257
UK	63	15 864
Total	159	147 324



Zostera bed

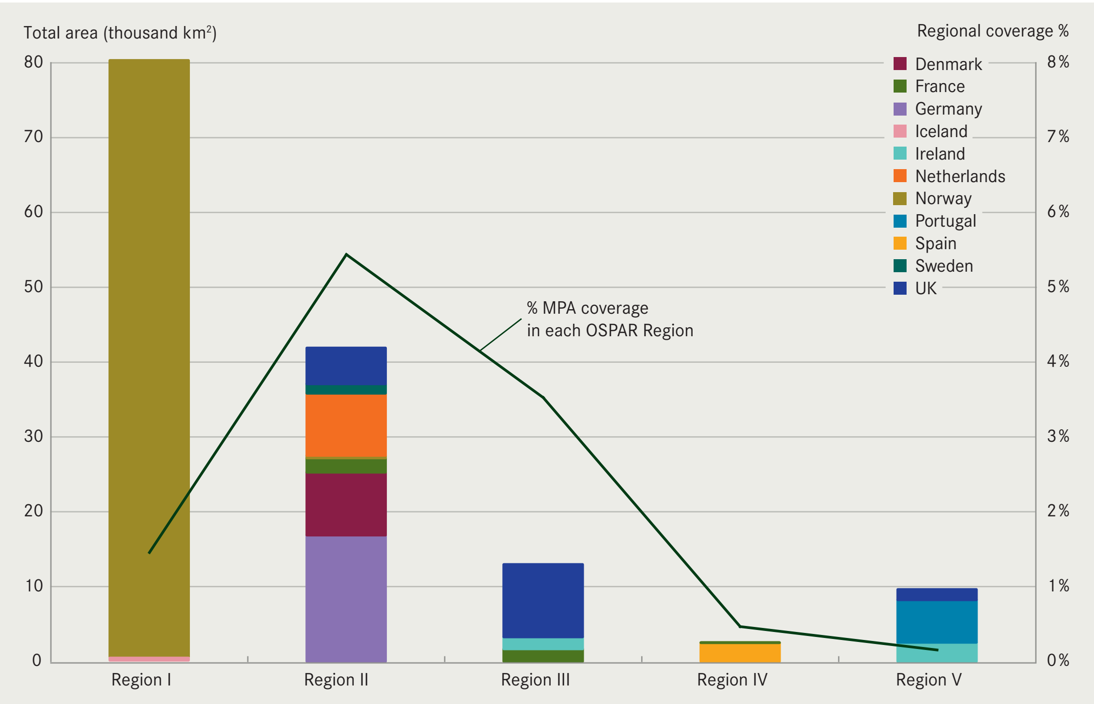
Maerl bed

In Regions II and III, a substantial coverage of MPAs has been achieved in nearshore waters around the UK and Ireland and along the North Sea coast of Sweden, Denmark, Germany and the Netherlands. These protect a diverse range of coastal ecosystems, including tidal inlets and rivers, fjords, estuaries, salt marshes, sandbanks and rocky shores. Extensive areas of intertidal mudflats are included, with the Wadden Sea the most prominent example, together with seagrass beds (*Zostera* sp.), maerl, flat oyster beds, or intertidal mussel beds. The sites also host a number of species under threat and/or in decline, including harbour porpoise, common skate, salmon, cod, sea lamprey, dogwhelk, ocean quahog, and a variety of seabirds such as the Balearic shearwater or black-legged kittiwake. Some MPAs are dedicated to protecting cold-water coral reefs, for example in the Skagerrak. MPAs have also been established in offshore waters, specifically protecting reefs and sandbanks (e.g. the Dogger Bank in the central North Sea).

In Region IV, one MPA is located in offshore waters. The site (known as El Cachucho) protects a unique deep-sea ecosystem in the Cantabrian Sea. It is located in the Spanish EEZ and comprises an extensive elevated bank and seamount with a system of channels and canyons, and an inner basin that separates the bank from the continental shelf. Cold-water coral reefs, carbonate mounds, deep-sea sponges, giant squid and deep-water sharks are found at this site. The remaining MPAs in Region IV are situated along the Breton and Galician coastlines including the Mer d'Iroise to the west of Brittany (France). These sites include intertidal mudflats and beds of oysters, mussels and kelp, and rare species such as the leatherback turtle, loggerhead turtle and short-snouted seahorse.

In Region V, MPAs are being used to protect the cold-water reefs on the Darwin mounds off the north-west coast of the UK, a number of carbonate mounds in offshore waters to the west of Ireland and the rich marine ecosystems around the Azores. Three hydrothermal vent fields have been included in the MPA network: Menez Gwen, Lucky Strike and Rainbow → **BOX 10.1**, as part of the recently created Azorean Marine Park. The MPAs also include sea-

FIGURE 10.3 *Distribution of OSPAR marine protected areas by Region (January 2010).*



Svalbard archipelago

mounts, volcanoes, deep-sea sponge aggregations and cold-water coral reefs, especially of *Lophelia pertusa*. Some of the species listed by OSPAR as threatened and/or declining only occur in Region V, for example, the Azorean barnacle, Azorean limpet and the little shearwater. Other threatened and/or declining species found in these MPAs include the blue whale, loggerhead turtle and orange roughy.

In Region I, MPAs have been established along the coast of Norway, around the Svalbard archipelago and in Icelandic coastal waters. Many protect cold-water coral reef systems, which provide important feeding grounds and shelter for several fish species, including commercially valuable species such as redfish, ling, and tusk. The most common macro-fauna in these reef systems are deep-sea sponges, gorgonians, soft corals, squat lobsters, hermit and other crabs, and sea urchins. Around Iceland, two isolated hydrothermal vent fields are protected by MPAs. Three MPAs around Svalbard and Bear Island (Bjørnøya) form the most extensively protected zone in the OSPAR network, covering approximately 78 000 km^2. These MPAs protect a highly biologically diverse and productive ecosystem that is considered to be one of the most important seabird areas in the world.

Ecological coherence of the OSPAR network

A comprehensive assessment of the ecological coherence of the current network of MPAs is hampered by the limited information available on the distribution of many species and habitats within the OSPAR area, including in OSPAR MPAs. A preliminary spatial assessment considering the distribution of OSPAR MPAs suggests that ecological coherence has not been reached across the entire OSPAR area. Within the North Sea, Celtic Seas and the Azores and around the Svalbard archipelago the current MPA coverage provides some degree of connectivity and representativity. It is clear that further sites need to be included in the network to ensure its coherence across the OSPAR area, especially offshore and in the deep seas.

Management status of MPAs

OSPAR is collecting and evaluating information on the management systems applied in the various MPAs. So far, most OSPAR MPAs are also Natura 2000 sites and so management regulations for these sites are based on the requirements of the Birds Directive and the Habitats Directive. However, an increasing number of the sites established as OSPAR MPAs are not Natura 2000 sites. For these a range of management plans, including conservation objectives and related measures, have been established following OSPAR guidelines. OSPAR has also established guidance for the involvement of stakeholders in the designation and management of MPAs, as has been done for the Swedish Koster-Väderöfjord MPA → BOX 10.6. Transnational cooperation is also taking place between Sweden and Norway in the development of the marine national parks Kosterhavet and Ytre Hvaler.

Giant squid from El Cachucho (upper); benthic communities of La Mer d'Iroise (lower)

BOX 10.6 Koster-Väderöfjord agreement: an example of stakeholder participation in MPA management

The Koster-Väderöfjord in the Skagerrak is designated as a Natura 2000 site for reefs and sub-littoral sand banks and the northern part is proposed as a marine national park. About 30 fishing vessels operate in the area. Trawling for deep-water shrimp is the most important fishery with annual catches of about 200 tonnes. No other types of trawling are permitted. Historically, demersal fish were the main catch in the area but have suffered a decline.

In 1996, the Swedish Environmental Protection Agency declared its intention to designate the area as an MPA. In response to strong concerns by fishermen regarding possible fisheries closures, the regulator agreed to a study to define the nature conservation values of the area in more detail. As a result, the area was surveyed using remotely operated underwater vehicles (ROVs) and multi-beam scanning bathymetry. The data obtained were studied alongside results from previous sampling programmes.

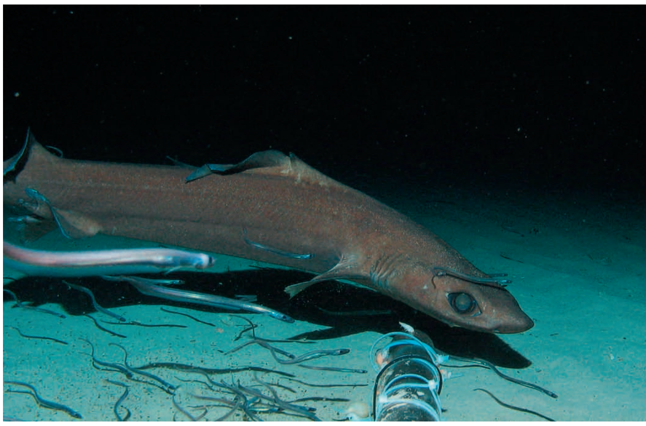
The initial findings proved controversial with local fishermen. In 1999, a working group that included local fishermen, the Swedish board of fisheries and local and regional authorities was set up to manage the potentially destructive shrimp fishery. Among other measures, the group agreed to close 635 hectares to trawling and increased the minimum trawling depth from 50 to 60 m to protect shallow water habitats. Local fishermen agreed to restrict the number of days of fishing per week, as had been done historically in the area. Another initiative by fishermen was to enforce the use of sorting grids in shrimp trawls in order to reduce by-catch.

Protecting areas beyond national jurisdiction

Since 2003, the UN General Assembly has repeatedly called upon states and relevant intergovernmental organisations and bodies to address the conservation and sustainable use of vulnerable marine biological diversity and ecosystems beyond areas of national jurisdiction. With a view to extending the OSPAR MPA network to areas beyond national jurisdiction, OSPAR has been working to identify areas in the deep seas which would merit protection in the form of MPAs → **FIGURE 10.4**. One area being considered, that was initially identified as being beyond national jurisdiction, is an especially complex section of the Mid-Atlantic Ridge between Iceland and the Azores known as the Charlie-Gibbs Fracture Zone. In this area the Mid-Atlantic Ridge rises to many peaks that are shallower than 1500 m and provides benthic fauna with the only hard substrate at these depths in the open North Atlantic Ocean.

The Charlie-Gibbs Fracture Zone opens a major deep-sea connection between the North-West and North-East Atlantic. Within the water column, cold Arctic waters and warm Atlantic waters create a permanent front that forms a major biogeographic divide. The area has several species and habitats under threat and/or in decline, including seamount communities with cold-water corals and deep-sea sponges, seamount-aggregating fish species such as orange roughy and several species of deep-water shark. The main activities in the area are fishing, on some of the seamounts, and shipping. There may be interests for deep-seabed mining. OSPAR has been working with other international bodies towards the protection of this area and significant progress has been made with the closure of the area to bottom fishing activity by the North East Atlantic Fisheries Commission (NEAFC) until 2015. Designating this part of the Mid-Atlantic Ridge as an MPA would be a pioneering step towards adequate protection and good governance of High Seas areas and would provide protection for around 323 900 km^2 or 5 % of Region V.

Deep-sea sponges (left); deep-water leafscale gulper shark (right)



OSPAR has also identified several other ecologically significant areas in the High Seas of Region V, that would merit protection as MPAs: parts of the Reykjanes Ridge, a section of the Mid-Atlantic Ridge north of the Azores, and the seamounts Altair, Antialtair, Josephine and Milne.

Although all these areas were initially identified as being beyond national jurisdiction, some are in part the subject of submissions to the UN Commission on the Limits of the Continental Shelf concerning the definition of the outer limits of the extended continental shelf of coastal states. There are, therefore, important jurisdictional issues that need to be addressed in considering their designation as MPAs.

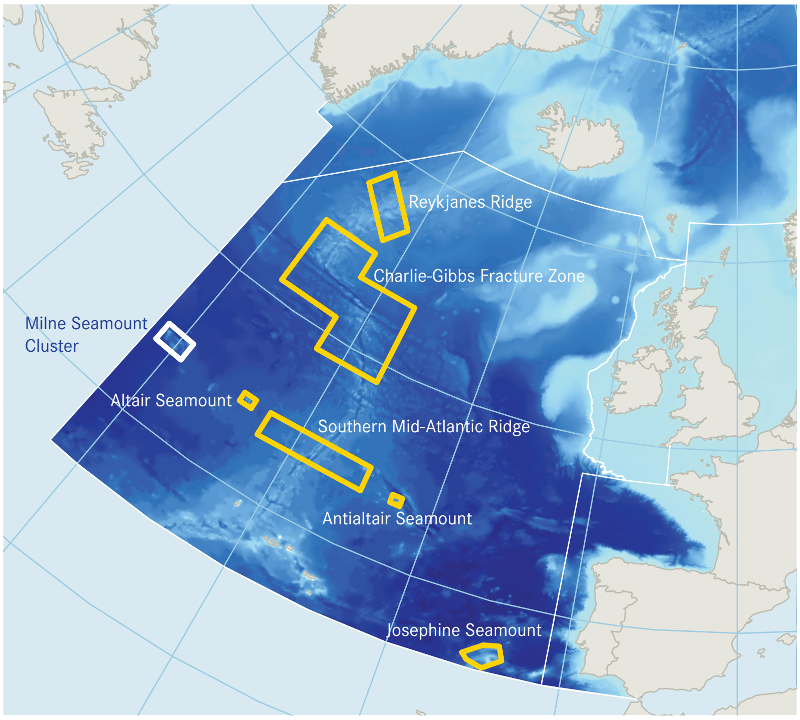


FIGURE 10.4 *Ecologically significant areas being considered by OSPAR for the establishment of marine protected areas in areas beyond national jurisdiction. Areas delimited in yellow were initially identified as being areas beyond national jurisdiction, but are either wholly or partly the subject of submissions to the UN Commission on the Limits of the Continental Shelf concerning the definition of the outer limits of the extended continental shelf of coastal states.*

How does this affect the quality status?

