OSPAR
COMMISSION

Status and trend of marine chemical pollution

Hazardous Substances Series

2009

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.

Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, la Finlande, la France, l'Irlande, l'Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d'Irlande du Nord, la Suède et la Suisse et approuvée par la Communauté européenne et l'Espagne.

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Executive Summary

Cessation target in reach for a third of OSPAR priority chemicals

Measures at OSPAR, EU and international level have contributed to decreasing pressures from chemical pollution over the past 20 years. A third of OSPAR's 26 priority (groups of) chemicals which pose a risk to the marine environment are expected to have been phased out by 2020 if current efforts continue. These include six pesticides, SCCPs, TBT, nonylphenol/ethoxylates and two brominated flame retardants (decaBDE, pentaBDE). For all other priority chemicals, additional action is needed to progress toward the OSPAR 2020 target of cessation of their releases to the environment.

Chemical contamination still a problem in the OSPAR Regions

Concentrations of heavy metals (cadmium, lead and mercury) and organic pollutants (PAHs and PCBs) in sediment, fish and shellfish have decreased but remain unacceptably high in many, mostly coastal areas especially in Region II (Greater North Sea), Region III (Celtic Seas) and Region IV (Bay of Biscay/Iberian Coast), with risk of pollution effects for marine organisms. The continuous phase-out of TBT in antifouling paints for ships has resulted in a clear decrease of pollution effects on marine snails, but problems persist over large parts of the OSPAR area, in particular in vicinity of harbours.

Contamination with persistent organic pollutants such as PCBs, SCCPs, PFOS and brominated flame retardants is widespread and their long-range air transport to the OSPAR area, especially Region I (Arctic Waters), is of concern. There is no OSPAR monitoring in Region V (Wider Atlantic) and an assessment of this Region has not been made. There is however scientific evidence that contaminants such as TBT, PCBs and brominated flame retardants find their way into the deep-sea food web.

Further actions needed to reduce chemical pollution

Further efforts are needed to move toward the OSPAR cessation target 2020 for many of the priority chemicals. This includes strengthening the implementation of existing measures, especially of the EU IPPC Directive, Water Framework Directive and its daughter directive, and the Marine Strategy Framework Directive. Abatement at source is still important and should continue and improve; especially emissions of PAHs from combustion of fossil fuels such as coal need to reduce. OSPAR should work with the EU on further actions on secondary sources (*e.g.* of lead and mercury) and uses in products not yet regulated (*e.g.* di-substituted organotins, HBCD). For some chemicals more information about their releases and impacts are needed to direct further action.

There is a general need for improved data on production and use, trends in discharges, emissions and losses, and occurrence in the environment to track progress.

Global actions required to reduce widespread pollution with persistent organic pollutants

Priority chemicals can reach the North-East Atlantic through waste streams of imported goods and through atmospheric deposition. Atmospheric transport is an important pathway to the OSPAR area for persistent organic pollutants and other chemicals such as mercury and other heavy metals and PAHs. With industrial development in other parts of the world, *e.g.* Asia, it is expected that atmospheric transport of those chemicals, in particular PAHs, may increase in future.

OSPAR should support the UNEP initiative for a global legally binding instrument to control and reduce mercury releases, and actions in UNEP (Stockholm POPs Convention) and UNECE (LRTAP Convention) to include in their legal frameworks additional persistent organic pollutants (*e.g.* decaBDE, SCCP, HBCD) for elimination.

Understanding of the effects of hazardous substances needs improving

OSPAR countries have not yet implemented a fully coordinated biological effects monitoring programme. While progress has been made in standardising reference methods for biological indicators, it is not yet possible in most cases to link the 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. Efforts on biological effects monitoring and assessment should therefore continue and be enhanced, also in relation to combined effects on ecosystem function.

Since the Quality Status Report 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. There is urgent need to progress on dealing with endocrine disruptors.

Lessons learnt for future monitoring and assessment

The Coordinated Environmental Monitoring Programme (CEMP) has provided well tested, quality assured methodologies and standards for environmental monitoring which are suitable to support evaluation of good environmental status under the Marine Strategy Framework Directive and good chemical status under the Water Framework Directive. Future assessment and monitoring under the CEMP need to be supported by extending data sets further offshore beyond highly impacted coastal areas and a coordinated and expanding contaminant coverage of the OSPAR monitoring programmes; improved understanding of the effects of hazardous substances, particularly cumulative effects; and improved information collection on the production, uses and various pathways to the marine environment, especially for substances which are not candidates for environmental monitoring.

OSPAR’s work on identifying chemical threats should continue in partnership with the EU

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 continue to focus on substances posing risks to the marine environment that are not yet adequately covered by the EU and by other appropriate international bodies. Continued cooperation with industry is important.

OSPAR should continue to actively generate 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 REACH and other relevant EU legislation to reduce releases of these substances from products and wastes and control risks for the marine environment.

Récapitulatif

L'objectif de cessation est réalisable pour un tiers des produits chimiques prioritaires OSPAR

Les mesures prises au niveau d'OSPAR, de l'UE et international ont contribué à une diminution des pressions exercées par la pollution chimique au cours des vingt dernières années. On prévoit qu'un tiers des 26 (groupes de) produits chimiques prioritaires OSPAR qui présentent un risque pour le milieu marin seront progressivement abandonnés d'ici 2020 si on continue les efforts actuels. Il s'agit notamment de six pesticides, SCCP, TBT, nonylphénol/éthoxylates et deux retardateurs de flamme bromés (decaBDE, pentaBDE). Des mesures supplémentaires sont nécessaires pour tous les autres produits chimiques afin de progresser dans le sens de l'objectif d'OSPAR de cessation en 2020 en ce qui concerne leur décharge dans l'environnement.

La contamination chimique pose toujours des problèmes dans les Régions OSPAR

Les teneurs de métaux lourds (cadmium, plomb et mercure) et de polluants organiques (HAP et PCB) dans les sédiments, le poisson et les mollusques ont diminué mais leur niveau est toujours élevé de manière inacceptable dans de nombreuses zones, essentiellement côtières, en particulier dans la Région II (Mer du Nord au sens large), la Région III (Mers celtiques) et la Région IV (Golfe de Gascogne/côtes ibériques), ce qui risque de présenter des risques de pollution pour les organismes marins. L'abandon progressif de l'utilisation du TBT dans les peintures antisalissure pour les navires a entrainé une diminution nette des effets de la pollution sur l'escargot de mer mais des problèmes persistent dans des parties étendues de la zone OSPAR, en particulier à proximité des ports.

La contamination par des polluants organiques tels que les PCB, les SCCP, le PFOS et les retardateurs de flamme bromés est étendue et leur transport à longue distance vers la zone OSPAR, en particulier dans la Région I (Eaux arctiques), cause des préoccupations. OSPAR ne réalise aucune surveillance dans la Région V (Atlantique au large) et aucune évaluation de cette région n'a été effectuée. Il existe cependant des preuves scientifiques que des contaminants tels que le TBT, les PCB et les retardateurs de flamme bromés pénètrent la chaine alimentaire des eaux profondes.

Il est nécessaire de prendre des mesures supplémentaires afin de réduire la pollution chimique

Des efforts supplémentaires sont nécessaires afin de progresser dans le sens de l'objectif OSPAR de cessation de 2020 pour de nombreux produits prioritaires. Il s'agit notamment de renforcer la mise en œuvre des mesures existantes, en particulier de la Directive IPPC, de la Directive cadre sur l'eau et de sa directive fille, et de la Directive cadre de stratégie marine de l'UE. Une réduction à la source est encore importante et devrait se poursuivre et être améliorée, il faut réduire en particulier les émissions de HAP provenant de la combustion de combustibles fossiles. OSPAR devra coopérer avec l'UE en ce qui concerne les mesures futures relatives aux sources secondaires (par exemple le plomb et le mercure) et l'utilisation de produits ne faisant pas encore l'objet d'une réglementation (par exemple organostanniques disubstitués, HBCD). Il est nécessaire d'obtenir des informations supplémentaires pour certains produits chimiques afin de pouvoir prendre de nouvelles mesures.

Il est nécessaire, dans l'ensemble, d'obtenir de meilleures données sur la production et l'exploitation, les tendances des rejets des émissions et des pertes et la présence dans l'environnement afin de suivre les progrès réalisés.

