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.

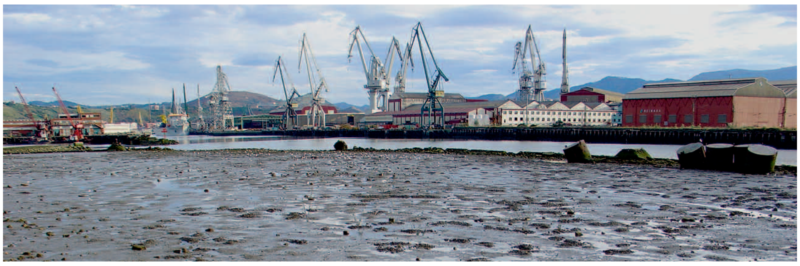
Key OSPAR assessments

→ 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.

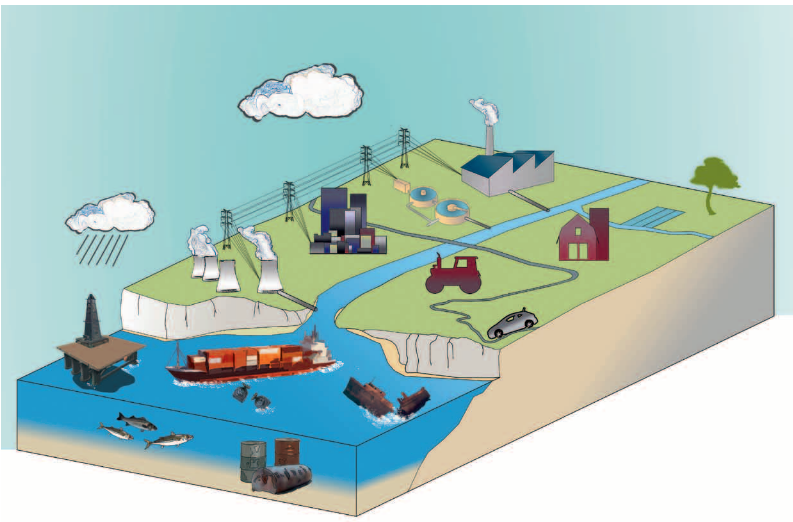


FIGURE 5.1 *Schematic overview of the main sources of hazardous substances and pathways to the marine environment. Waterborne substances enter the sea directly, for example through sewage and industrial discharges, or from offshore activities such as oil and gas extraction* → **CHAPTER 7**, *mariculture* → **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.