Protecting key features should contribute to the overall quality status

Measures to protect the various species and habitats identified by OSPAR as threatened and/or declining should have a positive benefit for the overall quality status of the marine environment. Although a focus on rare and declining species does not ensure that all key functions of the ecosystem are protected, there will be some benefit to other species, habitats and ecological processes.

In 2009, a re-assessment of the species and habitats listed as threatened and/or declining showed that for most species there had been no change in overall status since their listing in 2003. Some are close to extinction (e.g. Azorean limpet, European sturgeon, Iberian population of the guillemot, northern right whale), many are severely declining (e.g. Balearic shearwater, most diadromous fish species, leatherback turtle), one is now stable but in very low numbers (little shearwater) and one is slightly increasing in numbers (dogwhelk). Stocks of commercially fished species such as bluefin tuna, orange roughy and cod (in parts of the North Sea and Irish Sea) are at a low level. Threats to habitats justifying their inclusion in OSPAR's List continue. Many of the habitats on the list may still be decreasing in extent and even with the implementation of appropriate measures it will be some time before any improvement can be detected, especially where habitats host long-lived species.

Little shearwater (upper); leatherback turtle (lower)

Monitoring and assessing ecosystem health

Although OSPAR countries undertake a wide range of biological monitoring programmes, there is a need for improved coordination. These programmes mostly focus on protected sites or features rather than the functional aspects of the ecosystem. In developing the next phase of OSPAR's work it will be important to give more emphasis to monitoring

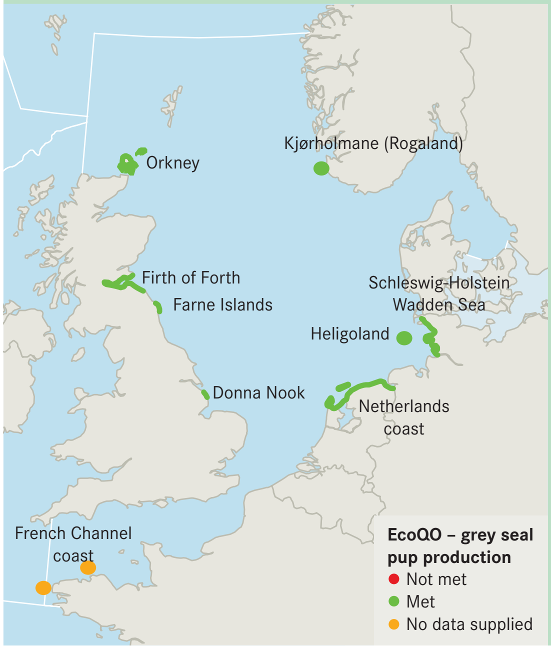
BOX 10.7 Healthy seal populations

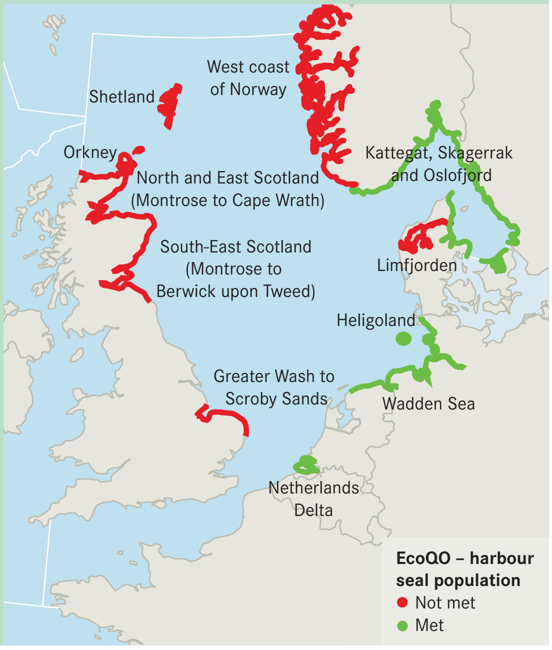
North Sea EcoQO: Taking into account natural population dynamics and trends, there should be no decline in pup production of grey seals or harbour seal population size (as measured by numbers hauled out) of ≥10% as represented in a five-year running mean or point estimates (separated by up to five years) within any one of a set of defined sub-units of the North Sea.

Of the five species of seal that occur in the OSPAR area, only the grey seal and the harbour seal are common in the North Sea (Region II). Separate EcoQOs have been adopted for grey seals and harbour seals to account for their differing biological characteristics. Harbour seals breed more widely around the coast than grey seals, which have breeding colonies in specific locations. In recent decades, virus infections led to high mortality among seals. OSPAR's EcoQO is to maintain healthy populations of these seal species in the North Sea by triggering management action when needed.

In general, recruitment of grey seal pups in the North Sea increased while the population of harbour seals has decreased over the years up to 2006. Based upon the five years up to 2006 the EcoQO was met for grey seals for all significant units of the North Sea population (see map left). Over the same period, the harbour seal EcoQO was not met in several areas where declines of seals of more than 10% occurred (Shetland, Orkney, east of Scotland, Greater Wash to Scroby Sands, Limfjorden in Denmark, and West Norway) (see map right). Of these areas only the Limfjorden area has been affected by an outbreak of the morbillovirus in recent years. In other areas, the cause of the decline is unknown. Data from 2008 suggest that more recently harbour seal populations in the Wadden Sea have been increasing.

This EcoQO acts as a general ecological indicator, because seals are top predators and their status depends on a wide range of variables. The failure to meet the EcoQO for harbour seals needs to be investigated. Changes in population size or pup recruitment might indicate wider problems in the ecosystem, such as depletion of food stocks through fisheries, pollutants affecting reproductive ability or changes in distribution associated with climate change. A combination of pressures may cause physiological stress and increase susceptibility to disease. If the decline is found to be the result of human activities, then suitable management measures must be implemented.





Zostera bed

Harbour porpoise

and assessing status and impacts at the ecosystem scale. OSPAR's work on EcoQOs in the North Sea provides a basis for this, for example the EcoQO for healthy seal populations → **BOX 10.7**. Assessing marine ecosystems that contain a mosaic of different habitats and a diverse range of species is still a challenge. A pilot of a matrix approach to ecosystem assessment is reported in Chapter 11. This provides some useful experience but also reveals that there is a long way to go in order to be able to carry out integrated assessments in a scientifically credible manner. The approach also demonstrates the need for improved methods for monitoring and assessing the extent and condition of habitats. Efforts on habitat classification and mapping must be continued and strengthened, to provide better information on the distribution, extent and condition of habitats in future assessments. There is also an important link to the concept of good environmental status under the EU Marine Strategy Framework Directive, which seeks to embrace ecosystem functioning.

Protecting ecosystems beyond MPAs

An ecologically coherent network of well-managed MPAs supports the wider ecosystem. Species and habitats within an MPA depend upon and contribute to processes occurring outside the MPA. These relationships are often more complex and occur over a larger scale than in terrestrial ecosystems and are particularly important for highly mobile species, such as certain seabirds, marine mammals and fish. One of the concepts behind an ecologically coherent network of MPAs is to safeguard areas critical to certain stages of the lifecycle. A network of MPAs can also provide greater ecosystem resilience in response to changing environmental conditions, such as climate change. Monitoring within MPAs needs to be extended to allow evaluation of whether OSPAR MPAs have improved the status of the local or the wider environment.

What happens next?

Reducing the rate of biodiversity loss

On the basis of current evidence, the UN target of reducing the loss of biodiversity by 2010 is far from being achieved in the North-East Atlantic. There is an urgent need for effective protection and conservation of the threatened and/or declining species and habitats on OSPAR's List, which are primarily affected by pressure from fishing, general environmental status and the developing pressures from climate change. OSPAR must ensure that biodiversity protection is fully taken into account in related policies for the management of human activities, such as fisheries policies, in the EU Marine Strategy Framework Directive, and in marine spatial planning. This will require more intensive cooperation with other bodies as well as public outreach and awareness raising. These efforts must also be supported by targeted actions and measures to support the conservation of these features.

Effective monitoring of biodiversity

To support the ecosystem approach, OSPAR must extend its focus beyond protecting individual species and habitats or specific sites. Given the array of different actors managing the pressures that impact upon biodiversity and ecosystems, OSPAR should prioritise the development of an effective scheme for monitoring and assessing wider biodiversity status and ecosystem function. This must be linked with the concept of good environmental status under the EU Marine Strategy Framework Directive.

Moving forward with MPAs

The goal of an ecologically coherent network of well-managed MPAs by 2010 will not be met across the entire OSPAR area. Fuller use should be made of the potential of the MPA network to protect species, habitats and ecological processes beyond those covered by Natura 2000 sites, including those on the OSPAR List, and in areas not covered by Natura 2000, especially beyond the coasts and in areas beyond national jurisdiction.

Effective management of the MPA network needs to be ensured, both at the national and international level. This will further support the extent to which the network can move towards the goal of being ecologically coherent. This should be strengthened by integrating MPAs with marine spatial plans, seeking both to protect marine biodiversity and to ensure MPAs can contribute to the wider goals of sustainable management and use of the OSPAR area.

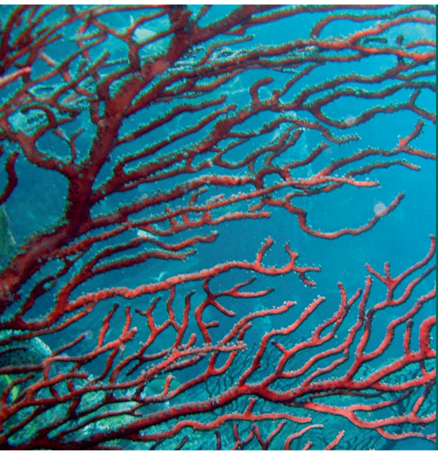
Delivering OSPAR Strategy objectives for biodiversity and ecosystems

→ LEGEND: BACK-COVER FOLD-OUT

OSPAR Region	Status of threatened and/or declining species and habitats	Progress on protective areas (MPAs, fisheries closures etc.)	Key factors and pressures (outlook)	Cumulative outlook for pressures[1]	Action needed
Region I	Many problems * *	Some	Climate Change ↑ Fishing ↓	?	UN, EU, OSPAR, NEAFC and others OSPAR, ICES and others
Region II	Many problems * *	Some	Fishing ↓ Coastal activities ↑	?	UN, EU, OSPAR and others OSPAR, ICES and others
Region III	Many problems * *	Some	Fishing ↓ Coastal activities ↑	?	UN, EU, OSPAR and others OSPAR, ICES and others
Region IV	Many problems * *	Limited	Fishing ↓ Coastal activities ↑	?	UN, EU, OSPAR and others OSPAR, ICES and others
Region V	Many problems *	Some	Fishing ?	?	UN, EU, ICES and others UN, EU, OSPAR, NEAFC and others

[1] *Information is insufficient to judge the cumulative outlook for pressures on biodiversity.*

11 TOWARDS ECOSYSTEM ASSESSMENT



OSPAR has a well-established set of monitoring and assessment tools which support the implementation of its thematic strategies. Tools for assessing ecosystem health have been tested, but overarching ecosystem assessments remain a major challenge.

OSPAR Contracting Parties should cooperate

→ to develop an integrated monitoring and assessment programme based around an improved and comprehensive set of indicators that describe a clean, healthy and biologically diverse sea;
→ to draw current strands of OSPAR work into this context;
→ to extend the development and application of ecosystem assessment methodologies;
→ to seek consistency with developments under the EU Marine Strategy Framework Directive;
→ to research into impacts of pressures and biological changes that are insufficiently understood.

Key OSPAR assessments

→ Evaluation of the OSPAR system of Ecological Quality Objectives for the North Sea
→ Utrecht workshop report

The sustainable use of ecosystem goods and services through the application of the ecosystem approach is a core aspiration that is reflected in OSPAR's vision of a clean, healthy and biologically diverse North-East Atlantic ecosystem and expressed in the EU Marine Strategy Framework Directive as … *maintaining biodiversity and providing diverse and dynamic oceans and seas which are clean, healthy and productive*. Delivering the objectives of the OSPAR Strategies will contribute to achieving this aspiration.

The ecosystem approach requires the comprehensive integrated management of human activities based on the best available scientific knowledge about ecosystems and their dynamics, in order to identify and take action on influences which are critical to the health of marine ecosystems. This presents a challenge to existing methods for the assessment of the marine environment by requiring consideration of the wider implications of human activities on the quality, structure and functioning of marine ecosystems. Yet, understanding of the functioning of marine ecosystems and their interactions with human activities, and the availability of data supporting an ecosystem assessment are – and are likely to remain – limited. Assessment methodologies that support the ecosystem approach must accommodate these limitations and evolve with developments in knowledge.

A key starting point for developing methodologies to assess ecosystem health is an assessment of the overall status of biodiversity of the OSPAR area. Species and habitats that occur in the marine environment interact in complex and dynamic spatial and temporal patterns. Assessment methodologies need to link knowledge of the biology, chemistry and physics of the ecosystem. The basic challenge comprises three main steps: (1) to assess the status of species and habitats; (2) to assess the pressures from human activities; (3) to link the status and the impacts from pressures and take into account cumulative effects arising from multiple pressures and the interactions among species and habitats in the ecosystem. Knowledge from OSPAR's established assessment work → **CHAPTERS 4–10** needs to be brought into the context of what is known about the North-East Atlantic's biodiversity. This is important for those parts of the ecosystem that are subject to multiple pressures, especially those that play a key role in ecosystem functioning.

During the reporting period covered by the QSR 2010, OSPAR has made important steps toward supporting the ecosystem approach through the concept of Ecological Quality Objectives (EcoQOs) which provide a link between human activities and impacts on biodiversity and collectively provide a means of expressing a clean, healthy and biologically diverse sea. OSPAR has also progressed the development of approaches to assess the cumulative impact of pressures on specific species groups and habitat types as well as to rank the various pressures specific to each OSPAR Region. OSPAR has noted complementary approaches to ecosystem assessment, such as those developed by the ICES (International Council for the Exploration of the Sea) Study Group for the Regional Integrated

Sponges in waters off Ireland

Assessment of the North Sea. These approaches are clearly part of an evolving field of work, which needs to incorporate new knowledge as it becomes available. This chapter outlines some of these OSPAR developments and illustrates their contribution to ecosystem assessments.