Il est nécessaire de prendre des mesures universelles afin de réduire la pollution étendue causée par les polluants organiques persistants

Les produits chimiques prioritaires peuvent pénétrer l'Atlantique du Nord-est par les jets de rebus provenant des produits importés et par les retombées atmosphériques. Le transport atmosphérique représente une voie de pénétration importante, dans la zone OSPAR, des polluants organiques persistants et autres produits chimiques tels que le mercure et autres métaux lourds et HAP. On peut s'attendre à l'avenir à une augmentation éventuelle du transport atmosphérique de ces produits chimiques, en particulier des HAP, du fait du développement industriel dans d'autres parties du monde, en Asie par exemple.

OSPAR devrait soutenir l'initiative du PNUE, à savoir un instrument global juridiquement contraignant permettant de contrôler et de réduire les rejets de mercure, et les mesures du PNUE (Convention de Stockholm sur les POP) et de la CENUE (Convention LRTAP) afin d'inscrire dans leurs cadres juridiques des polluants organiques persistants supplémentaires (par exemple decaBDE, SCCP, HBCD) dans le but de leur élimination.

Il faut mieux comprendre les effets des substances dangereuses

Les pays OSPAR n'ont pas encore mis en œuvre un programme de surveillance des effets biologiques complètement coordonné. Il n'est pas encore possible, dans la plupart des cas, d'établir un lien entre la surveillance chimique et l'observation des effets sur les espèces de telle sorte que l'on puisse tirer des conclusions sur l'impact des contaminants sur le fonctionnement des écosystèmes au niveau régional, bien que des progrès aient été réalisés dans la normalisation des méthodes de référence des indicateurs biologiques. Il faut donc poursuivre les efforts quant à la surveillance et l'évaluation des effets biologiques et les augmenter en ce qui concerne les effets conjugués sur la fonction des écosystèmes.

L'amélioration des connaissances sur les teneurs de produits chimiques causant potentiellement des troubles endocriniens rejetés dans le milieu marin est faible depuis le Bilan de santé 2000. Des travaux récents ont mis en évidence la possibilité pour des substances synthétiques de perturber les systèmes immunitaires et la communication chimique entre les organismes. Les effets sur les systèmes hormonaux et reproductifs du poisson constituent encore l'aspect le mieux connu de la perturbation endocrinienne, bien que la recherche dans ce domaine soit en pleine expansion. Il est nécessaire de progresser de toute urgence dans ce domaine.

Leçons retenues en ce qui concerne la surveillance et les évaluations futures

Le Programme coordonné de surveillance continue de l'environnement (CEMP) offre des méthodologies et des normes bien testées et d'une qualité assurée pour la surveillance environnementale qui permettent d'étayer l'évaluation du bon état écologique dans le cadre de la Directive cadre de stratégie marine et le bon état chimique dans le cadre de la Directive cadre sur l'eau. Il faut étayer la surveillance et l'évaluation futures, dans le cadre du CEMP, en étendant les séries de données aux zones situées offshore au delà des zones côtières très impactées et en s'assurant que les programmes de surveillance OSPAR offrent une couverture coordonnée et en expansion des contaminants; en ayant de meilleures connaissances des effets des substances dangereuses, en particulier des effets cumulatifs, et en assurant un meilleur recueil d'informations sur la production, l'utilisation et les diverses voies de pénétration dans le milieu marin, en particulier pour les substances qui ne sont pas candidates pour la surveillance environnementale.

Les travaux d'OSPAR relatifs à la détermination des menaces chimiques devront se poursuivre en coopération avec l'UE

OSPAR a déterminé les menaces, que présente un éventail étendu de substances potentiellement préoccupantes pour le milieu marin, qui doivent être traitées dans le cadre d'un forum pertinent. OSPAR doit continuer à se concentrer sur les substances, présentant un risque pour le milieu marin, qui ne sont pas encore couvertes de manière adéquate par l'UE et autres organes internationaux pertinents. Il est important de poursuivre la coopération avec l'industrie.

OSPAR doit continuer à contribuer à la détermination, la sélection et le classement selon les priorités des substances dangereuses préoccupantes pour le milieu marin, dans le cadre de l'UE. OSPAR doit également promouvoir les mesures dans le cadre de REACH et d'autres législations pertinentes de l'UE afin de réduire les rejets de ces substances provenant de produits et de déchets et contrôler les risques pour le milieu marin.

1. Introduction

Chemical substances form an essential part of our everyday life. They can be naturally occurring, like trace metals in the Earth's crust, formed as unintended by-product of natural and human-induced processes, or synthesised specifically for use in various industrial process and consumer products. About 100 000 chemicals are on the EU market and around 30 000 of these have an annual production greater than 1 tonne per year. Some of these substances are hazardous and contaminate the marine environment, with harmful effects on marine life and ultimately human health via the food web.

The objective of the OSPAR Hazardous Substances Strategy is:

- to prevent pollution of the OSPAR maritime area by continuously reducing discharges, emissions and losses of hazardous substances and to make every endeavour to move towards the target of cessation of their releases by the year 2020 (the "cessation target");
- ultimately, to achieve concentrations in the marine environment near background values for naturally occurring substances and close to zero for man-made synthetic substances.

This report evaluates the development of the quality status of the OSPAR maritime area and its Regions in relation to hazardous substances and progress made since OSPAR's last holistic Quality Status Report (QSR) 2000 towards achieving the objectives of the OSPAR Hazardous Substances Strategy. The QSR 2000 identified the implementation of OSPAR's Strategy on hazardous substances as one of the top priorities, in particular concerning organotin antifouling treatments and the newly developing concerns about endocrine disruptors (OSPAR, 2000).

This report has been prepared under the OSPAR Joint Assessment and Monitoring Programme and is a key contribution to the Quality Status Report 2010. The assessment emphasises status and trends since 1998 (cut-off year for the QSR 2000) of pollution caused by hazardous substances in the marine environment of the OSAPR maritime area and its five Regions (Figure 1.1).

The report summarises the evaluation of status and trend in data and information collected through the monitoring strategies for each of the substances in open use on the OSPAR list of chemicals for priority action ("priority chemicals"). It builds on detailed assessments prepared under the Joint Assessment and Monitoring Programme relating to data collected on emissions, discharges and losses, waterborne and atmospheric inputs and concentrations and effects in the marine environment of OSPAR priority chemicals (Box 1). This includes in particular the data collected and assessed under the three OSPAR monitoring programmes are:

- Coordinated Environmental Monitoring Programme (CEMP)
- Comprehensive Atmospheric Monitoring Programme (CAMP)
- Comprehensive Study on Riverine Inputs and Direct Discharges (RID)

Box 1

Electronic navigator to complementary QSR assessments and documentation on hazardous substances

- ➥ Towards the cessation target (OSPAR, 2008a)
- ➥ Trends in atmospheric concentrations and deposition (OSPAR, 2009a)
- ➥ Trends in waterborne inputs (OSPAR, 2009b)
- ➥ Trends and concentrations in sediments and biota (OSPAR, 2009c)
- ➥ Complementary national environmental monitoring (Annex 2 to this report)

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Together with the detailed assessments the present report provides the science basis on the chemical status of the OSPAR area for the Quality Status Report 2010 and supports the national initial assessments of OSPAR countries to which the commitments of the Marine Strategy Framework Directive (2008/56/EC) apply.

The assessment aims to address the following assessment questions of the Joint Assessment and Monitoring Programme for the five OSPAR Regions (Figure 1.1):

- What are the concentrations in the marine environment of the substances on the OSPAR list of chemicals for priority action ("priority chemicals")? Are they at background levels for naturally occurring substances and close to zero for man made substances?
- For the individual priority chemicals, what are the sources, what are the levels of discharges, emissions and losses, and what are the pathways to the marine environment? Are the discharges, emissions and losses of these substances to the marine environment decreasing, and are they moving towards the target of cessation by 2020?
- Are there any problems emerging related to the presence of hazardous substances in the marine environment? In particular, are any unintended/unacceptable biological responses, or unintended/unacceptable levels of such responses, being caused by exposure to hazardous substances?