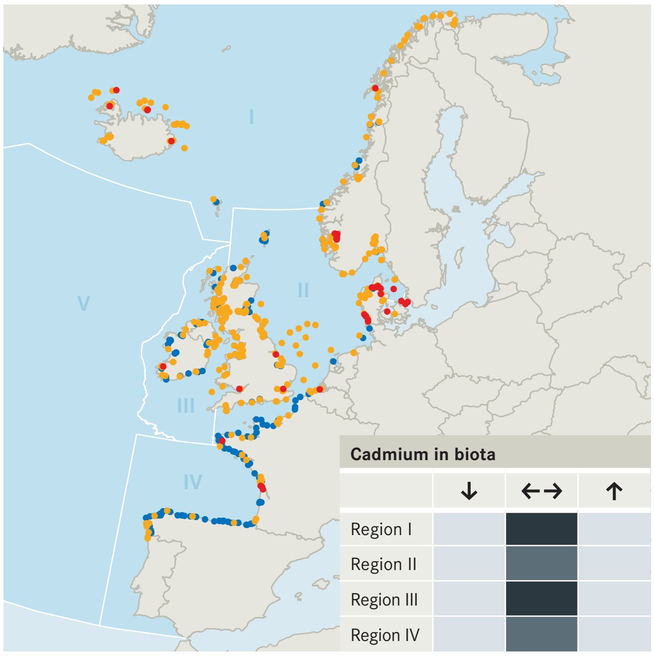
Contamination from PCBs is widespread and there are few areas where concentrations are close to zero → **FIGURE 5.2**. Concentrations are lowest along the northern coast of Norway (Region I). PCBs are however among the most prevalent pollutants in the Arctic and are widely distributed by long-range atmospheric 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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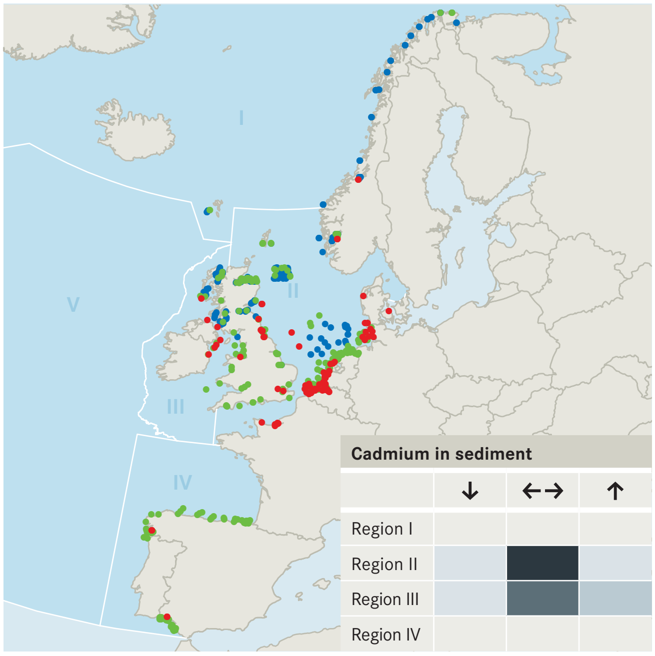