Methods established to evaluate progress towards some OSPAR objectives

OSPAR's Joint Assessment and Monitoring Programme includes well-developed approaches for assessing eutrophication, hazardous substances and radioactive substances → TABLE 11.1. Commonly agreed tools, methodological standards and guidelines provide the basis for a coordinated and quality assured evidence base across much of the OSPAR maritime area and have delivered OSPAR-wide assessments, for example, of contaminant concentrations. At the same time there has been a need to evolve the assessment of contaminant concentrations on the basis of their biological effects. Such developments have proved extremely challenging and, for the time being, the capacity to associate observed biological effects in the marine environment with specific contaminant concentrations is generally limited. Furthermore, understanding the cumulative effects of hazardous substances on populations of marine organisms remains an area of development. In support of this, OSPAR, in cooperation with ICES, is exploring techniques to evaluate toxic and genetic effects in organisms which are representative of marine ecosystems.

OSPAR assessment work is founded in sound science and supported by exchange with ongoing marine research, particularly on underlying processes in the marine environment and on cause and effect relationships. It has taken considerable debate and scientific research to develop these assessment frameworks → TABLE 11.1. The experience gained in this process contributes to their continuing evolution. There is important complementary

TABLE 11.1 *Overview of well-established OSPAR assessment frameworks.*

Eutrophication	→ CHAPTER 4
Target	A healthy marine environment where no eutrophication occurs
Parameters	*Pressure:* Atmospheric and waterborne inputs *Environment:* Ten indicators of nutrient enrichment, algal blooms, loss and changes in biodiversity (macrophytes, zoobenthos, fish), oxygen deficiency
Geographical scope	OSPAR area
Assessment reference point	Area-specific assessment levels which may show a maximum deviation of 50% of the natural background levels
Hazardous substances	→ CHAPTER 5
Target	Preventing pollution from hazardous substances listed on the OSPAR List of Chemicals for Priority Action with the ultimate aim of achieving concentrations near background values for naturally occurring substances or close to zero for man-made substances
Parameters	*Pressure:* Atmospheric and waterborne inputs *Environment:* Environmental concentrations in marine sediments and biota and biological effects
Geographical scope	OSPAR area
Assessment reference point	Natural background concentrations or zero for man-made substances Assessment levels where no adverse effects on the ecosystem can be assumed
Radioactive substances	→ CHAPTER 6
Target	Concentrations of radionuclides near background values for naturally occurring radioactive substances or close to zero for artificial radioactive substances
Parameters	*Pressure:* Discharge rates from nuclear and non-nuclear sources (total α-activity, total β-activity and specified indicator radionuclides) *Environment:* Levels of indicator radionuclides for the nuclear and non-nuclear sectors in seawater, seaweeds, molluscs and fish
Geographical scope	OSPAR area
Assessment reference point	*Discharges:* Baseline for trend assessment (1995–2001) established for certain indicator radionuclides discharged from the nuclear sector; baseline for the non-nuclear sector not yet established *Concentrations in the environment:* Baseline for trend assessment (1995–2001) established for certain indicator radionuclides for the nuclear sector in many areas. Baseline for indicator radionuclides for the non-nuclear sector not yet established

assessment work carried out by other bodies in relation to commercial fish stocks and oceanographic parameters which needs to be incorporated into OSPAR assessments and methodologies. Monitoring and assessment of biodiversity is still a challenge as it requires significant information not only in relation to priority species and habitats, but also ecosystem structure and functioning, and needs to be linked with the existing OSPAR assessment work.

EcoQOs provide an indicator-based assessment approach in Region II

The system of EcoQOs for the North Sea, developed by OSPAR in collaboration with ICES, defines the desired qualities of selected components of marine ecosystems in relation to human pressures. The EcoQOs set objectives for specified indicators and provide a means to measure progress. Collectively, EcoQOs are intended to provide comprehensive coverage of ecosystems and the pressures acting upon them, such that meeting all EcoQOs should provide the evidence that the ecosystem is in a good state. Where EcoQOs are not met, OSPAR should investigate the reasons for this and, where appropriate, should consider measures to regulate the relevant human activities.

Evaluation of the initial set of EcoQOs used in the North Sea shows that the objectives set have mostly not yet been achieved and that continued efforts are needed to improve the quality of the North Sea → TABLE 11.2. There are, however, signs that the impacts of tributyltin (TBT) and oil on marine life and the contamination of seabird eggs with chemicals have been decreasing. Some important commercial fish stocks for which reference levels have been set continue to be beyond safe limits, but the size composition of demersal fish communities has been improving, although the desired objective has not yet been reached. Litter in the marine environment is still a concern as indicated by the amount of plastic found in fulmar stomachs. By-catch of harbour porpoises is still high and the data are insufficient to assess whether the EcoQO is met.

The set of EcoQOs, developed for the North Sea, is not yet considered comprehensive. Most EcoQOs link to specific human activities, such as shipping (oil at sea), litter and fishing, and some link with established assessment approaches by evaluating adverse effects from hazardous substances and excess nutrients. Some EcoQOs indicate the health status of ecosystem components more generally, such as the EcoQO for seal populations. The experience from applying EcoQOs points to the need for consistent implementation across Region II and the need for improvements in quality assurance and data management. The EcoQOs have also provided a focus for discussions with stakeholders

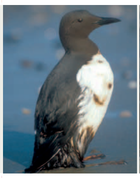
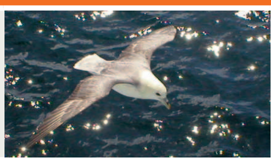
Benthic communities off southern England

on the management of the North Sea. Examples include the EcoQO on oiled guillemots which was a focus for governmental cooperation with coastal communities, bird rescue centres and volunteers in handling oiled birds in the case of oil spills. In the Netherlands, the EcoQO on plastic particles in seabird stomachs has been used to evaluate efficiency of port waste reception facilities.

OSPAR needs to develop the EcoQO system further to provide more comprehensive coverage of ecosystem components and pressures. Additional EcoQOs are already under development on seabird populations, threatened and/or declining habitats and marine beach litter. A more complete system would strengthen overall assessments of the North Sea status. Development of EcoQOs that can be applied in other OSPAR Regions may require the adaptation of the North Sea EcoQOs (e.g. use of more regionally appropriate species). Experience in expanding the application of EcoQOs to other OSPAR Regions has already been gained for TBT and eutrophication, through the development of assessment criteria which can be applied in all OSPAR Regions. The indicator on which the large fish EcoQO is based has also been trialled in other OSPAR Regions in addition to the North Sea.

OSPAR's concept of EcoQOs has supported the selection of indicators for measuring progress toward good environmental status under the EU Marine Strategy Framework Directive and should continue to support the development of a comprehensive set of criteria for good environmental status under the Directive. The aim must be to have a common set of indicators, regionally bespoke where appropriate (e.g. regionally appropriate species or assessment criteria), enabling a comparable judgement of good environmental status across the OSPAR area.

TABLE 11.2 *Summary of current status of the North Sea in relation to Ecological Quality Objectives (EcoQOs) based on assessments in Chapters 4 to 10. Further EcoQOs are under development on seabird populations, threatened and/or declining habitats and marine beach litter. Confidence: *** High; ** Moderate; * Low.* **?** *Status not known*

	Ecological Quality Objective		Status for the North Sea	
Biological diversity	**Healthy seal populations**			**→ CHAPTER 10**
	No decline of greater than 10 % in grey seal pup populations or harbour seal populations over a five-year running mean, taking into account natural population dynamics and trends		Some problems * * *	Harbour seals: EcoQO not met: Shetland; Orkney; North and East Scotland; South-East Scotland; Greater Wash to Scroby Sands; Limfjorden; west coast of Norway south of 62° N EcoQO met: the Netherlands Delta area; the Wadden Sea; Heligoland; the Kattegat, Skagerrak and Oslofjord Grey seals: EcoQO met in all areas
	Reduce by-catch of harbour porpoises			**→ CHAPTER 8**
	By-catch rates should be no more than 1.7 % of the population		**?**	Unknown status in absence of reliable by-catch information
Commercial fish stocks/Food webs	**Increase proportion of large fish in the fish community**			**→ CHAPTER 8**
	More than 30 % of fish should be longer than 40 cm		Many problems * * *	EcoQO not met, but movement towards the objective detected
	Fish stocks at biologically safe levels			**→ CHAPTER 8**
	All commercial stocks should be at or above safe levels		Some problems * * *	EcoQO met for 9 stocks EcoQO not met for 3 stocks Unknown status for 13 stocks
Eutrophication	**Eliminate eutrophication**			**→ CHAPTER 4**
	Dissolved inorganic nitrogen and phosphorus, chlorophyll a, phytoplankton, oxygen and benthic species should not exceed assessment levels		Many problems * * *	EcoQO not met in coastal areas along the continental coast of the North Sea, some offshore areas in the southern North Sea and some UK estuaries
Contaminants	**Reduce level of imposex in dogwhelks and other gastropods**			**→ CHAPTER 5**
	Imposex should be below levels indicating negative effects from exposure to TBT		Many problems * * *	EcoQO not met at most locations, but levels of imposex are decreasing
	Reduce number of oiled guillemots			**→ CHAPTER 9**
	There should be less than 10 % of birds found dead or dying which are oiled	 	Many problems * * *	EcoQO met: Shetland, Orkney. Percentage of oiled guillemots is decreasing EcoQO not met: Belgium, Netherlands, Germany No information: East Scotland, East England, Denmark, Sweden, Norway
	Reduce levels of hazardous substances in seabird eggs			
	Mercury should not exceed reference levels Organochlorines should not exceed set values		Some problems * * *	EcoQO not met for organohalogens and mostly not met for mercury. Concentrations are decreasing
Marine litter	**Reduce levels of litter (plastic particles) in fulmar stomachs**			**→ CHAPTER 9**
	There should be less than 10 % of fulmars with more than 0.1 g of plastic in their stomach		Many problems * * *	EcoQO not met: Current levels still well above the objective

Pilot of a new assessment approach

OSPAR has piloted one approach that aims to determine the status of ecosystems building on the identification and quantification of the main pressures and their cumulative impacts on species groups and habitat types. At a workshop held in Utrecht (the Netherlands) in February 2009, over 70 experts in marine science drawn from all OSPAR Regions participated in a trial assessment. The pilot provided important insight into the complexity of assessing ecosystems, and the lessons learnt are an essential contribution to the further development of assessment methodologies. In many cases the results of the Utrecht workshop concur with the findings of the thematic assessments prepared through regular OSPAR work, but there are also many gaps and short-comings, as would be expected when applying a new method to such a complex assessment for the first time. The results are presented in the Utrecht workshop report and Table 11.3 illustrates a possible outcome of impact assessments against pressures to support an overall assessment of quality status per region. The main messages drawn from the Utrecht workshop concern the method itself, the learning process and the way forward.

The Utrecht workshop followed a systematic analytical methodology described by Robinson *et al.* (2009). The workshop focused on assessing, at the scale of OSPAR Regions, the impact of pressures from human activities, as listed in the EU Marine Strategy Framework Directive, and those driven by climate change, on a selection of four species groups (fish, cetaceans, seals, seabirds) and four habitat types (rock and biogenic reef habitats, shallow sediment habitats, shelf sediment habitats, deep-sea habitats). The assessment process followed a series of steps:

- The first step was to map the geographic distribution of human activities and to describe the spatial and temporal extent, intensity and frequency of the pressures resulting from these activities.
- The second step was to define the geographic distribution of species groups and habitat types that are sensitive to these pressures.
- The third step was to estimate the degree of impact, where pressures and ecosystem elements overlap in space and in time. For this purpose, generic criteria and associated threshold values were developed for geographic range, population size and condition for species groups, and on range, extent and condition for habitats. The threshold values were based on those given in EU guidance for assessing favourable conservation status of species and habitats under the Habitats Directive. The degree of impact, following these criteria, was assessed against a reference status (based on an absence of the pressure). The percentage deviation from this reference status was used to classify the outcome as 'low', 'moderate' or 'high' impact.
- The fourth step was to summarise the different impacts from human activities in order to derive an overall status assessment per species group and habitat type (→ TABLE 11.3 for example output).
- Finally, the impacts on all species groups and habitat types were summarised to assess the total impact per pressure → TABLE 11.3 and consequently their relative contribution to the total impact in each Region.

The assessment drew upon data and information on the distribution of the range of human activities presented in Chapters 8 and 9 and the supporting thematic assessments. In some cases, information on impacts from these activities and the status of species and habitats for all OSPAR Regions is very limited. These gaps were filled by collective expert knowledge which was also limited for some Regions and pressures. The level of confidence was determined for each assessment of impact. Lack of consensus among experts was addressed, but could not always be resolved. A review of the method and results of the workshop by ICES recognised that there were shortcomings in the performance of the method which needed to be addressed in its further development. However, the diverse range of experts engaged in the process had clearly added credibility to the expert opinion process.

The Utrecht workshop provided good experience in linking human activities and their associated pressures to the assessment of the selected ecosystem components and trialled a generic, large-scale approach to ecosystem assessment. There are several lessons learnt which inform future work.

- Mapping of human activities and ecosystem components is promising for the assessment of separate and cumulative impacts on habitats and related sessile species (which are bound to a particular area). It seems less applicable to mobile species.