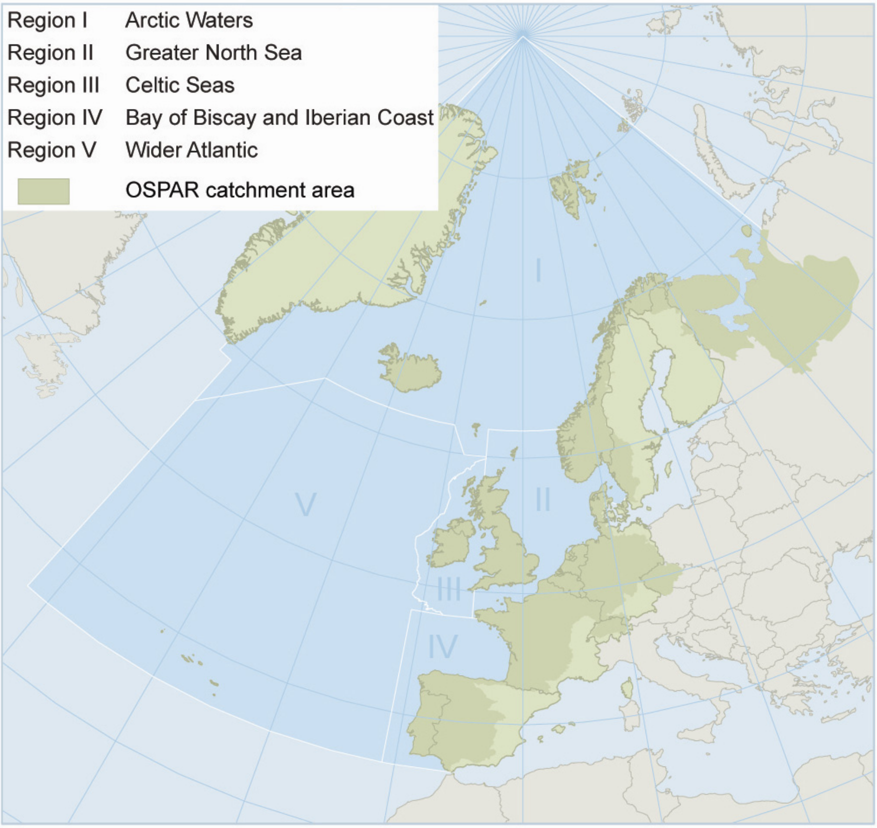


***Figure 1.1**: For assessment purposes, the OSPAR area is divided into five Regions. The Contracting Parties co-operating under the OSPAR Convention to protect the marine environment of the North-East Atlantic are Belgium, Denmark, France, Finland, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the European Union.*

2. Contamination with hazardous substances

Hazardous substances are found in sea water, sediments and marine organisms. In marine areas near heavily populated and industrialised areas, concentrations have been measured in sediment and organisms which are at levels that pose a risk to marine life and to humans consuming seafood. Effects on marine life from the presence of hazardous substances have also been observed such as incidence of fish disease.

Once released to the environment, hazardous substances may end up in the sea water and sediments, accessible for uptake by living organisms. Unwanted effects of hazardous substances include harm to organisms in the lower level of the food chain, such as plankton and invertebrates. Through the food web concentrations of some chemicals are magnified and result in high exposure levels for top predators like seabirds and marine mammals and for seafood consumers. Hazardous substances have a wide range of sublethal effects on living organisms, where even low concentrations interfere with the hormone and immune system and reproduction processes. Biological effects can extend beyond individual marine organisms to a whole population with adverse consequences for species composition and ecosystem structures. Marine organisms are exposed to many hazardous substances at a time. Several hazardous substances can interact with each other. The consequences are often difficult to predict.

2.1 The contaminants

There is a steadily increasing number of chemical substances on the market. Since 1998, the OSPAR Hazardous Substances Strategy requires a systematic approach to identify the substances that may be hazardous and pose a risk for the marine environment (Box 2). This includes persistent, bioaccumulating and toxic (PBT) substances as well as highly active compounds which exert a more delicate impact by disrupting ecological and biological processes at low concentrations. OSPAR currently lists over 300 substances as of possible concern for the marine environment. The focus has been on 26 of the 40 (groups of) substances presently prioritised for action because of their risk for the marine environment (Table 2.1). For each of these 26 priority (groups of) chemicals, a Background Document evaluates what the problem is in terms of their intrinsic properties, sources and pathways, and their occurrence and effects in the marine environment. It also identifies the priorities for action to meet the cessation target, and sets out the best strategies to monitor progress towards the OSPAR objectives.

Box 2

Selection and prioritisation of hazardous substances

The OSPAR dynamic selection and prioritisation mechanism for hazardous substances (DYNAMEC) has provided the tool to list substances of possible concern for the marine environment and to prioritise those which need to be tackled first. DYNAMEC is mainly based on the evaluation of substances' intrinsic properties, using agreed OSPAR cut-off values for persistence (P), bioaccumulation (B) and toxicity (T). A substance not meeting all PBT criteria may still give rise to an equivalent level of concern justifying selection and prioritisation based on considerations, such as widespread occurrence in the marine environment and observed adverse effects on marine organisms. An example of the latter is endocrine disruption caused by substances which mimic hormones and interfere with hormone-controlled processes. Methods to systematically test substances for endocrine disruption are still under development, for which OECD and the EU have taken the lead. Since 2004, OSPAR has stalled a systematic review of chemicals to identify priorities for action in light of similar work in the EU, but retains the option to work on substances of concern which are not covered by the EU framework. A recent screening of the OSPAR substances of possible concern will help OSPAR to focus review on those substances in open use which are presently not covered by the EU. OSPAR has continuously taken into account new information on selected substances. As a result, a number of substances have been removed from the OSPAR lists.

➥ *OSPAR List of Chemicals for Priority Action (OSPAR, 2004a)*

➥ *OSPAR List of Substances of Possible Concern (OSPAR, 2002)*

Table 2.1 OSPAR priority chemicals, key sources and main regulatory actions

● covered by regulatory framework; ⊙ one or more individual substances of a group covered by regulatory framework;
○ group or individual substance under review for inclusion in regulatory framework. Cf. Table 3.1 for reference to instruments.

OSPAR priority chemicals (click on substance to link to the Background Document.; updates are available on **http://www.ospar.org**)		Key sources	OSPAR measures		EU legislation						International instruments		
			BAT/ BEP	Use restriction	Pollution control: IPPC/ EPER	Use restrictions			Water quality: WFD priority	UNECE LRTAP POP and HM Protocol	UNEP Stockholm POPs Conv.	Rotterdam PIC Conv.
						Marketing/use	Biocide	Pesticide				
Metals	Cadmium	Metallurgic processes, fossil fuel	●	●	●	●			●	●		
	Lead and organic lead compounds	Mining, petrol	●		●	●			●	●		
	Mercury and organic mercury compounds	Metallurgic industry, fossil fuel, incineration, chlor-alkali industry, dental amalgam	●	●	●	●		●	●	●		●
Organometals	Organic tin compounds	Antifoulants, consumer products, polymer industry	●	●	⊙	⊙	⊙	⊙	⊙			⊙
Organohalogens	Short-chain chlorinated paraffins	Rubber working plants, products, waste streams		●		●			●	○	○	
	Perfluorooctane sulphonates (PFOS)	Industrial applications, waste streams				●			○	○	●	
	Polychlorinated dibenzodioxins and dibenzofurans (PCDDs, PCDFs)	Incineration	●		●	●			○	●	●	
	Polychlorinated biphenyls (PCBs)	Industrial products, oils, legacies		●	●	●			○	●	●	●
	Certain brominated flame retardants	Manufacture, products, waste streams			⊙	⊙			⊙	⊙	⊙	
	Tetrabromobisphenol-A	Polymer industry, products, wastes										
	Trichlorobenzenes	Industrial processes			●	●			●			
Pesticides/biocides	Endosulfan	Pesticides, biocides, industrial processes, legacies					●	●	●	○	○	
	HCH isomers				●	●	●	●	●	●	●	●
	Dicofol							●	○	○		
	Methoxychlor							●				
	Pentachlorophenol (PCP)				●	●		●	●	○		●
	Trifluralin				●			●	●	○		
Phenols	2,4,6-tri-*tert*-butylphenol	Industrial processes, Oil production										
	Nonylphenol / Nonylphenol-ethoxylates	Industrial applications, products, oil production		●	●	●		●	●			
	Octylphenol	Industrial applications, products, oil production			●	●			●			
Phthalates	Dibutylphthalate (DBP), diethylhexyl-phthalate (DEHP)	Polymer industry, products			⊙	●			⊙			
Polycyclic aromatics	Polycyclic aromatic hydrocarbons (PAHs)	Oil production, fossil fuel	●	●	⊙	●		⊙	⊙	●	●	
Pharmaceuticals, personal care, and other substances	Clotrimazole	Domestic and hospital waste water										
	Musk xylene	Domestic waste water				●			○			
	4-(dimethylbutylamino) diphenylamin (6PPD)	Abrasion from products (tires)										
	Neodecanoic acid, ethenyl ester	Paints, coatings, adhesives				●						