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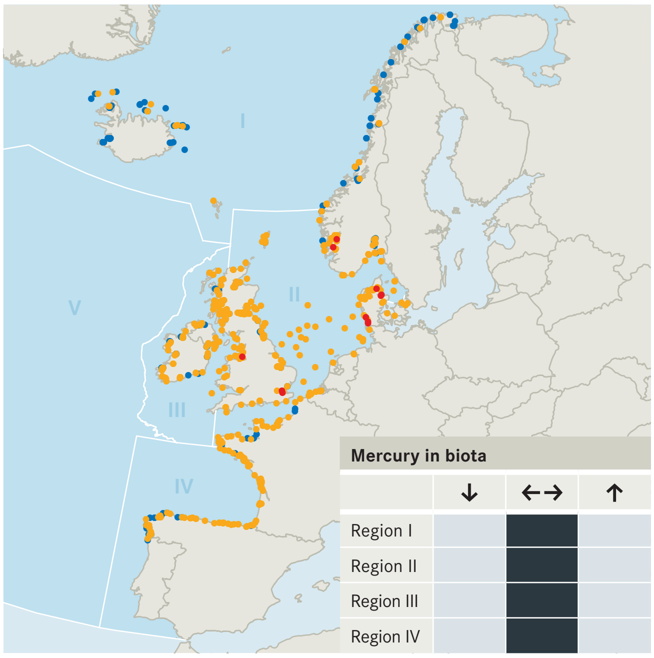
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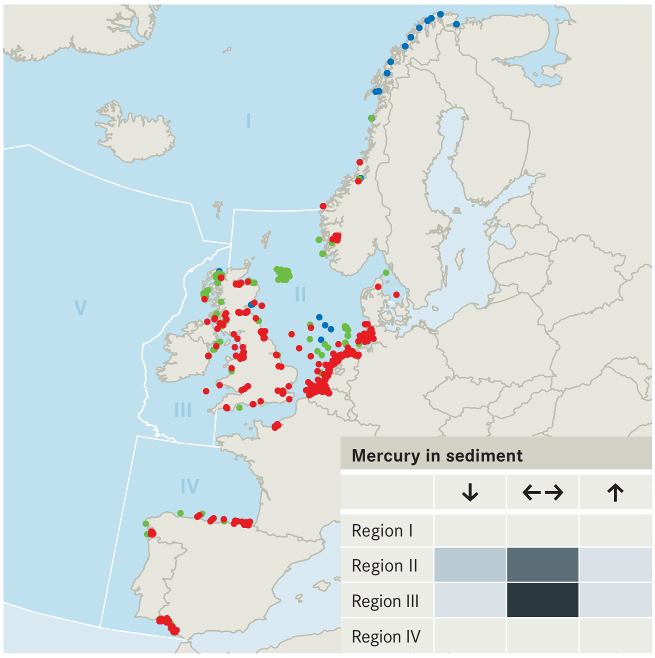
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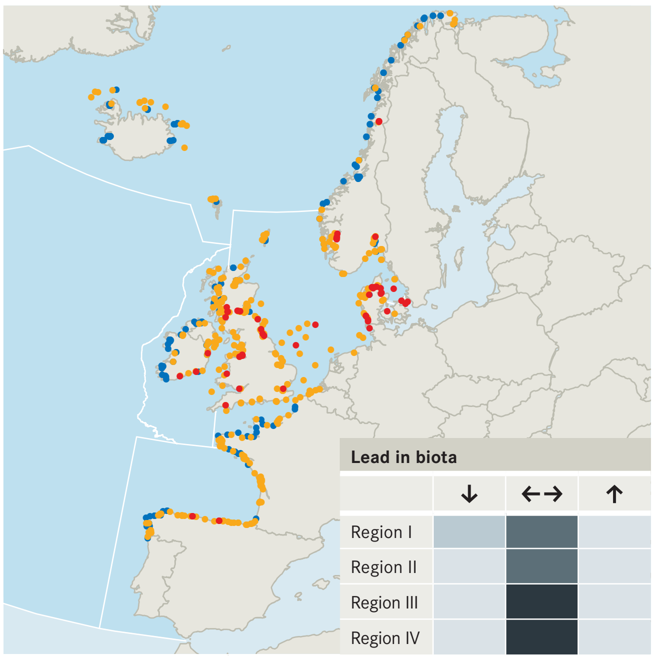
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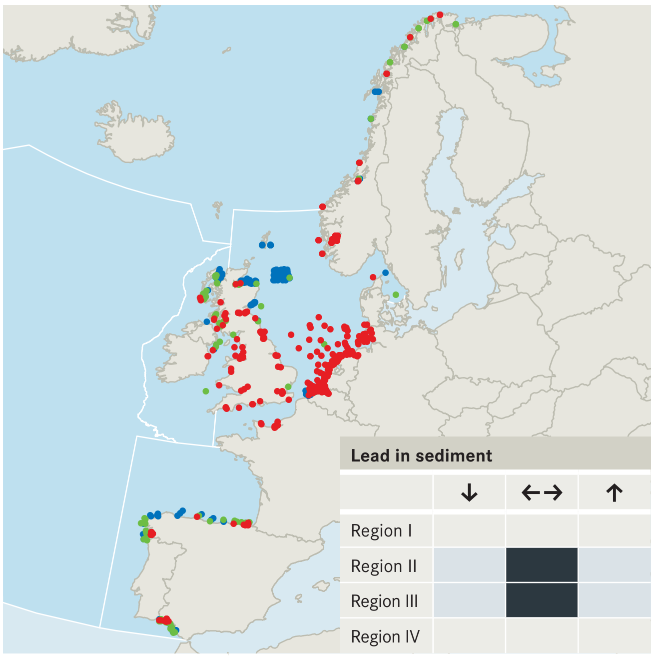
Lead in sediment
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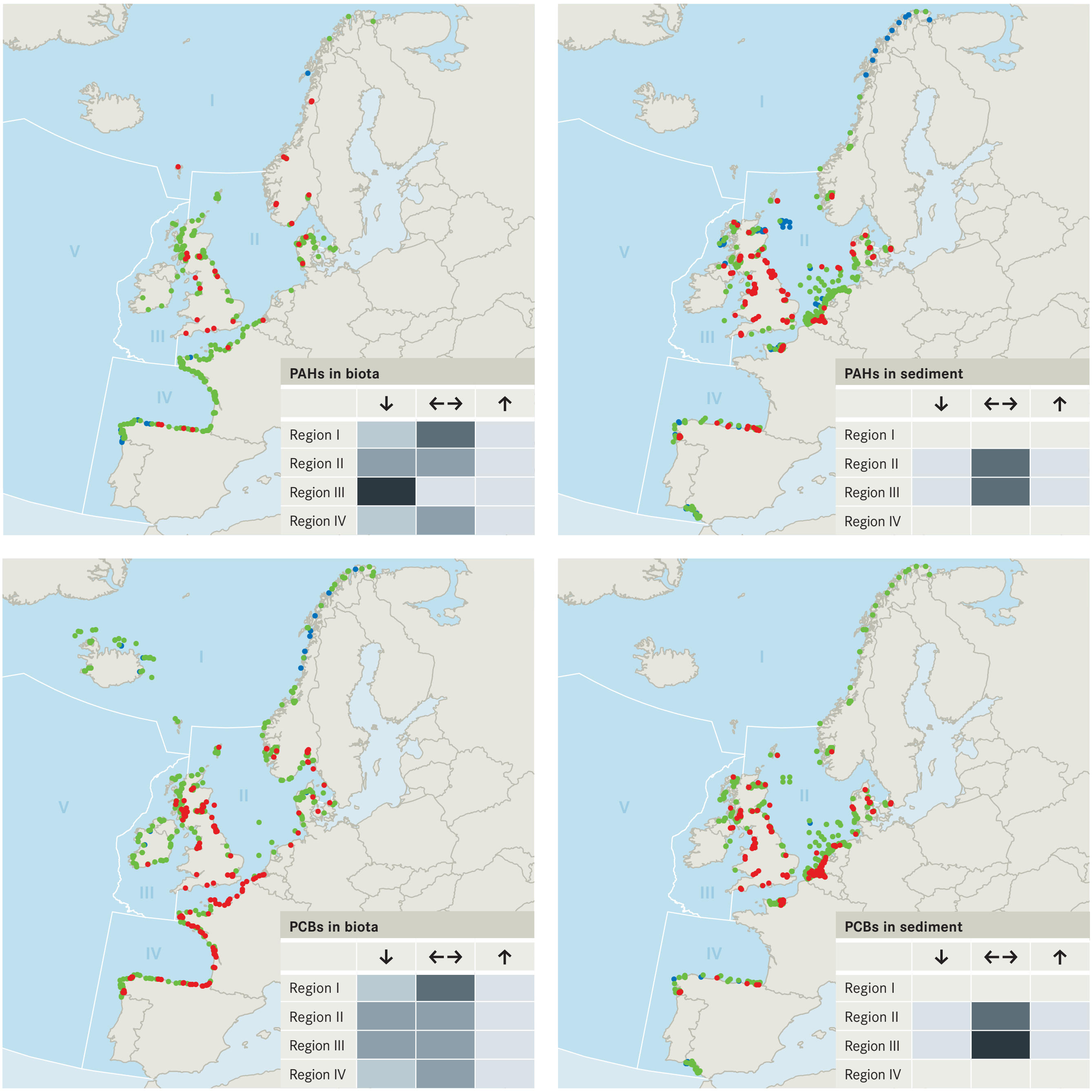