Fan worm near Cabo Peñas, northern Spain

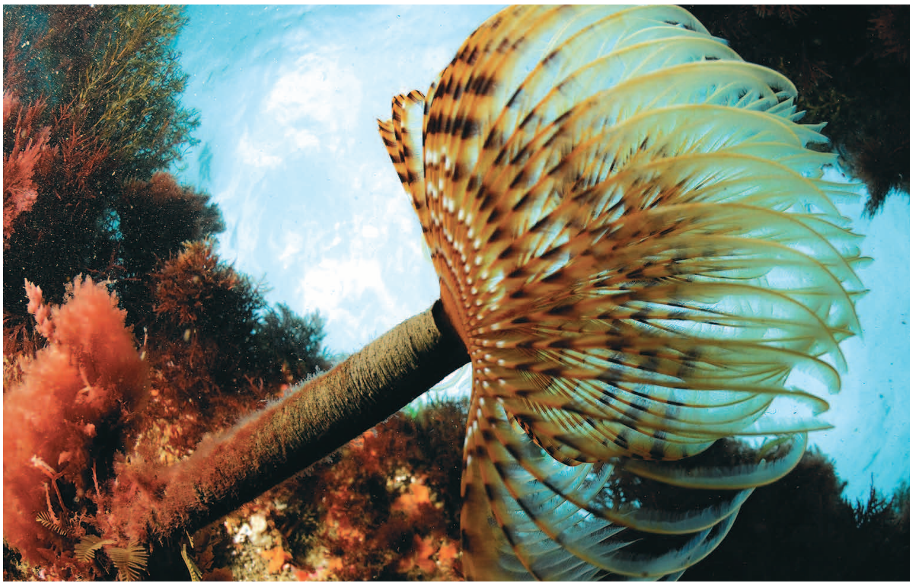
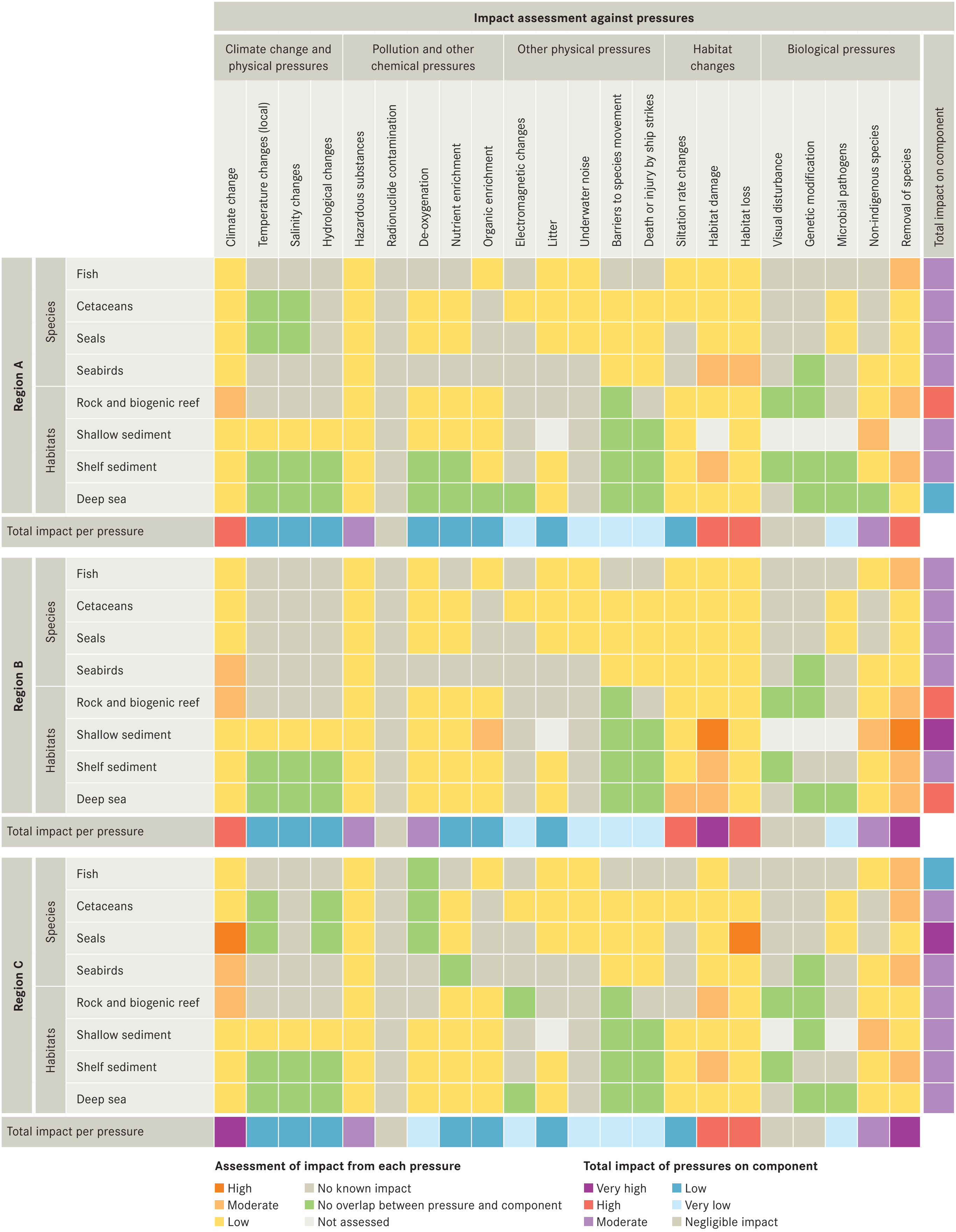
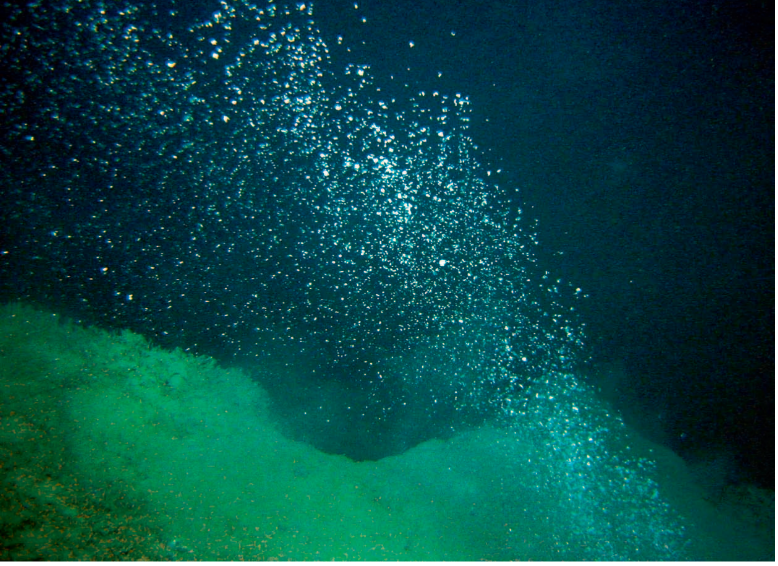


TABLE 11.3 *Illustration of results from a pilot assessment of four species groups and four habitat types. A total impact assessment was made per region from the sum of the individual impacts per ecosystem component (last column) and per pressure (last row).*





Methane bubbles, Håkon Mosby mud volcano, Barents Sea

Brittle star on Lophelia pertusa corals, Porcupine Bank

- Assessments at the scale of OSPAR Regions are too coarse to identify properly the often area-specific impacts of human activities. Many habitats also occur at a smaller geographical scale. It is therefore important that assessments of human impacts are undertaken at the appropriate scale, which may vary on a case by case basis.
- Generic assessment criteria and thresholds do not take into account the variation in life history characteristics for some species groups. The assessment criteria should be refined to allow for more differentiation in species and also habitat groups.
- The pilot assessment yields a first indication of cumulative effects. Further development of the method is needed to improve the assessment of cumulative effects.
- Judgement by a designated group of experts following well-defined procedures can complement limited datasets. The credibility of the outcome is enhanced by recording the confidence level and by describing how gaps in data were treated and how issues were addressed for which there was insufficient consensus.

Next steps towards ecosystem assessment

OSPAR's existing thematic assessment approaches have been extended by the development of EcoQOs as a North Sea pilot project. Through the Utrecht workshop, OSPAR has also piloted a new approach for assessing additional aspects of ecosystem status at a broader scale. This pilot assessment has provided important lessons for future integrated assessments, such as those that may be needed for the EU Marine Strategy Framework Directive.

Further development of OSPAR's monitoring and assessment capabilities to address wider ecosystem functioning and biodiversity status must build on, and seek compatibility with, assessment methods developed under the Marine Strategy Framework Directive as well as other EU Directives (Water Framework Directive, Habitats Directive, Birds Directive) and other regional marine conventions (e.g. HELCOM). OSPAR Contracting Parties should cooperate to address the following priorities for action:

- To develop an improved and comprehensive set of indicators building on the current EcoQOs to enable assessment against OSPAR's objectives of a clean, healthy and biologically diverse sea. These indicators should cover the main ecosystem components, the range of relevant pressures and should be suitable for assessing ecosystem functioning and cumulative effects.
- To identify information needs to enable a move from expert judgement to a more evidence-based assessment. Improvements in the accessibility of all marine data will support this.
- To extend the development of ecosystem assessment methodologies which bring together and build upon OSPAR's existing approaches for thematic assessments. This should include a consideration of appropriate ecosystem components and their interactions as part of ecosystem functioning. There is a need for assessment criteria (especially for species) that take into account regional differences and for agreement on the most appropriate geographic divisions. Aggregation and integration techniques need to be developed.
- To develop integrated monitoring programmes, which take into account monitoring being undertaken in other forums and draw together current strands of OSPAR's work (e.g. EcoQOs, species and habitats on the OSPAR list of threatened and/or declining species and habitats) and which integrate across physical, chemical and biological systems.
- To further research both the impact of pressures that are insufficiently understood (e.g. litter, noise, electromagnetic radiation) and biological changes that cannot presently be explained (e.g. declines in seabird populations).
- To develop methodologies to judge whether the North-East Atlantic is being used sustainably.

12 REGIONAL SUMMARIES

OSPAR's actions are clearly helping to reduce pollution of the marine environment, but many problems persist. The most widespread impacts on ecosystems result from fishing, and the emerging impacts of climate change cause serious concern. The current status in relation to the OSPAR Strategy objectives and other specific impacts of human activities is different for each Region → FIGURE 12.1, but a number of cross-cutting issues affect the quality status of large parts of the OSPAR area:

Climate change. Rising sea temperature and increasing acidification are already apparent throughout the OSPAR area, due to rising levels of carbon dioxide (CO_2) (and other greenhouse gases) in the atmosphere. Impacts on Arctic biodiversity are imminent with loss of sea-ice habitat. Pressures arising through climate change are set to grow in all five Regions and will interact with pressures from human activities. OSPAR must monitor the changes and their effects on marine ecosystems. → CHAPTER 3

Eutrophication. The OSPAR objective of no eutrophication by 2010 has not been achieved and there are problem areas in Regions II, III and IV. Action is needed to reduce the levels of nutrients reaching these areas from land, especially from agriculture, and via the air. → CHAPTER 4

Hazardous substances. Heavy metals are at unacceptable levels in sediments, fish and shellfish, mostly at coastal sites, especially in Regions II, III and IV. Contamination with polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) is widespread and unacceptable in many areas of Regions I, II, III and IV. Further action is needed to prevent discharges and emissions of both well-monitored and less well-known hazardous substances and to understand their biological effects. → CHAPTER 5

Radioactivity. β-activity discharges from the nuclear installations in the catchments of Regions II, III and IV have generally fallen and impacts on man and marine life are low. Radionuclides from past discharges are still present in sediments and will be a continued source of contamination in future. Other sources of radioactive substances, particularly naturally-occurring radionuclides introduced to the sea by offshore oil and gas activities, must continue to be monitored. → CHAPTER 6

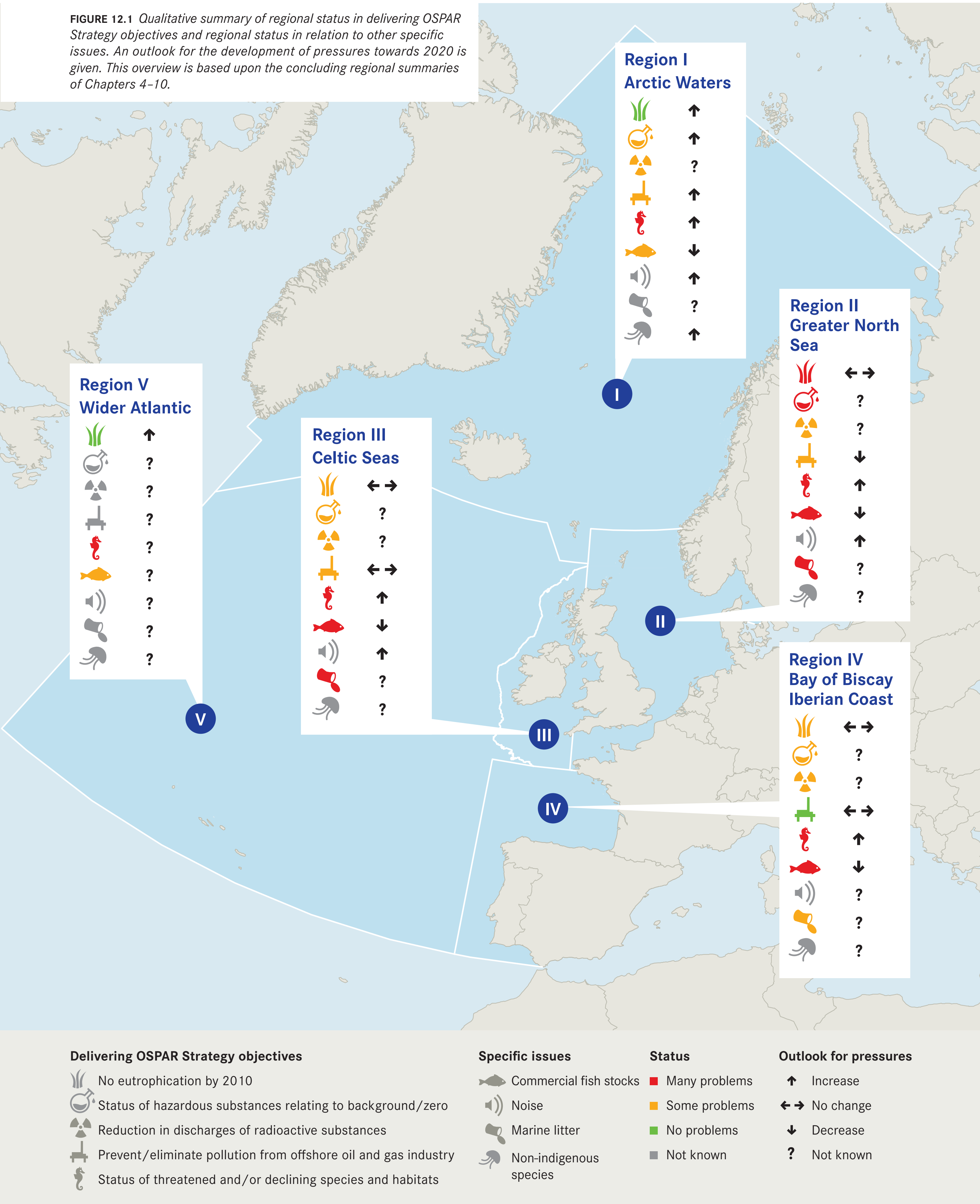
Oil and gas. Oil discharges from the production sites in Regions I, II and III have reduced on average by more than 20 %, with most countries meeting OSPAR's 15 % target. Discharges of organic-phase drilling fluids have largely ceased since 2005. OSPAR continues to manage and monitor discharges of oil and chemicals in produced water. → CHAPTER 7