2.2 The sources and pathways

The OSPAR Convention area includes many of the major industrial and population centres in western Europe, where a high proportion of the releases of contaminants occur through emissions to air, discharges to water or as losses during the life cycle of products or run-off from land (Figure 2.1). Contamination can also result from sea-based activities such as mariculture (OSPAR, 2009d). Offshore oil and gas activities (OSPAR, 2009e) and shipping (OSPAR, 2009f) contribute to releases through operational discharges and losses and accidental spills of hazardous substances to the sea. Historic pollution of river, estuarine and marine sediments can act as a continued source for releases, especially where sediments are disturbed and displaced, *e.g.* where they are dredged from rivers and estuaries to improve navigation and are disposed of at sea.

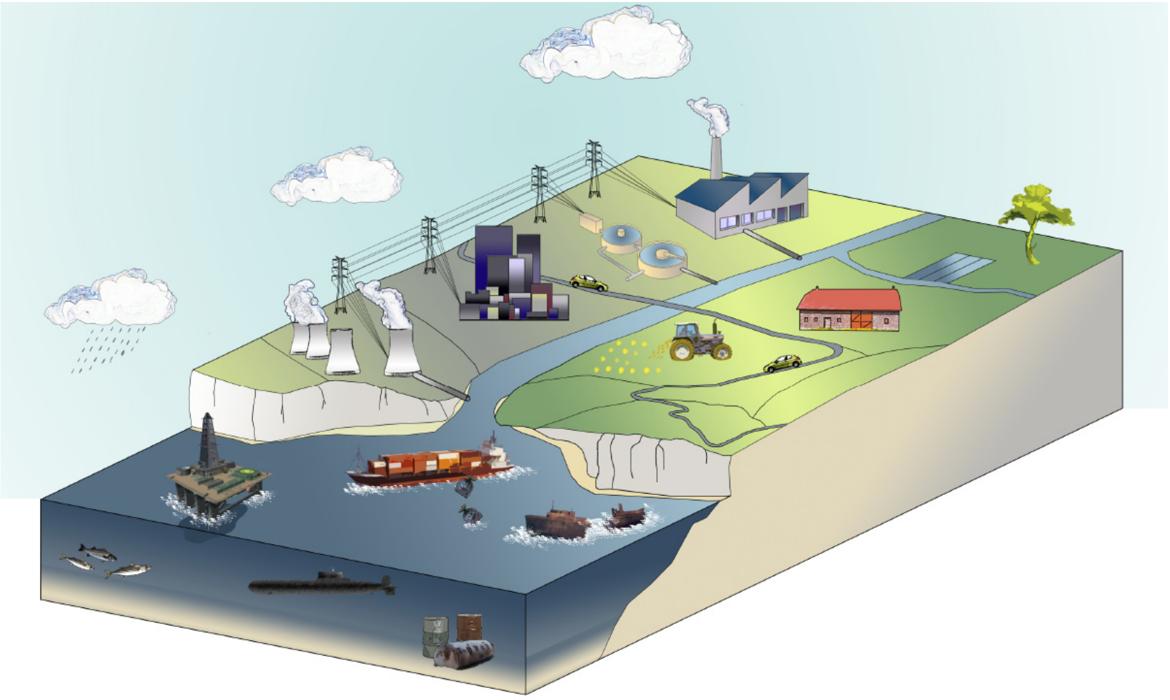


Figure 2.1: *Examples of sources of releases of hazardous substances and their pathways to the marine environment*

The problems of chemical contamination vary between and within the OSPAR Regions depending on the dominant sources and the different pathways of the hazardous substances to the sea. Waterborne hazardous substances enter the sea directly, for example through a sewage or industrial discharge, or are transported to the sea by rivers, which collect inputs from inland sources within the river catchment. This is an important pathway for contaminants to the Greater North Sea (Region II), Celtic Seas (Region III) and Bay of Biscay/Iberian Coast (Region IV).

Atmospheric transport, with contaminants reaching the sea through deposition, is an important pathway for volatile and semi-volatile substances and substances released as a result of combustion (*e.g.* particles) (Box 3). This is a dominant pathway for contaminants to the Arctic Waters (Region I) and Wider Atlantic (Region V) which are remote from the main pollution sources. Some hazardous substances are transported long distances by air from their emission sources, including from sources outside the OSPAR area, before they are deposited on the North-East Atlantic.

Warming of the atmosphere in response to climate change may increase the tendency for atmospheric transport of certain substances, more rain and floods can result in higher run-off from land and increased storminess may lead to additional remobilisation of contaminants from marine sediments.

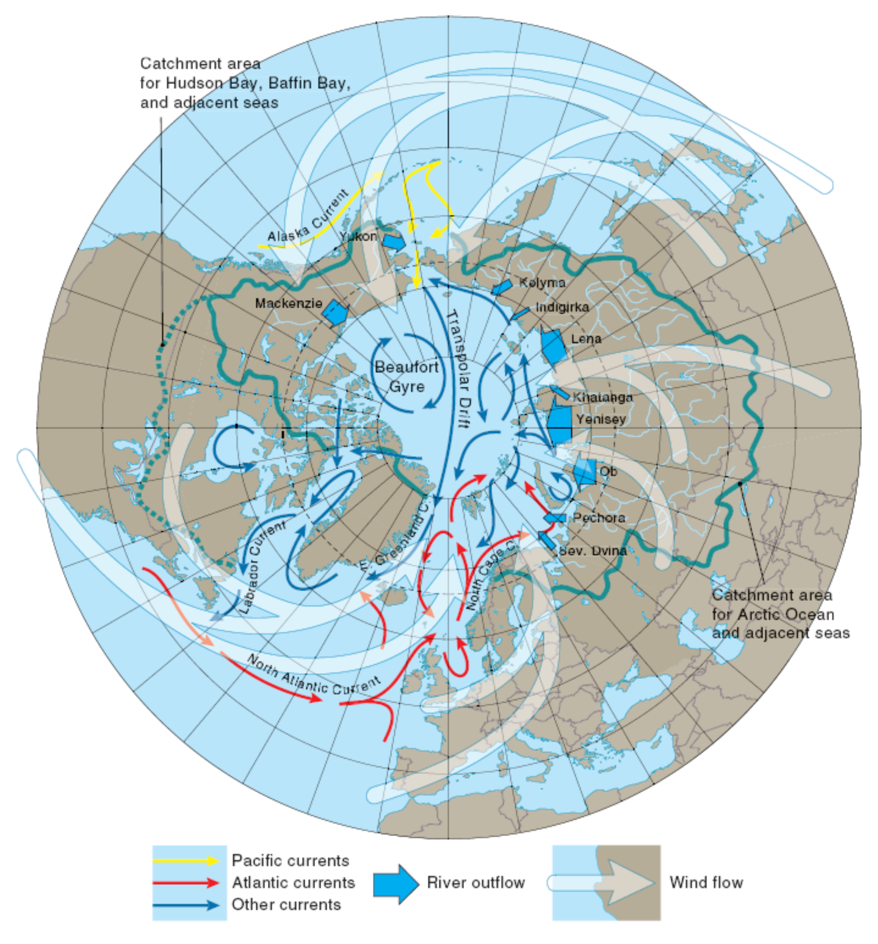
Box 3

Long-range transport of hazardous substances

Several OSPAR priority chemicals show a similar tendency for long range transport, either through air, water or via biological pathways, leading to concern for contamination of areas remote from pollution sources. Global cooperation on those substances is therefore essential to support OSPAR's objectives.