FIGURE 5.2 *Geographical distribution of status and temporal trends in contamination from cadmium, mercury, lead, PAHs and PCBs in biota (fish and shellfish) and sediments based on the OSPAR Coordinated Environmental Monitoring Programme. Status is indicated for the last year of monitoring in the period 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

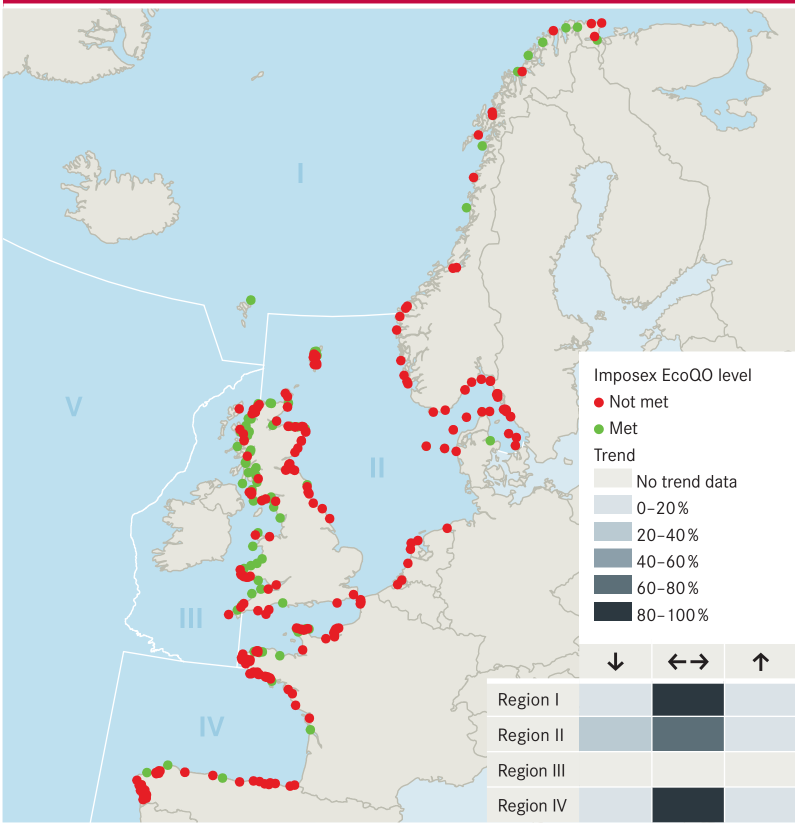
Over the past decade, a range of national and international measures have resulted in a continuous phase-out of paints containing TBT as an anti-foulant and their use on vessels, in aquaculture and on underwater structures in the OSPAR area. A global ban on TBT in anti-fouling systems on large vessels 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.