Fishing. Excessive fishing pressure is causing widespread problems in parts of the OSPAR area. Stocks are being fished at unsustainable levels, seabed habitats are being damaged and by-catch of fish, marine mammals and seabirds is too high. High discard rates need to be addressed as a priority. OSPAR must continue to work closely with fisheries management authorities to promote ecosystem-based fisheries management strategies that address these issues. → CHAPTER 8

Other uses of the sea. There are increasing demands for marine space and resources, including from shipping, renewable energy, coastal defence and mineral extraction. As well as their direct impacts, these activities also contribute to levels of noise and litter and introduce non-indigenous species to the OSPAR area, whose impacts and extent are not well understood. OSPAR is working towards a coordinated approach to marine planning, so that new developments are incorporated in a coherent strategy that protects the environment. → CHAPTER 9

Biodiversity. A reduction in the decline in biodiversity is still a long way off in all five Regions. Endangered habitats and species are still being damaged and targeted action is needed to protect them. OSPAR has drawn up a list of threatened and/or declining species and habitats and is establishing a coherent network of well-managed marine protected areas (MPAs). OSPAR countries also need better monitoring of biodiversity within and outside protected areas. → CHAPTER 10

FIGURE 12.1 *Qualitative summary of regional status in delivering OSPAR Strategy objectives and regional status in relation to other specific issues. An outlook for the development of pressures towards 2020 is given. This overview is based upon the concluding regional summaries of Chapters 4–10.*



Compared to other Regions, Region I is relatively unpolluted. Few people live in its catchments and parts of the Region are permanently ice-bound. The most intense pressures are at or near the coast of continental northern Europe. The Arctic hosts unique and specialised species, such as the polar bear and the narwhal, and the southern part of the Region has some of the world's most important fisheries, including those for cod, herring and capelin.

Despite its remoteness, Region I is far from isolated from the other OSPAR Regions. Region I is both a sink for contaminants carried in from other areas, which accumulate in fish and marine mammals, and a source of water for wide-ranging ocean currents.

A significant proportion of the world's known oil and gas reserves are in the Arctic, and large new extraction projects are already underway in the east, such as at the *Shtokman* field in the Russian Barents Sea.

The QSR 2000 concluded that the general status of Region I was good. Issues of high importance were: impacts of fishing; persistent organic pollutants in fish and marine mammals; fish farming; and lack of knowledge on the biological and chemical effects of climate change. Since the QSR 2000, some fish stocks have improved and fish farming is generally well managed.

Eutrophication problem area extent	**0 %**
Monitored sites with unacceptable status	
– Mercury	4 %
– PAHs	31 %
Species under threat	**19**
Habitats under threat	**7**
MPA coverage	**1.5 %**

Successes

Illegal cod catch down. The illegal cod catch in the Barents Sea fell by 85 % between 2005 and 2008, through cooperation between countries and better control of illegal fishing vessels.

Protection of vulnerable habitats. In the past ten years, fifteen MPAs have been established in Norwegian and Icelandic waters. Most protect cold-water coral ecosystems. Two isolated hydrothermal vents off the coast of Iceland and extensive coastal areas around the Norwegian Svalbard archipelago and Bear Island (Bjørnøya) are also protected.

Integrated management plans. The Norwegian plans for integrated management of the Barents Sea and the Norwegian Sea view the ecosystem as a whole. They are good examples of future management approaches for the OSPAR area.

Ongoing concerns

Impacts of climate change. Wildlife in Region I is especially at risk from climate change. Air temperature is rising faster in the Arctic than in the rest of the OSPAR area and satellite data show that summer sea-ice cover has dropped almost 9 % per decade since 1979. Winter sea-ice cover fell 2.5 % per decade over this period.

As the sea ice retreats, species that breed or hunt on the ice lose their habitat. Less ice could also mean more fishing, oil extraction, shipping and tourism.

Thawing permafrost could release locked-in nutrients like nitrogen and phosphorus to the ocean, and persistent organic pollutants may be freed from the ice as it melts.

Low temperatures, greater vulnerability. The Arctic ecosystem has low temperatures, a short growing season and highly variable weather. Its species may not be able to respond quickly to rapid change, or recover quickly from damage.

Arctic animals have high fat contents in their bodies to cope with the cold, which means they can accumulate persistent fat-soluble pollutants such as PCBs and brominated flame retardants. These are transported into the Arctic by winds from lower latitudes, and high concentrations can end up at the top of the Arctic food chain.

Ocean acidification. As CO_2 levels in the atmosphere increase, the harmful effects of ocean acidification may be felt earlier in the Arctic because CO_2 dissolves more quickly in cold water. As the acidity of the seawater rises, organisms with calcium carbonate shells, including cold-water corals, may have difficulty forming shells and skeletons. Recent projections suggest that this could start happening as early as 2016 in the Arctic winter, and throughout the year by 2026.

Declines in seabird populations. Populations of several seabird species have declined in Region I, especially in the Norwegian and Barents Seas. The decline has been most pronounced for species that feed in the open sea, such as the northern fulmar, black-legged kittiwake and common guillemot. The 2008 breeding seasons of these birds were some of the poorest ever recorded in the North-East Atlantic. Some species totally failed to breed. Food shortage and changes to other parts of the marine food chain may be to blame, but there is an urgent need for more research into the links between long-term health of seabird populations and environmental factors.

Increasing threat of pollution from shipping and industry. Oil and gas extraction and shipping are likely to increase in Region I in the coming years. This brings increased threats of direct pollution from oil and hazardous substances, and of pollution from atmospheric nitrogen.

An emerging activity is the carbon capture and storage industry. As part of efforts to mitigate climate change, there is strong political interest to store CO_2 under the seabed. Geological formations beneath the ocean are favoured, and old oil and gas fields in the Norwegian Sea are possible sites. This could generate significant industrial activity and a need for long-term monitoring in the area.

What should be done?

→ **Develop more integrated management plans**
Plans developed in the Barents Sea and Norwegian Sea demonstrate how OSPAR believes the Arctic ecosystem ought to be managed. The approach should be applied in other parts of Region I.

→ **Closely monitor the situation**
OSPAR must watch carefully for effects of climate change and ocean acidification on this ecosystem. It must monitor threatened species groups for evidence of decline, and continue to assess the impacts of industrial activity in the Region, especially offshore oil and gas, and shipping.

→ **Cooperate to protect**
OSPAR must cooperate even more closely with other organisations working to protect the Arctic environment, such as the Arctic Council and its working groups: Conservation of Arctic Flora and Fauna (CAFF), Protection of the Arctic Marine Environment (PAME) and the Arctic Monitoring and Assessment Programme (AMAP).

The human population density around much of the North Sea is high, with greatest pressure from humans in eastern and southern parts of the Region. More than 500 people per km^2 live in some coastal areas and intensive farming covers up to 70 % of the land that drains into this part of the ocean. Overall fishing effort is decreasing (down 25 % from 2000 to 2006), but around 30 different commercial fish stocks are still exploited.

Extensive mudflats and estuaries line the coasts of the southern North Sea. The Wadden Sea is the largest area of intertidal mudflats in the world, hosting 10 to 12 million migrating birds every year. In the north-west of the Region, there are large kelp forests in rocky areas and globally important island seabird colonies.

The North Sea has some of the busiest shipping lanes in the world and maritime transport continues to increase. Construction activities have also been increasing this decade, with more coastal structures and wind farms being built and operated, and more tourist traffic. This is why it is a crucial area for a coherent approach to planning and protecting the marine environment.

The QSR 2000 identified as issues of high importance in Region II: impacts of fisheries; hazardous substances, especially persistent organic pollutants; nutrient inputs from land; and a lack of knowledge on climate change.

Eutrophication problem area extent	**17 %**
Monitored sites with unacceptable status	
– Mercury	37 %
– PAHs	55 %
Species under threat	**29**
Habitats under threat	**10**
MPA coverage	**5.4 %**

Successes

Some fish stocks improved. Fisheries management is changing for the better, with long-term management plans for key stocks and substantial decreases in destructive practices such as beam and otter trawl fishing in some areas. The excessive discards of fish are beginning to be addressed. There are signs that fish communities near the seabed may be starting to recover.

Reduced inputs of hazardous substances and nutrients. Most OSPAR countries have met and many exceeded the OSPAR target for reducing phosphorus inputs to eutrophication problem areas, and three countries are approaching the 50 % reduction target for nitrogen. Inputs of mercury and lead to the sea from several major rivers have dropped.

Good MPA coverage. Region II has greater coverage by MPAs than the other Regions, with 5.4 % of the waters and seabed protected. The challenge now is to integrate management of these MPAs with wider spatial plans.

Ongoing concerns

Eutrophication on the coasts. Eutrophication caused by nutrient inputs is a problem along the east coast of the North Sea from Belgium to Norway, and in some small estuaries and bays of eastern England and north-west France. Associated problems include fish dying in the fjords of Denmark and Sweden, and sugar kelp declining along parts of the Norwegian coast. Nitrogen inputs, largely from agriculture, are the biggest cause of eutrophication and few countries approach OSPAR's 50% reduction target for nitrogen inputs to problem areas. It can take decades before reduced nutrient inputs benefit the marine environment because nutrients can be released from soil and sediments.

Pollution with hazardous substances. Concentrations of metals (cadmium, mercury and lead) and persistent organic pollutants are above background in some offshore waters of the North Sea, and unacceptable in some coastal areas. Lead levels, for example, were unacceptable at 40% of locations monitored, while PAHs and PCBs were at unacceptable levels at more than half of the monitoring sites.

Amounts of litter are a concern. Over 90% of fulmars have microscopic plastic particles in their stomachs and 45% to 60% have more than the Ecological Quality Objective (EcoQO) set by OSPAR. Beach litter in the southern North Sea is at OSPAR-wide average (around 700 items per 100 m beach), but levels are higher in the northern North Sea.

Progress towards sustainable fishing is slow. Some important North Sea fish stocks are still outside sustainable limits and while damaging practices have been reduced, the picture is not uniformly good. The poor status of cod is of particular concern. By-catch of rays, sharks, porpoises and dolphins in fishing nets is also of concern.

Breeding failure of seabirds. In the northern North Sea, some seabirds have suffered a decade of breeding failure, possibly due to the combined effects of climate change and fishing on key prey species. Although breeding success was good for the first time in 2009, the long-term picture is still one of serious concern.

Damage to seabed habitats. Significant damage has occurred to shallow sediment habitats and reefs as a result of bottom fishing practices, especially beam trawling. In the western Channel, thick beds of red calcareous seaweed called maerl declined in extent and quality, partly as a result of damage resulting from its extraction for use as an agricultural soil conditioner.

Impacts of climate change. The pace of warming of the sea is highest in Region II, with an increase in sea surface temperature of 1 to 2 °C over the past 25 years. Plankton and fish communities are already changing in response to warming. Fish like silvery John dory, sea bass and red mullet are becoming more common further north, while North Sea cod stocks seem to be falling faster than would be expected from the impact of fishing alone.

Pressures from responses to climate change. A number of industrial activities are likely to begin or increase in Region II in response to climate change. The coasts of the southern North Sea are susceptible to sea-level rise and erosion, so large-scale development of coastal defence is likely, with an associated increase in pressure on seabed habitats from sand extraction for beach nourishment. As in the Norwegian Sea (Region I), old North Sea oil and gas fields are proposed sites for sub-seabed storage of CO_2. The North Sea is an attractive site for offshore energy generation from renewable sources, owing to its proximity to large populations. The long-term effects of these large-scale projects are not clear.

What should be done?

→ **Develop coordinated spatial planning**
With pressure from multiple activities increasing and intense competition for space, improved marine spatial management is particularly urgent.

→ **Promote further action to manage fishing effort**
OSPAR must keep cooperating with the fisheries authorities to support sustainable management of fishing, including reductions in discards, improved stock assessments and better reporting and mitigation of by-catch of marine mammals and long-lived shark, skate and ray species.

→ **Focused targets to reduce pollution**
Efforts to reduce pollution from nutrients, hazardous substances and the oil and gas industry should now be focused on problem areas and regional hotspots, with appropriate reduction targets for discharges and losses in particular places.

Region III includes parts of the open Atlantic west of Ireland and Scotland, shallow seas surrounded by land in the Irish Sea and west of Scotland, numerous sea lochs, and large estuaries like the Shannon, Severn and Solway Firth. The most intense human activity in Region III is in and around the Irish Sea, particularly on the coasts, although population densities are not as high as around the North Sea and Iberian coast.

There are many different habitats here, including sea lochs and tidal mudflats, and thick beds of the red calcified seaweed called maerl which has built up over centuries. Most of the sea is relatively shallow. Region III supports some of the major migratory fish stocks of the North-East Atlantic, such as Atlantic mackerel, blue whiting and sea bass.

As in the North Sea (Region II), construction projects such as offshore renewable energy are increasing in Region III.

The QSR 2000 concluded that the quality status of Region III was generally good. Issues of high importance were: effects of pollution localised in urban estuaries; some fish stocks critically depleted; hormone disruption due to hazardous substances, including tributyltin (TBT) pollution; extensive coastal development; effects of climate change. Climate change has remained an ongoing concern.