Some of the OSPAR priority chemicals are volatile or semi-volatile making air the most important transport way. These include mercury and PAHs from combustion sources, pesticides (*e.g.* lindane) used in agriculture and other persistent organic pollutants (POPs) which hardly degrade in the environment, for example PCBs, brominated flame retardants and PFOS. The substances can be picked up in temperate regions as gases and are carried by air streams northwards. When temperatures drop they condense onto atmospheric particles and reach surface waters by precipitation (*e.g.* rain, snow) or dry deposition. They are found widely distributed in the marine environment across the world, including remote areas in the Arctic. Most of the contaminants in the Arctic come from sources outside the Region, in particular the industrialised areas of Europe, North America, and Asia (Figure below; source: AMAP, 2004). Many of the POPs are trapped by the stable conditions of the Arctic winter climate where they are deposited on the open sea, ice and land.

The problem of long-range transport is not confined to Region I, but atmospheric inputs supply relevant amounts of contaminants in Regions II, III, IV and V. Transport of contaminants by ocean currents is slower than by air, but can be an important pathway for non-volatile contaminants that remain in the water phase or bind to sediments.



3. Preventing pollution

OSPAR's work to prevent and reduce pollution has shifted from targeting industrial and diffuse sources of pollution to an increased focus on actions for the hazardous substances identified for priority action. OSPAR co-operates with industry and international organisations, for example the European Union (EU) and the Organisation for Economic Co-operation and Development (OECD), to identify substances of concern and promote programmes and measures to tackle the problems hazardous substances pose to the marine environment.

3.1 Priorities for action

More than 60 OSPAR Recommendations and legally binding Decisions regulate industrial sectors and substances

During the 1980s and 1990s, OSPAR worked to prevent and reduce pollution of the marine environment by addressing the main point and diffuse sources of contaminants (OSPAR, 2008a). More than 60 OSPAR Recommendations and legally binding Decisions commit OSPAR countries to implement best available techniques, best environmental practices and to achieve emission and discharge limit values in various industrial sectors (Box 4). These include the prescription of BAT for major industrial pollution sources for heavy metals, organohalogens and PAHs: large combustion plants; manufacturing of iron, steel, aluminium, textiles, chlorine, pharmaceuticals, organic chemicals, pulp and paper, and vinyl chloride; and the refining of crude oil in refineries. Further OSPAR measures target diffuse pollution sources by committing OSPAR countries to phase-out, or restrict the uses of hazardous substances. Examples include the phase-out of: TBT as antifoulant in paints for seagoing ships and underwater structures: PAH containing coal tar on ships; nonylphenol in domestic and industrial cleaning products; and short-chained chlorinated paraffins in metal and leather working fluids and as plasticiser and flame retardant in main applications.

Box 4

Best Available Techniques (BAT)

BAT refers to the use of the latest stage of development (state of the art) of processes, facilities and methods of operation which are suited to reduce discharges, emissions and waste. OSPAR has pioneered this concept internationally and adopted a large number of Recommendations and Decisions prescribing BAT for various industrial technologies and major pollution sources. BAT is a dynamic concept which develops with economic, scientific and technological advances. With the development of BAT descriptions under the EU IPPC Directive (2008/1/EC) for the main pollution sectors covered by OSPAR work, OSPAR has not recently updated its measures, but gave priority to contributing to EU work. This ensures that one set of BAT applies in Europe which takes into account concerns for the marine environment and forms the basis for formulating conditions for environmental permits. For existing installations, the deadline for issuing and complying with IPPC permits was October 2007 but implementation was still ongoing in most OSPAR countries in 2008.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In the last ten years, OSPAR countries have continued to report periodically on legal, regulatory and other efforts to implement OSPAR measures and on their effectiveness. This reporting provides evidence that the requirements of OSPAR measures have been broadly implemented across OSPAR. In many cases this has been supported by the implementation of similar EU legislation.

Most recent actions have been taken in partnership with the EU and other international organisations

OSPAR's focus has been directed in recent years to ensuring that hazardous substances which have been identified to pose a risk for the marine environment are adequately addressed either through OSPAR or other international frameworks. Increasingly, the EU has covered the field of OSPAR's work on hazardous substances and has developed into the main driving force for action by OSPAR countries that are member states of the EU and the European Economic Area.[1]

Through the Integrated Pollution Prevention and Control (IPPC) Directive (2008/1/EC), the EU has addressed since 1996 the main polluting sources originally covered by OSPAR measures (Table 2.1). The EU's chemicals policy together with water, air and waste legislation provides a comprehensive framework to target risks of hazardous substances for the environment and human health. OSPAR's work has shifted towards promoting actions within the EU that complement OSPAR's objectives (Table 3.1). Recent examples of measures promoted are marketing and use restrictions for mercury (measuring devices), phthalates in toys and for all main uses of perfluorooctance sulphonates.

OSPAR has also supported recent global actions to reduce or eliminate emissions of priority chemicals which can be transported by air, water and marine organisms from other parts of the world to the North-East Atlantic or are imported as substances or in products into the OSPAR Convention area (Table 3.1). These actions are important to achieve progress towards the cessation target for several priority chemicals.

Table 3.1: *Selected international and EU instruments complementary to OSPAR objectives.*

Instruments	**Means of controlling releases**
IPPC Directive (96/61/EC as codified in 2008/1/EC)	Permit requirements for installations Best Available Techniques Emission and discharge limits European Emission Pollution Release and Transfer Register
Use and Marketing Restrictions Directive (76/769/EEC, repealed by Annex VII of REACH Regulation)	Restrictions on the marketing and use of substances Risk assessment
Biocides Directive (98/8/EC)	Restrictions on the marketing and use of substances as biocides
Pesticides Directive (91/414/EC)	Restrictions on the marketing and use of substances as pesticides
REACH Regulation (EC No. 1907/2006)	Registration, evaluation, authorisation and restriction of chemicals
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 POPs Convention (adopted 2001/effective 2004)	Transboundary 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 (adopted 1998/effective 2004)	Control of international trade in certain hazardous substances Information exchange prior to import of pesticides and industrial chemicals

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[1] All OSPAR countries except Iceland, Norway and Switzerland are EU Member States. Iceland and Norway apply most of the relevant EU chemicals and environmental legislation through the Agreement on the European Economic Area. Switzerland has adopted national legislation following closely EU legislation.

3.2 Tracking progress

For each priority chemical OSPAR has agreed a monitoring strategy, which sets out the most efficient way of collecting data and information to track progress towards the OSPAR objectives (OSPAR, 2004b).

These include long-term environmental monitoring of selected priority chemicals in atmospheric and waterborne inputs and in the marine environment as part of OSPAR's Joint Assessment and Monitoring Programme, which provide the cornerstones of coordinated monitoring in the OSPAR area (Box 5). Monitoring methodologies and standards, including assessment procedures, have been continuously refined. Coverage of OSPAR priority chemicals by the monitoring programmes is however limited. Several OSPAR priority chemicals have only recently been included in the Coordinated Environmental Monitoring Programme (CEMP), others have not been deemed suitable for coordinated marine monitoring, for example where their characteristics make their widespread detection in the marine environment unlikely. For these, OSPAR countries have carried out a range of surveys and national environmental monitoring has been collected for use in the assessment (➥ *Annex 2*).

OSPAR environmental monitoring programmes are complemented by the collection of a wide range of data and information from Contracting Parties, industry and other international organisations such as the EU or the European Monitoring and Evaluation Programme (EMEP) to support the evaluation of progress towards the cessation target for priority chemicals. This includes information on the extent of use and production of substances, and on the implementation of measures to control releases which are used as proxies to judge trends in releases where no emission and discharge data are available.

The collected evidence for the priority chemical is generally insufficient to form a complete picture and the evaluation of the progress made towards the OSPAR objectives is based on expert judgement in many cases. An overview of data and information collected to provide the evidence for this assessment is given in Table A1 at Annex 1. A summary of overall progress towards the OSPAR objectives is given for each priority chemical at ➥ *Annex 1*.