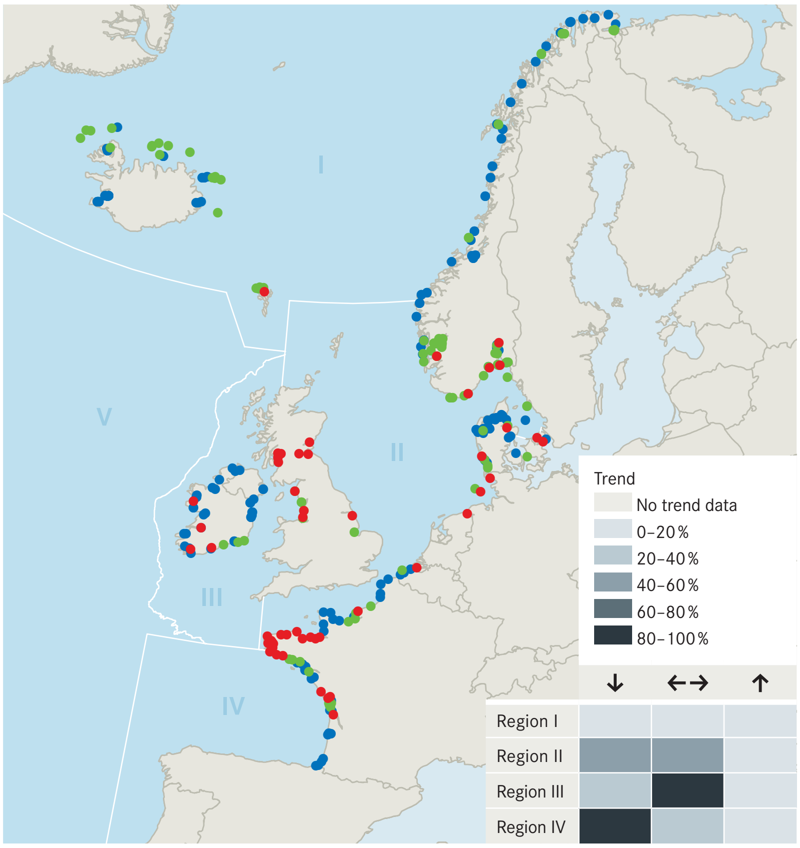


FIGURE 5.3 *Distribution and temporal trends in contamination from lindane in biota. Concentrations are unacceptable (red), acceptable (green) and close to zero (blue) (legend* → **FIGURE 5.2***).*