Eutrophication problem area extent	0.1 %
Monitored sites with unacceptable status	
– Mercury	24 %
– PAHs	61 %
Species under threat	23
Habitats under threat	11
MPA coverage	3.5 %

Successes

Radionuclides down. Region III has benefited from a reduction in the discharge of radionuclides from the nuclear sector. In particular, there have been drastic reductions in the discharge of radioactive technetium from nuclear reprocessing activities at Sellafield (UK).

TBT down. Region III is the Region with the greatest proportion of monitored sites where the impacts of TBT are now at acceptable levels, but there are still some problem areas close to harbours and busy shipping lanes.

Recovery for some fish communities. Recent trends show an improvement in the structure of fish communities that live on or near the seabed, particularly in the north of Region III. Following implementation of a long-term management plan, the northern hake stock recovered and is now classed as sustainable.

Ongoing concerns

Damage to seabed habitats. The seabed in shallow areas of Region III, including areas of sediment, rock and some biogenic reefs, has been significantly damaged by benthic trawling.

Increasing pressure from human activities. Pressures on species and habitats in Region III are expected to rise as coastal and offshore engineering activities increase. Many more offshore wind turbines are expected to be installed in the coming years and wave and tidal power generation developments may be introduced. Little is currently known about the long-term effects of these activities on ecosystems because there are so few and they are all relatively new. Their construction can disturb marine mammals and their presence may displace seabirds, but they can also provide retreat areas for fish.

Some fish have low stocks. While trawl effort has fallen in the Irish Sea and to the west of Scotland, fishing effort is still high in Region III. Some beam trawlers have switched to otter trawling or scallop dredging, a fishery without quotas.

Several fish stocks are harvested unsustainably. Cod and whiting are depleted to the west of Scotland and in the Irish Sea. To date recovery plans for cod have not been effective in rebuilding the Irish Sea stock.

The amount of fish caught and discarded in Region III must be addressed and by-catch is still a problem in some areas.

Poor knowledge of the status of marine mammals. At present, there are insufficient data on the populations of marine mammals in Region III. Harbour seals are counted every five or six years, the bare minimum to assess their status, and other marine mammals have little systematic recording. A decline in the harbour seal population in the Outer Hebrides has been reported.

Hazardous substances unacceptable at some coastal locations. Heavy metal, PAH and PCB concentrations in sediment, fish and shellfish have fallen, but are still above acceptable levels in some coastal areas of Region III, mainly around the Irish Sea. Concentrations of PAHs and PCBs are unacceptable at more than half the sites tested.

High levels of litter. On beaches around the Irish Sea there are unacceptable quantities of litter, reaching over 1000 litter items per 100 m beach in some areas. This can be dangerous to seabirds, and to turtles and marine mammals when washed into the sea. Much of this litter probably comes from sources on land.

What should be done?

→ **Develop coordinated spatial planning**
Demand for space from human activities is increasing, especially for marine renewable energy developments, so improved marine spatial management is particularly urgent.

→ **Reduce marine litter**
Monitoring of marine litter must continue. OSPAR needs to promote efforts to stop litter entering the marine environment.

→ **Promote sustainable fishing**
OSPAR needs to promote fisheries management plans that address depleted stocks, and encourage the adoption of rules to prevent fishing from damaging the seabed.

Region IV is characterised by well-mixed waters and upwelling of nutrients and cold water along the continental slope. The area is strongly affected by people. The Iberian coast is densely populated, with more than 500 inhabitants per km^2 in some areas and there are very active shipping routes. Most of the activities affecting the marine environment are concentrated along the narrow continental shelf, and coastal defences, cable-laying and tourism have all increased since 1998.

The seas are productive and there are large populations of pelagic fish. During spring, blooms of algae on the Iberian coast attract huge shoals of sardines and other fish. The coast is diverse, with many different habitats, from muddy shores to rocky cliffs. The seabed has some outstanding features, with seamounts and deep underwater canyons where giant squid and large sponges can be found. Because of its latitude, Region IV has both northerly species at the southern edge of their range and southerly or Mediterranean species at the northern edge of their range.

The QSR 2000 concluded that the quality status of Region IV was generally good, but a lack of information made it difficult to assess human impacts in many areas. Issues of high importance were: declining fish stocks (sardine, hake, anglerfish, bluefin tuna, swordfish); pressures from coastal development; and effects of climate change. Climate change has remained an ongoing concern.

Eutrophication problem area extent	**0.6 %**
Monitored sites with unacceptable status	
– Mercury	41 %
– PAHs	19 %
Species under threat	**25**
Habitats under threat	**9**
MPA coverage	**0.5 %**

Successes

Much better information than before. Although some gaps remain, there is much better knowledge about the state of the environment in Region IV than ten years ago.

Improvements in fishing practice. A number of improvements in fishing practice have been implemented to help protect the marine environment. For example, local prohibition of rock-hopper trawling has had a positive effect on the seabed and a driftnet ban has reduced the by-catch of marine mammals.

An important new protected area. The establishment of the El Cachucho MPA in the Cantabrian Sea is a major achievement. This MPA protects the wildlife associated with a seamount and a system of channels and canyons, and has strong measures to manage fisheries.

Ongoing concerns

Fish stocks in danger. The anchovy population in the Bay of Biscay has declined dramatically due to a lack of new young fish, and the fishery was closed between 2005 and 2009. The southern stock of hake is at low levels and subjected to unreported fishing. Most aspects of the demersal fish community on the French continental shelf are in a poorer state than in the mid- to late 1980s. There has been some improvement in the status of swordfish.

Eutrophication in the Bay of Biscay. There are eutrophication problems in small coastal bays and estuaries where waters are less active, particularly in the northern Bay of Biscay and in possibly some estuaries on the Spanish and Portuguese coasts.

Shipping incidents. Ship traffic has been increasing in Region IV over the past 20 years. Vessels often hit rough seas as they enter the exposed waters of the Atlantic en route from the North Sea and Baltic regions, and older ships are particularly vulnerable to accidents that create spillage. The *Prestige* oil spill in 2002 killed thousands of seabirds, and damaged some of the last remaining colonies of the Iberian population of the guillemot. The long-term effects of this spill are still not known.

Hazardous chemicals. Mercury remains a particular problem in Region IV, with over 40% of sites having unacceptable levels in sediments, perhaps as a legacy of past mining activities. In general, there is little information from Portugal on this type of pollution, but on other coasts, pollution from hazardous substances is found in coastal locations close to urban and industrial areas.

New industry. There are plans to store CO_2 under the Cantabrian continental shelf, and offshore wind, wave and tidal energy developments all seem likely in Region IV. As for the other OSPAR Regions, the long-term impacts and combined ecosystem effects of these activities are not well understood.

Lack of monitoring in deep sea areas (>200 m). Research has provided much greater knowledge of the habitats and ecosystems of this Region than was available ten years ago. Although the locations of canyons, seamounts and other important habitats are now known, there is no adequate monitoring of these sites. OSPAR must find ways and means to monitor marine life in these areas, so that it can assess and begin to understand human impacts.

What should be done?

→ **Develop coordinated spatial planning**
The limited extent of the continental shelf in Region IV, especially around the Iberian peninsula, and the demand for space for human activities including marine renewable energy developments, mean improved marine spatial management is particularly urgent.

→ **Expand the MPA network**
In Region IV there is a need to build upon the MPAs that have been established so far, to ensure that ecologically important areas are protected and form part of a network.

→ **Promote sustainable fishing**
OSPAR must promote the development of fisheries management plans that address depleted stocks, and encourage the collection of data to support the management of mixed fisheries.

Region V is dominated by the High Seas, so effective management requires international cooperation. The only inhabitants are the 250 000 people living on the Azores.

Beyond the continental slope much of the seabed is an abyssal plain. Dissecting the abyssal plain is the longest mountain range in the world – the Mid-Atlantic Ridge – which runs from Iceland to the Azores and beyond. Both the continental slope and these underwater mountains support diverse biological communities, including cold-water coral reefs and deep-sea sponge communities. The Mid-Atlantic Ridge is an active tectonic boundary, with hydrothermal vents occuring along its length where hot mineral-rich seeps support forms of life that are only just starting to be understood.

Sharks, tuna and marlin roam the High Seas, migrating far beyond the boundaries of Region V.

To date, there is no exploitation of oil and gas in Region V, but deep-water fishing is exerting pressure on the ecosystems. There is a tendency for fishing to target accessible areas of the seabed, that is, isolated seamounts and shallower parts of the Mid-Atlantic Ridge – precisely where biodiversity is likely to be highest. Some of these areas are now protected. Deep-water fish species have been shown to be particularly sensitive to exploitation.

Region V is important for Europe's threatened sea turtles, and wide-ranging oceanic seabirds like Cory's shearwater.

Eutrophication problem area extent	0 %
Species under threat	21
Habitats under threat	7
MPA coverage	0.2 %

The QSR 2000 concluded that the quality status of Region V was good but far from pristine. Issues of high importance were: over-fishing; large numbers of fish and marine mammals killed accidentally; lack of information about the impacts of climate change; mechanical damage to fragile habitats; expansion of the oil and gas industry into Region V; and increasing inputs of nutrients, hazardous substances, oil and litter.

Successes

Some international cooperation to control fishing. The potential for illegal, unregulated and unreported fishing is causing concern in Region V. Countries are cooperating to control it by preventing individual blacklisted vessels from landing at their ports. This effort needs to be intensified. Gill-netting, discards and other impacts on fish, marine mammals and seabed habitats are being regulated by the North East Atlantic Fisheries Commission (NEAFC).

Protecting deep-sea habitats. Owing to the efforts of OSPAR, NEAFC, the EU and a number of OSPAR countries, some deep-sea habitats (including on the Rockall and Hatton Banks, a large area around the Azores, sections of the Mid-Atlantic Ridge and several seamounts) now have some protection and are closed to bottom fishing at the least on a temporary basis.

Ongoing concerns

Information is still limited. While many issues of concern remain the same as in 2000 for Region V, there is not enough new information to establish trends since 2000. In particular, OSPAR must promote the long-term observation and monitoring of the major habitats in Region V, such as continental margins, seamounts, the Mid-Atlantic Ridge, and abyssal plains. OSPAR should work on more detailed maps of the seafloor with information about the extent of different habitats, so it is clear where to focus surveillance effort.

Long-lived species slow to recover. The full extent of deepwater fishing effort is not known. Management measures were first introduced in 2004. Many deep-sea species are very long-lived, for example, the orange roughy can live for more than 100 years. Their populations are slow to recover when they have been depleted by over-fishing. Large whale species, whose populations fell due to heavy exploitation before the 1980s, are recovering very slowly.

Bluefin tuna in trouble. The status of the Eastern Atlantic and Mediterranean stock of bluefin tuna is of major concern. The population declined strongly over the past decade, but there are not enough data to assess with certainty how many bluefin tuna are left. In 2007, the annual catch of bluefin tuna was estimated to be double that allowed by the fishing authorities and well in excess of the level scientists believe to be sustainable. Improved surveillance seems to have reduced catches in 2008, but the need of further reductions in catches, better monitoring and regulation of the fishery is urgent.

Increasing industrial activity. Exploration for oil and gas is still continuing but production has not yet expanded into Region V. As the continental margins become depleted, mineral extraction, fishing and possibly fossil energy industries will turn their attention to the High Seas. Activities such as deep seabed mining could have significant impacts on the environment and marine life. OSPAR must gather as much information about this environment as possible, so that when such activities begin, it can support management that protects the most important and biodiverse sites.

MPAs in the High Seas. Establishing MPAs in the large area outside national jurisdiction in Region V is challenging. This is partly due to the difficulties of defining such areas, and the international co-operation required to manage them. Several candidate areas have been identified in Region V, but there are important jurisdictional issues to be addressed in considering their designation as MPAs. One candidate area is the Charlie Gibbs Fracture Zone, a complex section of the Mid-Atlantic Ridge. The proposed area would cover 5 % of Region V, giving it the highest protected area coverage of any OSPAR Region.

What should be done?

→ **Continue and improve monitoring of fisheries**
OSPAR must continue to collaborate with the North East Atlantic Fisheries Commission to monitor and assess fisheries in Region V. Relevant fisheries organisations should be encouraged to expand the fisheries observer programme to gain better information on by-catch and accidental catches.

→ **Focus on helping fish stocks recover**
OSPAR must encourage the adoption of measures to aid the recovery of depleted fish stocks, including stocks that straddle several Regions, like the bluefin tuna.

→ **Protect the Mid-Atlantic Ridge and isolated seamounts**
OSPAR is working with other organisations to find the best way to establish an MPA that protects the unique ecosystems along the Mid-Atlantic Ridge and around isolated seamounts and seamount complexes. This would be a pioneering step towards protecting the marine life of the High Seas.