Box 5

Coordinated monitoring provides evidence on progress towards our objectives

Coordinated Environmental Monitoring Programme (CEMP) – Started in 1998, the CEMP capitalises on the regional monitoring developed up to that point under the Oslo and Paris Commission's Joint Monitoring Programme and related ICES activities. Its purpose is to assess temporal trend and spatial distribution of concentrations of contaminants in sediment and biota, and biological effects. It focuses on monitoring cadmium, mercury, lead, PCBs, PAHs and TBT and is being extended to include brominated flame retardants, dioxins and PFOS. ➥ *CEMP Programme (OSPAR, 2009g)*

Comprehensive Atmospheric Monitoring Programme (CAMP) – First adopted in 1989, the programme covers monitoring at coastal stations of concentrations of selected contaminants – heavy metals and lindane and, on a voluntary basis, PCBs and PAHs – in precipitation and air. Its purpose is to assess their annual atmospheric inputs and long-term trends in inputs, and to provide validation data for atmospheric transport models. ➥ *CAMP Principles (OSPAR, 2001)*

Comprehensive Study of Riverine Inputs and Direct Discharges (RID) – Since 1990, the programme covers monitoring of riverborne and direct inputs of selected contaminants – heavy metals and lindane and, on a voluntary basis PCBs, PAHs and organohalogens – to the OSPAR area in order to determine the long-term trends of such inputs. The programme aims to monitor 90% of all waterborne inputs to the OSPAR area and to provide estimates for the remaining 10%. ➥ *RID Principles (OSPAR, 1998)*

4. Moving towards the cessation target

In general, emissions, discharges and losses of (groups of) OSPAR priority chemicals to the marine environment have decreased as a result of the measures taken over the past 20 years. However, evaluation of the progress towards the target of cessation of releases is difficult due to a lack of data, and OSPAR atmospheric and waterborne input trend monitoring is available for only a few selected substances. There is a general need for improved data on production and use, trends in discharges, emissions and losses, and occurrence in the environment. Best data coverage is for cadmium, lead, and mercury.

The information presented in this section results from regular monitoring of heavy metals under the OSPAR waterborne inputs (RID) and atmospheric (CAMP) monitoring programmes and the recent detailed assessment of data and information collected on sources, uses and releases of each OSPAR priority chemical. ➥ *Towards the cessation target (OSPAR, 2008a)*

4.1 Cessation target in reach for a third of priority chemicals

The phase-out of six pesticides (dicofol, endosulfan, lindane, methoxychlor, pentachlorophenol and trifluralin), short-chained chlorinated paraffins (SCCPs), nonylphenol/ethoxylates, the organic tin compound tributyltin (TBT) and of the two brominated flame retardants octa- and pentabrominated diphenyl ethers (BDEs) is well underway in the OSPAR area. Provided current efforts are continued, it is likely that the releases of these substances will have more or less ceased by 2020.

OSPAR countries had already made considerable progress in phasing out the pesticides identified by OSPAR for priority action by the end of the 1990s. By 2009, almost all uses of the six pesticides have effectively ceased under EU legislation. A period of grace for dicofol products expires in 2010.

The main uses of SCCPs in leather and metal working fluids have ceased and consumption volumes have dropped by 75% in the period 1998 – 2008. Nearly half of OSPAR countries have reported that the agreed OSPAR target of phasing out of all remaining uses of SCCPs as a plasticiser and flame retardant was achieved by 2004; other countries will use forthcoming EU measures as a basis for their own actions. A voluntary agreement with producers further contributes to the phase-out of SCCP in the OSPAR area.

Nonylphenol/ethoxylates were already nearly completely phased out in 1997 as cleaning agents in domestic products under PARCOM Recommendation 92/8. By 2005, significant reductions in industrial uses have been achieved, with four countries reporting a complete phase-out and further four countries reporting good progress towards the phase-out.

Following a European ban of TBT containing paints in 2003, the use of TBT in antifouling systems on sea-going vessels has been globally banned with effect from 2008 after entry into force of the 2001 International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS Convention), adopted in the framework of the International Maritime Organization. In practice, major shipping companies had started the phase-out of TBT in ship coatings already in 2001. Those measures and actions supplemented OSPAR and EU measures to prohibit use of TBT on small boats, aquaculture and underwater structures. OSPAR countries had reduced the use of TBT under PARCOM Recommendation 87/1. Other organotin compounds, including disubstituted organotins such as dibutyltin and dioctyltin, are still used in high volumes in consumer products and uses as stabilisers in plastic are expected to increase.

Of the diverse group of certain brominated flame retardants identified for priority action, octaBDE and pentaBDE have been banned in 2004 and it is expected that releases of those individual substances other than from products and wastes will more or less cease by 2020.

For all other priority chemicals further efforts are needed to move towards the cessation of their releases by 2020. This includes tightening up the implementation of existing measures. Where these measures are not addressing all existing sources, the scope for further action should be investigated.

Improved knowledge of the sources, releases and pathways of several priority chemicals is needed to direct further efforts to achieve the cessation target by 2020. ➥ *Table 6.1*

4.2 Point sources are well regulated and further progress in reducing releases is becoming more difficult

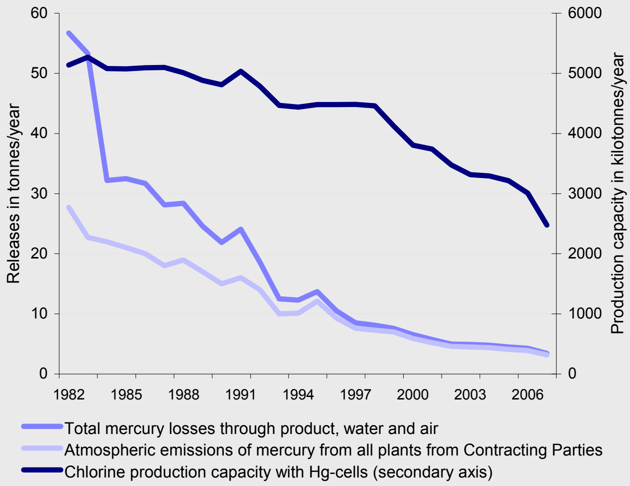
Over the past 20 years OSPAR, together with the EU, the UNECE and other international conventions, has made substantial progress in reducing releases of hazardous substances from point sources. The phase-out of old technologies and stringent pollution control measures have reduced releases from main industrial sources. Examples include the close-down of bleached kraft and sulphite paper mills which were important contributors of discharges of chlorinated organic substances in the OSPAR area.

Much of the reduction of some of the hazardous substances was achieved in the 1990s as a result of technological and regulatory advances. Since then, overall progress has slowed as industry is meeting emission and discharge limits and it is technically and economically more difficult to further reduce releases. For example, releases of mercury from the chlor-alkali industry decreased considerably and at a higher rate than the production capacity, but further progress will depend on the phase-out of mercury cell technology (Box 6).

Box 6

Mercury cells – an old technology still surviving

Mercury has been used for more than 100 years to produce chlorine (see mercury cell room in picture below). In the 1980's, the chlor-alkali industry was one of the main sources of mercury releases in the OSPAR area. Since the introduction of OSPAR Decision 90/3, aiming to phase-out mercury cells in the chlor-alkali industry and end associated pollution by 2010, emissions of mercury to air have declined by more than 90%, reaching 3.9 tonnes in 2007 (Figure below; source: OSPAR, 2009h). All 30 operating plants in the OSPAR Convention area (20 in the OSPAR catchment) comply with the key emission limit value of 2 g Hg/t and in many plants air emissions continue to fall. While overall emissions, discharges and losses halved since 1997, increases have been reported for some countries since 2004. The reasons for the increase are not yet known. In 2005, the chlor-alkali industry was still the main consumer of mercury (190 tonnes) in Europe. Old plants approaching the end of their economic lifetime may be closed in the near future or change to mercury free production processes to meet the requirements of the EU IPPC Directive (2008/1/EC). There is good progress towards the OSPAR target, but it will be difficult to see the phase-out fully achieved by 2010 unless considerable additional efforts are being made.



4.3 Most reductions in releases of heavy metals occurred before 2000

OSPAR measures have resulted in the reduction of mercury discharges from dentistry by 95% across the OSPAR area (Recommendation 93/2) and a significant decrease of air emissions from crematoria (Recommendation 2003/4). However, observations reported under OSPAR's atmospheric and waterborne input monitoring programmes and emission inventories reported to the European Monitoring and Evaluation Programme (EMEP) suggest that substantial reductions were achieved by industry in the 1990s, but that overall progress has slowed down over the past decade. There remains a need to address secondary sources, for example lead in ammunition and fishing equipment.