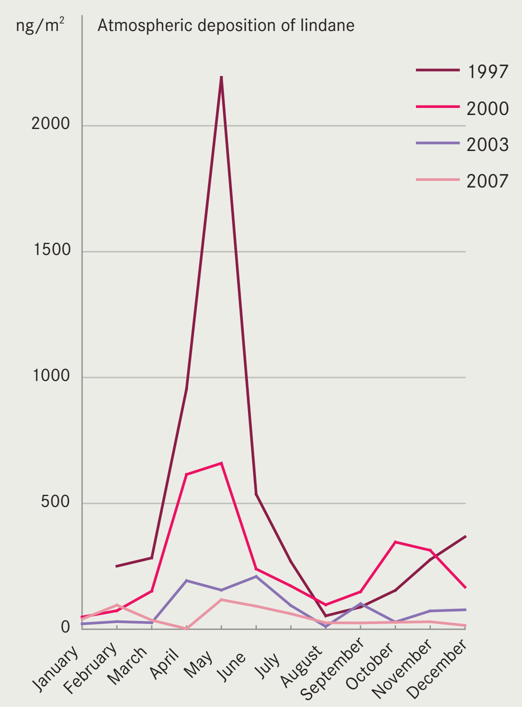
Better regulation is needed for some brominated flame retardants

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.

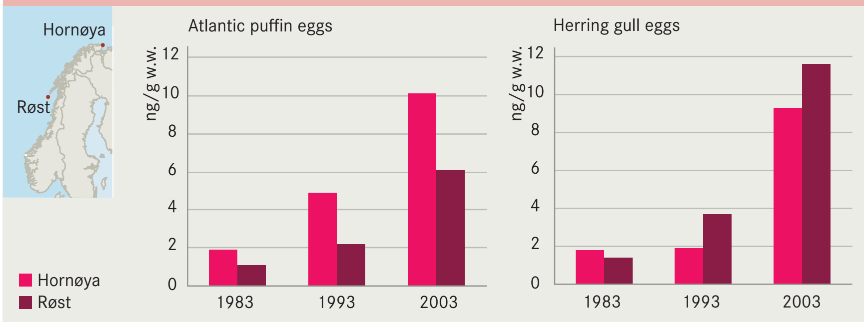
There continues to be a clear decreasing gradient in lindane deposition with increasing distance from mainland Europe. By 2007, deposition in the southern North Sea, for example, was up to 50 times lower than in 1997, but levels were still well above background.



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.

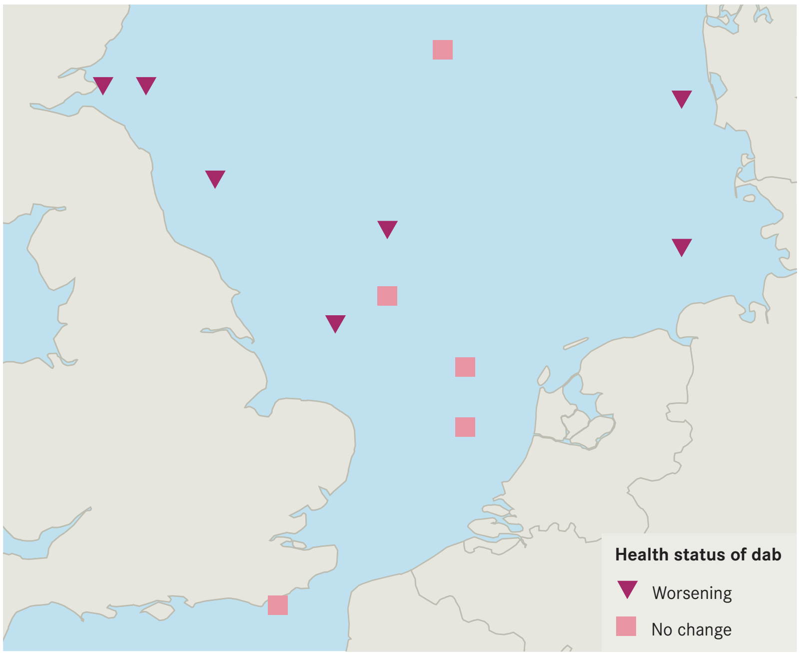
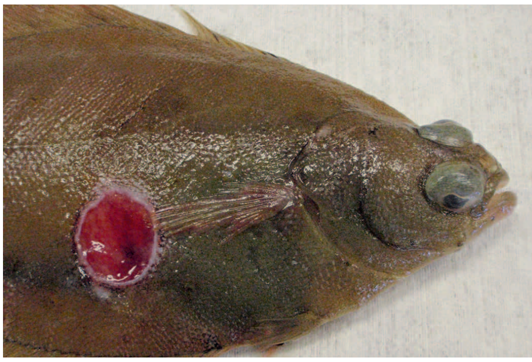


FIGURE 5.4 *Changes in the health status of dab in the North Sea in the period 2002–2007 compared to the period 1992–2001 based on the trial of a fish disease index. This involves the occurrence of various external disease symptoms, infections caused by external parasites and visible growth of liver 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.