ABBREVIATIONS

°C	Degrees Celsius
6PPD	4-(dimethylbutylamino)diphenylamin
ACCOBAMS	Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic Area
AEWA	Agreement on the Conservation of African-Eurasian Migratory Waterbirds
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
Atm	1 atmosphere = 1.013 x 10^5 Pascal
BAT	Best Available Techniques
BDE (Penta, octa and deca)	Penta-, octa- and decabromodiphenyl ether
BEP	Best Environmental Practice
Bq	Becquerel (1 disintegration per second)
CAMP	Comprehensive Atmospheric Monitoring Programme (OSPAR)
CBD	Convention on Biological Diversity
Cefas	Centre for Environment, Fisheries and Aquaculture Science (UK)
CEMP	Coordinated Environmental Monitoring Programme (OSPAR)
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
cm	Centimetre
CMS	Convention on Migratory Species
CO_2	Carbon dioxide
DBP	Dibutylphthalate
DDT	4,4'-dichlorodiphenyl-1,1,1-trichloroethane
DEHP	Diethylhexylphthalate
dw	Dry weight
EC	European Community
EcoQO	Ecological Quality Objective
EEA	European Environment Agency
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMEP	European Monitoring and Evaluation Programme
EMSA	European Maritime Safety Agency
EROD	Ethoxyresorufin-O-deethylase
EU	European Union
F	Fishing mortality
FAO	United Nations Food and Agriculture Organization
FFL	Fishing for Litter
G (prefix)	Giga, 10^9
GDP	Gross Domestic Product
Gy	Gray
H_2S	Hydrogen sulphide
HBCD	Hexabromocyclododecane
HCH	Hexachlorocyclohexane
HELCOM	Helsinki Commission for the Protection of the Marine Environment of the Baltic Sea
IAEA	International Atomic Energy Agency
ICCAT	International Commission for Conservation of Atlantic Tunas
ICES	International Council for the Exploration of the Sea
ICZM	Integrated Coastal Zone Management
IIASA	International Institute for Applied Systems Analysis
IMO	International Maritime Organization
IOC	Intergovernmental Oceanographic Commission
IPCC	United Nations Intergovernmental Panel on Climate Change
IPPC	Integrated Pollution Prevention and Control (EU)
ISA	International Seabed Authority
IUU	Illegal, Unregulated and Unreported
IWC	International Whaling Commission
JAMP	Joint Assessment and Monitoring Programme (OSPAR)
kg	Kilogramme
km	Kilometre
km^2	Square kilometre
M	Molar mass
M (prefix)	Mega, 10^6
MARPOL	International Convention for the Prevention of Pollution from Ships (1973/1978)
mm	Millimetre
MPA	Marine Protected Area
MSY	Maximum Sustainable Yield
N	Nitrogen
n (prefix)	Nano, 10^{-9}

N	Nitrogen
n (prefix)	Nano, 10^{-9}
NAMMCO	North Atlantic Marine Mammal Commission
NASCO	North Atlantic Salmon Conservation Organisation
NEAFC	North East Atlantic Fisheries Commission
nm	Nautical mile
NOAA	National Oceanic and Atmospheric Administration (USA)
NO_x	Nitrogen oxides
NSIDC	National Snow and Ice Data Centre (USA)
OECD	Organisation for Economic Cooperation and Development
OSPAR	The term 'OSPAR' is used in this report to refer to both the OSPAR Commission and the former Oslo and Paris Commissions. The 1972 Oslo Convention and the 1974 Paris Convention were replaced by the 1992 OSPAR Convention when it entered into force on 25 March 1998
P	Phosphorus
p (prefix)	Pico, 10^{-12}
PAH	Polycylic aromatic hydrocarbon
PBDE	Polybrominated diphenyl ether
PCB	Polychlorinated biphenyl
PCDD	Polychlorinated dibenzodioxin
PCDF	Polychlorinated dibenzofuran
PCP	Pentachlorophenol
PFOS	Perfluorooctane sulphonates
PIC	Prior Informed Consent
POP	Persistent Organic Pollutant
PSSA	Particularly Sensitive Sea Area
QSR	Quality Status Report
QSR 2000	Quality Status Report for the entire OSPAR maritime area published by OSPAR in 2000
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals (EU)
RID	Comprehensive Study on Riverine Inputs and Direct Discharges (OSPAR)
RMP	Revised Management Procedure (International Whaling Commission)
s	Second (time)
SCCP	Short-chain chlorinated paraffin
SECA	SO_x Emission Control Area
SO_2	Sulphur dioxide
SO_x	Sulphur oxide
SOLAS	International Convention for the Safety of Life at Sea
SSB	Spawning Stock Biomass
Sv	Sievert (1 J/kg x (modifying factors))
t	Tonne
T (prefix)	Tera, 10^{12}
TAC	Total Allowable Catch
TBBP-A	Tetrabromobisphenol-A
TBT	Tributyltin
toeq	Tonnes of oil equivalents
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
VMEs	Vulnerable Marine Ecosystems
VOC	Volatile Organic Compounds
W	Watt
WFD	Water Framework Directive (EU)
ww	Wet weight
WWF	World Wildlife Fund
yr	Year
μ (prefix)	Micro, 10^{-6}

GLOSSARY

Abyssal plain	The more or less flat region of the deep ocean floor below 4000 m, excluding ocean trenches, formed by deposition of pelagic sediments and turbidity currents that obscure the pre-existing topography
Adaptation (climate change)	Actions addressing the consequences of climate change through enhancing the resilience of natural and human systems, i.e. their capacity to cope with those consequences
Adaptive management	The integration of programme design, management and monitoring to systematically test assumptions in order to adapt and learn
Advection	The transfer of heat or matter by horizontal movement of air or water
Anthropogenic	Caused or produced by human activities
Anti-foulant	A coating, paint, surface treatment, surface or device that is used on a ship or underwater structures to control or prevent attachment of unwanted organisms
Artificial reef	A submerged structure placed on the seabed deliberately to mimic some characteristics of a natural reef
Background concentrations of naturally occurring substances	Concentrations of certain naturally occurring hazardous substances that would be expected in the North-East Atlantic if certain industrial developments had not happened
Ballast water	Water, with its suspended matter, taken on board a ship to control trim, list, draught, stability or stresses of the ship
Benthos	Organisms attached to, living on, or in the seabed
Best available techniques	The latest stage of development (state of the art) of processes, facilities or methods of operation which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste
Best environmental practice	The application of the most appropriate combination of environmental control measures and strategies
Bioaccumulation	The accumulation of a substance within the tissues of an organism, which can lead to biomagnification through the food web
Bioavailability	The extent to which a substance can be absorbed into the tissues of organisms. Possibly the most important factor determining the extent to which a contaminant will enter the food chain and accumulate in biological tissues
Biological diversity	Variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems
Biomass	The total mass of organisms in a given place at a given time
Bloom	An abundant growth of phytoplankton or certain macroalgae, typically triggered by sudden favourable environmental conditions (e.g. excess nutrients, light availability, reduced grazing pressure)
By-catch	That part of the catch that is not the main target of the fishery, i.e. the retained catch of non-targeted species together with the portion of the catch returned to the sea as a result of economic, legal, or personal considerations
Climate	The long-term average conditions of the atmosphere and/or ocean
Common Procedure	The OSPAR 'Common Procedure for the Identification of the Eutrophication Status of the OSPAR Maritime Area' provides the framework for a comprehensive, harmonised characterisation of marine areas by OSPAR countries in terms of 'problem areas', 'potential problem areas' and 'non-problem areas' with regard to eutrophication
Congeners	Related or similar substances forming a group of substances
Continental shelf	The shallowest part of the continental margin between the shoreline and the continental slope; not usually deeper than 200 m
Continental slope	The steeply sloping seabed from the outer edge of the continental shelf to the continental rise
Contracting Parties	The Contracting Parties to the OSPAR Convention are the OSPAR countries Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom, and the European Community
Coordinated Environmental Monitoring Programme (CEMP)	That part of the monitoring under the OSPAR Joint Assessment and Monitoring Programme where the national contributions overlap and are coordinated by the use of commonly agreed monitoring guidelines, quality assurance procedures and assessment tools
Cuttings	Solid material removed from drilled rock together with any solids and liquids derived from any adherent drilling fluids
Demersal fish	Fish that feed on or near the bottom of the sea
Diatoms	Common type of unicellular phytoplankton with a silicate cell wall. The ratio of diatoms to flagellates in phytoplankton communities is used as an indicator of eutrophication
Diffuse sources	Sources of pollution that are not discrete and extend over a wide geographical area
Discards	That part of the catch taken on board a fishing vessel that is not landed, consumed on board or used as bait in subsequent fishing operations, but put back into the sea
Discharge	Intentional transfer of substances into water
Displacement water	Seawater contained in oil storage tanks which is displaced by incoming or outgoing crude oil, due to the densities of oil and water
Dose rate	The quantity of radiation absorbed per unit time
Drilling fluids	The fluid with added chemicals used when drilling boreholes to lubricate and cool the drilling bit
Dumping	The deliberate disposal in the maritime area of wastes or other matter from vessels or aircraft, from offshore installations, and any deliberate disposal in the maritime area of vessels or aircraft, offshore installations and offshore pipelines
Ecological Quality Objective (EcoQO)	Objectives set by OSPAR and the North Sea Conferences for the desired state of individual aspects of the structure and function of the marine ecosystem
Ecosystem	A community of organisms and their physical environment interacting as an ecological unit

Ecosystem approach	The comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of the marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity
Emission	An intentional release into air
Endemic	Native, and restricted, to a particular locality or specialised habitat
Endocrine disrupter	A substance from an external source that interferes with an organism's endocrine system, including hormone regulation and hormone equilibria, and produces adverse developmental, reproductive, neurological, and immune effects
Environmental impact assessment	Procedure to identify the potential impacts of a project or activity on the environment and to develop mitigation measures to reduce these to acceptable levels
Eutrophication	The enrichment of water by nutrients causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned, and therefore refers to the undesirable effects resulting from anthropogenic enrichment by nutrients
EU Bathing Water Directive	Directive 2006/7/EC of the European Parliament and of the Council concerning the management of bathing water quality and repealing Directive 76/160/EEC
EU Biocides Directive	Directive 98/8/EC of the European Parliament and of the Council concerning the placing of biocidal products on the market
EU Birds Directive	Council Directive 79/409/EEC on the conservation of wild birds
EU Blue Book on an Integrated Maritime Policy	Commission communication on an integrated maritime policy for the European Union (COM(2007) 575 final)
EU Environmental Impact Assessment (EIA) Directive	Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment
EU Habitats Directive	Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora
EU IPPC Directive	Directive 2008/1/EC of the European Parliament and of the Council concerning integrated pollution prevention and control, codifying Directive 96/61/EEC
EU Marine Strategy Framework Directive	Directive 2008/56/EC of the European Parliament and of the Council establishing a framework for community action in the field of marine environmental policy
EU Marketing and Use Directive	Council Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations (repealed by Annex XVII REACH Regulation)
EU National Emissions Ceiling Directive	Directive 2001/81/EC of the European Parliament and of the Council on national emission ceilings for certain atmospheric pollutants
EU NATURA 2000 network	EU wide network of nature protection areas established under the EU Habitats Directive. The aim of the network is to assure the long-term survival of Europe's most valuable and threatened species and habitats. It is comprised of Special Areas of Conservation (SAC) designated by Member States under the Habitats Directive, and also incorporates Special Protection Areas (SPAs) which they designate under the EU Birds Directive
EU Nitrates Directive	Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources
EU Pesticides Directive	Council Directive 91/414/EC concerning the placing of plant protection products on the market
EU Port Waste Reception Facilities Directive	Directive 2000/59/EC of the European Parliament and of the Council on port reception facilities for ship-generated waste and cargo residues
EU REACH Regulation	Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals
EU Recommendation on Integrated Coastal Zone Management	Recommendation 2002/413/EC of the European Parliament and of the Council concerning the implementation of Integrated Coastal Zone Management in Europe
EU Regulation 812/2004	Council Regulation (EC) No 812/2004 laying down measures concerning incidental catches of cetaceans in fisheries and amending Regulation (EC) No 88/98
EU Shellfish Directive	Council Directive 79/923/EEC on the quality required of shellfish waters
EU Strategic Environmental Assessment Directive	Directive 2001/42/EC of the European Parliament and of the Council on the assessment of the effects of certain plans and programmes on the environment
EU Thematic Air Strategy	Commission communication on a thematic strategy on air pollution (COM(2005) 446 final)
EU Urban Waste Water Treatment Directive	Council Directive 91/271/EEC concerning urban waste water treatment
EU Water Framework Directive	Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for Community action in the field of water policy
EU WFD Daughter Directive on environmental quality standards	Directive 2008/105/EC of the European Parliament and of the Council on environmental quality standards in the field of water policy
Exclusive Economic Zone (EEZ)	An area in which a coastal state has sovereign rights over all the economic resources of the sea, seabed and subsoil (see Articles 56–58, Part V, UN Convention on the Law of the Sea 1982)

Fishing effort	The amount of fishing taking place, quantified as the effective utilization of the existing fishing capacity (fleet power) in a management period. It is usually expressed as kilowatt-days
Fishing mortality	A measure of the proportion of a fish stock taken each year by fishing. A limit reference point (F_{lim}) and a precautionary reference point (F_{pa}) guide management of fisheries targeting the stock
Flagellates	Common type of unicellular phytoplankton with a whip-like appendage (flagellum) which enables them to swim. The ratio of diatoms to flagellates in phytoplankton communities is used as an indicator of eutrophication
Food web	The network of interconnected food chains along which organic matter flows within an ecosystem or community
Greenhouse gases	Gases such as carbon dioxide, methane and nitrous oxide which have the potential to trap heat radiation from the Earth's surface and cause warming in the lower atmosphere
Gross Domestic Product (GDP)	Market value of all final goods and services made within the borders of a country in a year
Harmful algal blooms	Blooms of phytoplankton that result in harmful effects such as the production of toxins that can affect human health, oxygen depletion and kills of fish and invertebrates and harm to fish and invertebrates, for example, by damaging or clogging gills
Harmonised mandatory control system	This comprises OSPAR Decision 2000/2 on a Harmonised Mandatory Control System for the Use and Reduction of the Discharge of Offshore Chemicals (as amended), OSPAR Recommendation 2000/4 on a Harmonised Pre-screening Scheme for Offshore Chemicals (as amended), and OSPAR Recommendation 2000/5 on a Harmonised Offshore Chemical Notification Format (HOCNF) (as amended)
Hazardous substances	Substances or groups of substances which are either (i) toxic, persistent and liable to bioaccumulate; or (ii) assessed by OSPAR as giving rise to an equivalent level of concern
High-grading	Retaining on board for ulterior landing only those fish that can fetch good prices at the market, while discarding the less-valued fish
Imposex	A condition in which the gender of an organism has become indeterminate as a result of hormonal imbalances or disruption, as in the case of the effect of tributyltin on marine gastropods
Integrated Coastal Zone Management (ICZM)	A dynamic, multidisciplinary and iterative process to promote sustainable management of coastal zones through a variety of tools to balance environmental, economic, social, cultural and recreational objectives
London Convention	The 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter. The Convention is administered by the International Maritime Organization
Losses	Unintentional transfers of substances, other than as discharges, emissions or the result of accidents, directly or indirectly to the marine environment, which have, for example (i) leached, eroded or become detached from a manufactured product, waste or structure; (ii) leached or run off from land on which it has been spread or deposited; (iii) leaked or escaped from a container in which it has been kept
Macrophytes	Large, often rooted aquatic plants
Marine protected area (MPA)	An area within the maritime area for which protective, conservation, restorative or precautionary measures, consistent with international law have been instituted for the purpose of protecting and conserving species, habitat, ecosystems or ecological processes of the marine environment
Marine spatial planning	A public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that are usually specified through a political process (synonym: maritime spatial planning)
Maritime area (synonym: OSPAR area)	The waters covered by the OSPAR Convention
MARPOL	The International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto
Maximum sustainable yield (MSY)	The largest yield (or catch) that can be taken from a fish stock over an indefinite period. Management policies should ideally aim at maintaining fish stocks, for a long term, at levels capable to produce MSY, although other environmental, economic and social objectives may also play an important factor
Mitigation (climate change)	Actions addressing anthropogenic causes of climate change and ocean acidification
Non-problem area (eutrophication)	Those areas for which there are no grounds for concern that anthropogenic enrichment by nutrients has disturbed or may in the future disturb the marine ecosystem
Nordic Seas	Collective term for the Norwegian, Iceland and Greenland Seas
NO_X (nitrogen oxides)	For the purposes of OSPAR reporting on emissions from offshore installations, NO_X is the sum of nitric oxide (NO) and nitrogen dioxide (NO_2)
Nuisance species	Species that are not in themselves dangerous or toxic but can negatively disrupt ecosystems and environments
Nutrients	Dissolved phosphorus, nitrogen and silicon compounds
Ocean acidification	Decrease in the pH of the ocean. Causative factors include the oceanic uptake of carbon dioxide from the atmosphere
Organic-phase drilling fluid	An emulsion of water and other additives in which the continuous phase is a water-immiscible organic fluid of animal, vegetable or mineral origin
Organohalogens	Substances in which an organic molecule is combined with one or more of the halogen group of elements (i.e. fluorine, chlorine, bromine, iodine)
OSPAR area (synonym: maritime area)	The waters covered by the OSPAR Convention
Oxidised nitrogen	For the purpose of CAMP monitoring, nitrate (NO_3) in precipitation and nitrogen dioxide (NO_2), nitric acid (HNO_3) and nitrogen monoxide (NO) in air/aerosol
Pelagic fish	Fish that spend most of their life swimming in the water column with little contact with, or dependency on, the bottom