In 2007, air emission levels were still significant with around 900 tonnes for lead and around 40 tonnes each for cadmium and mercury (http://www.ceip.at/emission-data-webdab). Overall emission levels and associated model based estimates of atmospheric inputs of cadmium and mercury have remained relatively constant since 1998, but lead emissions have continued to decline up (Figure 4.1). Emissions have not been reduced to the same degree across all OSPAR countries and emission sectors. Available observations of concentrations of the heavy metals in precipitation for Region II and for lead in Region I are broadly consistent with trends in emissions and show a decrease of cadmium and lead concentrations of around 10% since 1998. While slightly increasing measurements of mercury in air at selected stations in the OSPAR area may be influenced by meteorological factors, the increase is sufficient reason to keep a close eye on these measurements in the future. ➥ *Trends in atmospheric concentrations and deposition (OSPAR, 2009a)*

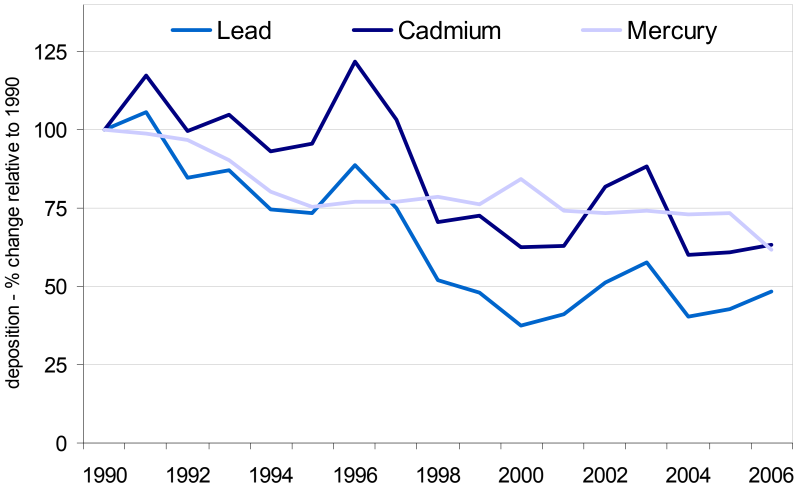


Figure 4.1: *The steep decrease of EMEP model estimates of lead and cadmium atmospheric deposition at the end of the 1990s follows European regulations banning lead in car fuels and restricting cadmium in batteries. Since then estimated deposition levels remained fairly constant. Source: OSPAR, 2009a*

Waterborne inputs show the same pattern as atmospheric deposition with less marked reductions since 1998 (Figure 4.2). Trends in the main catchments of the Greater North Sea show reductions in riverine inputs of 40% of cadmium from the Elbe, 70% of mercury from Rhine and Meuse and 90% of lead from the Seine which underlie the regional trends (Table 4.2). Direct discharges are the smaller part of the total waterborne inputs in most Regions and their inputs have significantly decreased since 1990.

Table 4.2: *Trends in riverine inputs 1990 - 2006*

Parameter	Region I	Region II	Region III
Cadmium	40% ↓	20% ↓	60% ↓
Lead	85% ↓	50% ↓	No trend
Mercury	No trend	75% ↓	85% ↓

➥ *Trends in waterborne inputs (OSPAR, 2009b)*

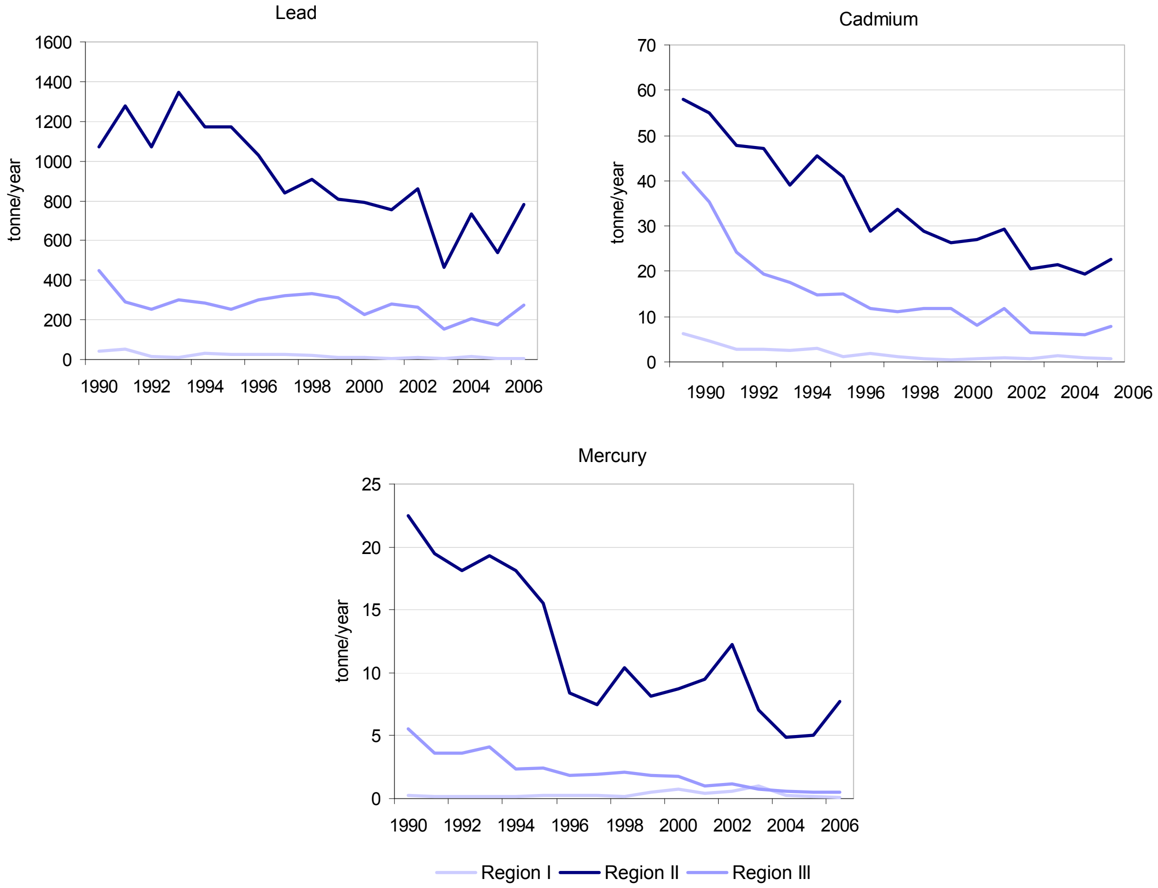


Figure 4.2: *Total waterborne inputs (riverine inputs and direct discharges) of most metals have substantially decreased since 1990 in Regions I, II and III. Statistically significant downward trends have been confirmed for riverine inputs in the period 1990 – 2006 for most heavy metals in Regions I, II and III (Table 4.2). Changing monitoring regimes for rivers in Region IV do not allow a trend analysis. Source: OSPAR, 2009b*

4.4 Combustion is a continued regional and global concern for unintentional releases of PAHs, dioxins and heavy metals

PAHs, dioxins and heavy metals are emitted to air as unintended by-products of burning of fuel and organic material. OSPAR and EU measures have targeted emissions from the main point sources: aluminium, iron and steel and refinery industry; combustion in power plants; waste incineration; domestic combustion *e.g.* coal stoves; road traffic and ship engines. Aluminium smelters, for example, were significant sources for emissions of PAHs to air and discharges to water. In 2007, the majority of facilities with old production technology in the OSPAR Convention area have been reported closed or changed to recommended techniques which prevent PAH generation and keep emissions below limit values (OSPAR, 2008b).

Progress towards cessation of releases of these substances requires further improvement and application of emission abatement technology in combustion processes, thus effective implementation of the IPPC Directive is particularly important. With increasing industrial development and energy consumption outside the OSPAR Convention area it is expected that external releases, especially of PAHs and mercury, become increasingly important and require global control.