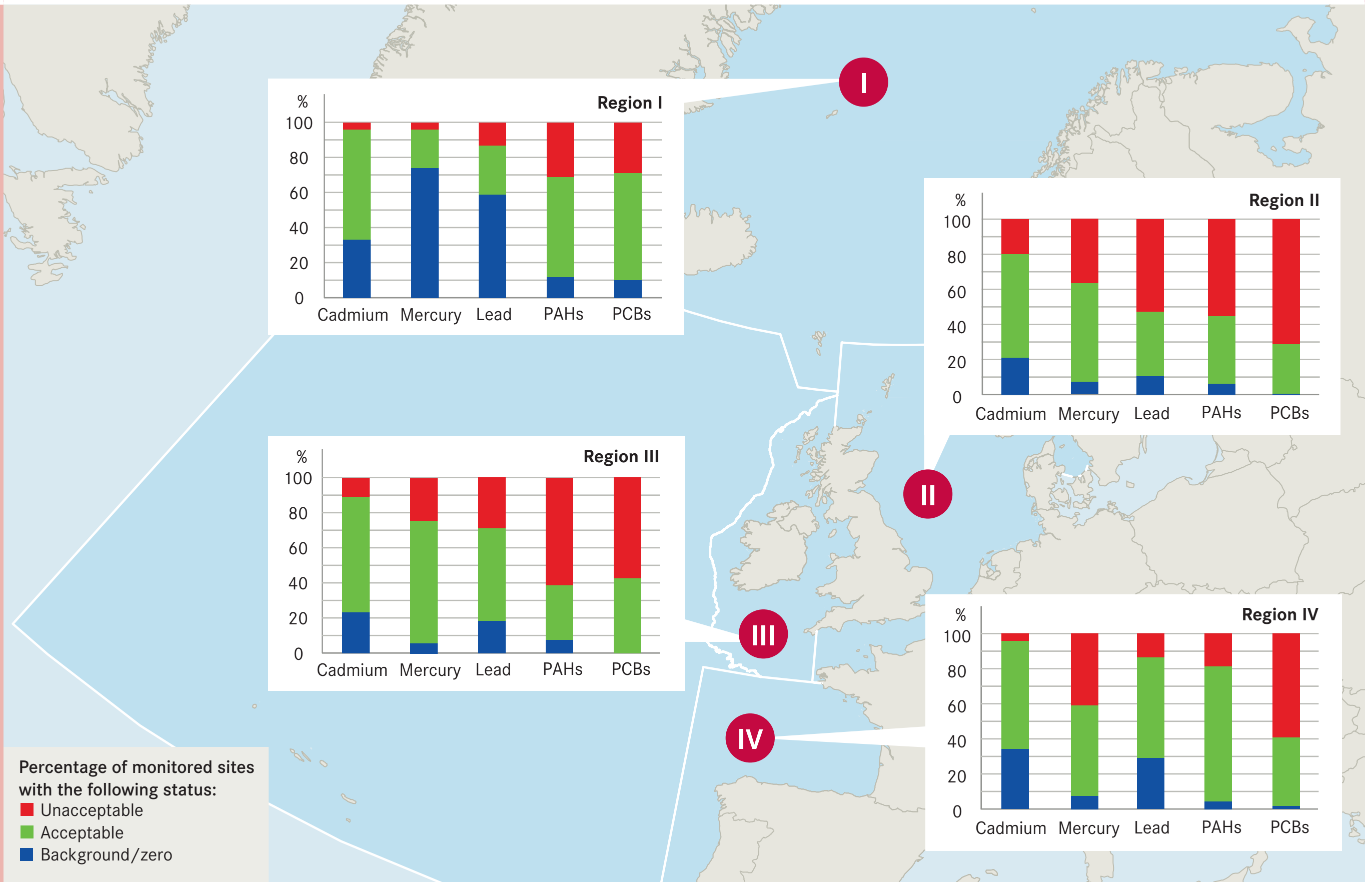
Emerging problems from substitute chemicals

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