Persistent substances	Substances that persist in the environment. The principal criterion is that the substance has a half-life in the freshwater or marine environment of 50 days or more
Phytoplankton	The collective term for the photosynthetic members of plankton
PLONOR substance	OSPAR List of Substances/Preparations Used and Discharged Offshore which are Considered to Pose Little or No Risk to the Environment
Point source	Identifiable and localised point of emissions to air and discharges to water
Pollution	The introduction by man, directly or indirectly, of substances or energy into the maritime area which results, or is likely to result, in hazards to human health, harm to living resources and marine ecosystems, damage to amenities or interference with other legitimate uses of the sea
Potential problem area (eutrophication)	Those areas for which there are reasonable grounds for concern that the anthropogenic contribution of nutrients may be causing or may lead in time to an undesirable disturbance to the marine ecosystem due to elevated levels, trends and/or fluxes in such nutrients
Precautionary approach	Management approach where preventive measures are to be taken when there are reasonable grounds for concern that substances or energy introduced, directly or indirectly, into the marine environment may bring about hazards to human health, harm living resources and marine ecosystems, damage amenities or interfere with other legitimate uses of the sea, even when there is no conclusive evidence of a causal relationship between the inputs and the effects
Problem area (eutrophication)	Those areas for which there is evidence of an undesirable disturbance to the marine ecosystem due to anthropogenic enrichment by nutrients
Produced water	The water that comes up from oil and gas wells along with the oil and gas. Some of it is water that has been in the hydrocarbon reservoir for geological time along with the oil or gas ('formation water'). Some of it is water produced by condensation during the production process ('condensation water')
Priority chemical	For the purpose of the QSR, substance on the OSPAR List of Chemicals for Priority Action
Radionuclide	Atoms that disintegrate by emission of electromagnetic radiation, i.e. emit alpha, beta or gamma radiation (α-emitting particles, β-emitting particles, γ-rays)
Reduced nitrogen	For the purpose of CAMP monitoring, reduced nitrogen includes ammonium (NH_4) in precipitation and the sum of ammonia (NH_3) and ammonium in air aerosol. For the purpose of EMEP atmospheric emission/depostion, reduced nitrogen refers to ammonia (NH_3)
Safe biological limits	Limits (reference points) for fishing mortality rates (F_{pa}) and spawning stock biomass (B_{pa}), beyond which the fishery is unsustainable
Seamount	An elevated area of limited extent rising 1000 m or more from the surrounding ocean floor, usually conical in shape
Shelf break	The outer margin of the continental shelf marked by a pronounced increase in the slope of the seabed; usually occurring at around 200 m in depth along European margins
Spawning stock biomass (SSB)	The total weight of fish in the stock that are old enough to spawn. It is one of the most important metrics of the size and health of commercial fish stocks. A limit reference point (B_{lim}) and a precautionary reference point (B_{pa}) guide management of fisheries targeting the stock
Stratification	The separation of seawater into layers
Total allowable catch (TAC)	The maximum quantity of fish that is allowed to be caught and subsequently landed from a stock during a management period (usually one year)
Toxic	The property of a substance that will cause damage to a living organism or their progeny
Toxin	A poisonous substance produced by living organisms and biological processes, usually proteinaceous
Trophic	Pertaining to nutrition
Turbidity	The degree to which the water loses its transparency due to the presence of suspended particulates
Upwelling	This occurs near coasts where winds persistently drive surface water seaward, causing an upward movement of cold, nutrient-rich water from ocean depths, and in the open ocean where surface currents are divergent
Vitellogenin	A protein in blood plasma used as a biomarker for exposure to endocrine disrupters that promote the development of female sex characteristics
Volatile organic compounds (VOCs)	For the purposes of OSPAR reporting on emissions from offshore installations, volatile organic compounds comprise all hydrocarbons, other than methane released to the atmosphere
Water column	The vertical column of water extending from the sea surface to the seabed
Water mass	A body of water within an ocean characterised by its physicochemical properties of temperature, salinity, depth and movement
Zoobenthos	Animals that live on or in the seabed
Zooplankton	The animal component of the plankton; animals suspended or drifting in the water column including larvae of many fish and benthic invertebrates

SPECIES LIST

Common (English) name	Scientific name
Mammals	
Bearded seal	*Erignathus barbatus*
Beluga, white whale	*Delphinapterus leucas*
Blue whale	*Balaenoptera musculus*
Bottlenose dolphin	*Tursiops truncates*
Bowhead whale	*Balaena mysticetus*
Common dolphin	*Delphinus delphis*
Fin whale	*Balaenoptera physalus*
Grey seal	*Halichoerus grypus*
Harbour porpoise	*Phocoena phocoena*
Harbour seal	*Phoca vitulina*
Harp seal	*Pagophilus groenlandicus*
Hooded seal	*Cystophora cristata*
Long-finned pilot whale	*Globicephala melas*
Minke whale	*Balaenoptera acutorostrata*
Narwhal	*Monodon monoceros*
Northern right whale	*Eubalaena glacialis*
Polar bear	*Ursus maritimus*
Ringed seal	*Phoca hispida*
Sperm whale	*Physeter macrocephalus*
Walrus	*Odobenus rosmarus*
Birds	
Arctic skua	*Stercorarius parasiticus*
Arctic tern	*Sterna paradisaea*
Atlantic puffin	*Fratercula arctica*
Auks	Family of *Alcidae*
Balearic shearwater	*Puffinus mauretanicus*
Black-legged kittiwake	*Rissa tridactyla*
Common scoter	*Melanitta nigra*
Common tern	*Sterna hirundo*
Cory's shearwater	*Calonectris diomedea*
Glaucous gull	*Larus hyperboreus*
Guillemot, Common murre	*Uria aalge*
Herring gull	*Larus argentatus*
Ivory gull	*Pagophilia eburnea*
Lesser black-backed gull	*Larus fuscus fuscus*
Little shearwater	*Puffinus assimilis baroli*
Little tern	*Sterna albifrons*
Northern fulmar	*Fulmarus glacialis*
Roseate tern	*Sterna dougallii*
Sandwich tern	*Sterna sandvicensis*
Steller's eider	*Polysticta stelleri*
Thick billed murre	*Uria lomvia*
Reptiles	
Leatherback turtle	*Dermochelys coriacea*
Loggerhead turtle	*Caretta caretta*

Fish	
Albacore, long-finned tuna	*Thunnus alalunga*
Allis shad	*Alosa alosa*
Anchovy	*Engraulis encrasicolus*
Angel shark	*Squatina squatina*
Anglerfish	*Lophius piscatorius*
Basking shark	*Cetorhinus maximus*
Bass	*Dicentrarchus labrax*
Blackscabbard fish	*Aphanopus carbo*
Blue shark	*Prionace glauca*
Blue whiting	*Micromesistius poutassou*
Bluefin tuna	*Thunnus thynnus*
Capelin	*Mallotus villosus*
Cod	*Gadus morhua*
Common skate	*Dipturus batis* (synonym: *Raja batis*)[1]
Dab	*Limanda limanda*
European anchovy	*Engraulis encrasicolus*
European eel	*Anguilla anguilla*
European sturgeon	*Acipenser sturio*
Flounder	*Platichthys flesus*
Gulper shark	*Centrophorus granulosus*
Greater forkbeard	*Phycis blennoides*
Greater silver smelt	*Argentina silus*
Haddock	*Melanogrammus aeglefinus*
Hake	*Merluccius merluccius*
Herring	*Clupea harengus*
Houting	*Coregonus lavaretus oxyrinchus*
Leafscale gulper shark	*Centrophorus squamosus*
Lesser Sandeel	*Ammodytes marinus*
Ling	*Molva molva*
Long-snouted seahorse	*Hippocampus guttulatus* (formerly ramulosus)
Mackerel	*Scomber scombrus*
Marlin	*Istiophoridae*
Norway pout	*Trisopterus esmarkii*
Orange roughy	*Hoplostethus atlanticus*
Plaice	*Pleuronectes platessa*
Porbeagle	*Lamna nasus*
Portuguese dogfish	*Centroscymnus coelolepis*
Red mullet	*Mullus surmelletus*
Redfish	*Sebastes* spp.
(Golden) redfish	*Sebastes marinus*
(Beaked) redfish	*Sebastes mentella*
Saithe	*Pollachius virens*
Salmon	*Salmo salar*
Sandeel	*Ammodytes tobianus*
Sardine	*Sardina pilchardus*
Sea bass	*Dicentrarchus labrax*
Sea lamprey	*Petromyzon marinus*
Sea trout	*Salmo trutta*
Short-snouted seahorse	*Hippocampus hippocampus*
Silvery John dory	*Zenopsis conchifer*
Sole	*Solea solea*
Spotted ray	*Raja montagui* (synonym: *Dipturus montagui*)
Spurdog	*Squalus acanthias*
Swordfish	*Xiphias gladius*
Thornback ray	*Raja clavata*
Tusk	*Brosme brosme ascanius*
White skate	*Rostroraja alba*
Whiting	*Merlangius merlangus*

[1] Recent research suggests this is a species complex

Lower animals	
Acorn barnacle	*Austrominius* (=*Elminius*) *modestus*
Asian shore crab	*Hemigrapsus sanguineus*
Asian shore crab, brush-clawed shore crab	*Hemigrapsus takanoi*
Australasian barnacle	*Elminius modestus*
Azorean barnacle	*Megabalanus azoricus*
Azorean limpet	*Patella aspera*
Blue mussel	*Mytilus edulis*
Brittle star	*Gorgonocephalus* sp.
Chinese mitten crab, mitten crab, Chinese freshwater edible crab	*Eriocheir sinensis*
Chironomid	*Telmatogeton japonicus*
Cold-water coral	*Lophelia pertusa*
Comb jelly	*Mnemiopsis leidyi*
Copepod	*Calanus helgolandicus*
Copepod	*Calanus finmarchicus*
Deep-water shrimp	*Pandalus borealis*
Dogwhelk	*Nucella lapillus*
Fan worm	*Sabella spallanzanii*
Flat oyster	*Ostrea edulis*
Horse mussel	*Modiolus modiolus*
Jackknife clam, razor clam	*Ensis americanus* (=*directus*)
Japanese clam, Manila clam	*Venerupis philippinarum*
Kuruma shrimp	*Marsupenaeus japonicus*
Leathery sea squirt, Asian sea squirt	*Styela clava*
Nephrops, Norway lobster, Langoustine	*Nephrops norvegicus*
Ocean quahog	*Arctica islandica*
Pacific oyster	*Crassostrea gigas*
Portuguese oyster	*Crassostrea angulata*
Rapa whelk, veined whelk	*Rapana venosa*
Red gilled mud worm	*Marenzelleria* spp. (complex)
Red king crab	*Paralithodes camtschaticus*
Ross worm	*Sabellaria spinulosa*
Sea-pen	*Pennatulacea* sp.
Sea squirt	*Didemnum vexillum*
Ship worm	*Teredo navalis*
Skeleton shrimp	*Caprella mutica*
Slipper limpet	*Crepidula fornicata*
Soft-shelled clam, soft clam, long-necked clam	*Mya arenaria*
Squat lobsters	*Galatheidae*
Tubeworm	*Ficopomatus enigmaticus*

Other organisms	
Bacteria	*Escherichia coli*
Bryozoan	*Bugula stolonifera*
Bryozoan	*Tricellaria inopinata*
Parasitic protozoan	*Bonamia ostrea*

Plants	
Asian red algae	*Gracilaria vermiculophylla*
Centric diatom	*Coscinodiscus wailesii*
Common cord-grass, Townsend's grass or rice grass	*Spartina anglica*
Eelgrass	*Zostera marina*
Eelgrass	*Zostera noltii*
Green sea fingers	*Codium fragile* ssp. *fragile*
Lesser neptune grass	*Cymodocea nodosa*
Pacific diatom	*Neodenticula seminae*
Red alga	*Bonnemaisonia hamifera*
Sea lettuce	*Ulva* spp.
Sugar kelp	*Saccharina latissima*
Wakame, Japanese kelp	*Undaria pinnatifida*
Wire weed, jap weed, strangle weed	*Sargassum muticum*

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