Model calculations suggest that air emissions from combustion processes contributed between 70% and 90% to the atmospheric deposition of heavy metals in the five OSPAR Regions in 2005 (OSPAR, 2009a). Following the ban of lead in car fuels and the introduction of EU emission standards for cars, the relative importance of transport as an emission source for lead has drastically decreased. However, the transport sector as a whole continues to contribute around 17% to total lead atmospheric deposition to the OSPAR area. Waste is the second most important emission source for mercury contributing 13% to total mercury atmospheric inputs.

Air is an important pathway for PAHs. Overall air emissions of PAHs in the OSPAR area appear to have remained relatively constant in the last decade (ca. 1000 tonnes/yr) although accurate figures are not available.

Available inventories for dioxins reported to EMEP point to emissions having almost halved between 1998 and 2007 with a steady decline of releases from combustion in power plants, but no equivalent reduction in emissions from other industrial combustion processes.

4.5 Waste control gains importance for regulated substances

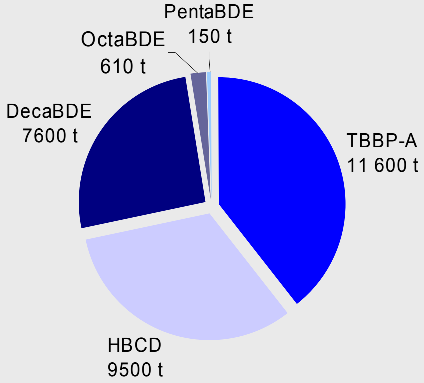
Even with the use of a number of OSPAR priority chemicals being restricted or being phased out, it will still take many years before releases from products containing these chemicals, either during their use or disposal (*e.g.* landfills), will cease, especially where the products concerned have long life cycles. Brominated flame retardants (Box 7) and PFOS are examples of groups of substances which have been used in high volumes and in a vast number of consumer products.

The importation of goods containing banned substances adds further to losses from wastes. Examples include imported textiles treated with lindane, nonylphenol or pentachlorophenol or wood treated with lindane.

Further action is needed to control losses of phased-out substances through the management of waste streams (*e.g.* waste (water) treatment, incineration, overflows, dredged material).

Box 7
Brominated flame retardants in waste streams

Brominated flame retardants are a group of bromine containing chemicals which have been very effective as flame retardants in plastics (for example computers) and textiles. The different substances have been gradually regulated. Octa- and penta-brominated diphenyl ethers (BDE) were banned in the EU in 2004, the use of polybrominated diphenyl ethers (PBDEs) and polybrominated biphenyls (PBB) in electrical and electronic appliances has been restricted since 2006. DecaBDE was exempted from this restriction until 2008 and is still widely used in Europe, mainly in polystyrene. DecaBDE and hexabromo-cyclododecane (HBCD) need more regulation and in anticipation of this industry has substantially reduced releases through voluntary actions.



The priority chemical tetrabromobisphenol-A (TBBP-A), which is expected to increasingly replace octaBDE in specific applications, was the most commonly used brominated flame retardant in the OSPAR Convention area in 2001 (see Figure on consumption of main brominated flame retardants; OSPAR, 2008a). No specific use regulations are in place for TBBP-A. Given its hazardous properties, releases and environmental concentrations, TBBP-A should be kept under review. Quantitative information on the use of brominated flame retardants and in wastes is however limited. A recent study estimates a total of 520 – 540 tonnes of brominated flame retardants in wastes in Norway in 2006, 90% of which has been attributed to waste electrical and electronic equipment. The study indicates that nearly 70% of brominated flame retardants escaping controlled collection systems (80 − 100 tonnes) relates to waste electrical and electronic equipment (OSPAR, 2008a). This suggests that the full implementation of the Waste Electrical and Electronic Equipment Directive (2002/96/EC) in the European Economic Area is vital for control of releases of PBDEs to the environment.

4.6 Information on releases of phthalates, clotrimazole, octylphenol and trichlorobenzenes is limited

Phthalates, clotrimazole, octylphenol and trichlorobenzenes are examples of priority chemicals which are suspected to disrupt hormone processes in organisms. Yet, very little monitoring has been in place to track releases.

Clotrimazole is a pharmaceutical fungicide which is mainly released via municipal and hospital sewage effluents (Box 8). Few measurements in effluents have been made.

The three priority phthalates – diethylhexylphthalate (DEHP), dibutylphthalate (DBP) and butylbenzyl phthalates (BBP) – are regulated under EU measures only in relation to selected consumer products (*e.g.* toys, child care products) and focus on human health. Estimates based on consumption figures suggest that in 2007 around 2000 tonnes of DEHP have been released to the environment in the EU.

Octylphenol, which is used in high volumes in the production of resins, also occurs as an impurity in nonylphenol. While the phase-out of nonylphenol/ethoxylates supports achieving the cessation target for octylphenol, use restrictions specific for octylphenol have only recently been proposed in the EU to address continued releases.

Production volumes of trichlorobenzenes in the OSPAR area have significantly decreased over the last decade. These chemicals are no longer used in articles that can result in dispersive emissions, but are still used in industry. Available information indicates that releases have gone down, but still continue.

Box 8

Releases and fate of pharmaceuticals in the marine environment need more attention

Attention given to the environmental fate and effects of pharmaceuticals, including veterinary medicines, in the marine environment has been limited. Worldwide studies indicate that a broad range of medicines – antibiotics, anti-cancer treatment, psychiatric drugs, anti-inflammatory, beta-blocker heart drugs *etc.* – are found in sewage and treated waste water and can reach the marine environment. Main sources are effluents from hospital and households and, for veterinary medicines, manure and run-off from land and direct applications in coastal waters on farmed fish. Although often found at trace concentrations in the aquatic environment, the properties of pharmaceuticals can affect the functions of marine organisms. Clotrimazole for example acts as a fungicide. Laboratory studies have shown its potential to block the metabolism of cytochrome P450, a large family of enzymes found in all life. A subset of these enzymes also has an important role in the synthesis of steroid hormones. Even low concentrations of clotrimazole can have adverse effects on enzyme functioning in marine organisms. Recent research results along the Swedish West coast suggest that the low observed levels of clotrimazole were sufficient to give rise to concern for risks of disturbance of growth and reproduction of single cell algae, the basis of the ocean's food chain (Porsbring *et al.,* 2009). Our knowledge about releases of pharmaceuticals like clotrimazole to the marine environment is very limited. There is a need to enhance the evidence base for releases of clotrimazole and other pharmaceuticals in the OSPAR area and their risk, individually and in combination with other contaminants, for marine life and ecology.

4.7 Shift in use patterns due to substitution – new problems emerging?

In many cases, phasing-out a chemical requires the introduction of a substitute. Often this is of benefit for the environment, but sometimes substitution can lead to new and unexpected problems. There is a need to investigate if such problems occur.

For example, medium-chained chlorinated paraffins (MCCPs) have been used as substitute following EU restrictions in 2002 on the main application of SCCPs as metal and leather working fluids. They are less harmful than SCCPs but are still of concern due to their persistency and accumulation in the marine environment. A recent EU risk assessment suggests that risk reduction measures may be required for the main uses as metal and leather working fluid and other uses (EU, 2005). A close watch also needs to be kept on the substitution of PFOS with other perfluorinated substances.

5. Status and trend in marine pollution

The ocean is a very dynamic medium, and there are strong seasonal patterns of change in both chemical and biological processes. These factors mean that identifying the status and trends of marine pollution requires coordinated monitoring to consistent international standards.

The core information presented in this section results from regular monitoring of the concentrations of hazardous substances and their effects under the OSPAR Coordinated Environmental Monitoring Programme (CEMP) ➥ *Trends and concentrations of hazardous substances in sediment and biota (OSPAR, 2009c)*. For priority chemicals only recently added to the CEMP or for which monitoring strategies do not envisage environmental monitoring, data have been collected outside the coordinated framework of the CEMP ➥ *Annex 2*.

5.1 Environmental monitoring tells us whether our measures are working

Monitoring under the Coordinated Environmental Monitoring Programme (CEMP) aims to indicate the extent of contamination of fish, shellfish and sediments, and to help OSPAR assessing the effectiveness of measures to reduce releases of hazardous substances to the environment (Box 9). CEMP monitoring is suitable to track contaminants which accumulate through the food chain in marine organisms but cannot easily be detected in seawater. Therefore CEMP assessment results may lead to different conclusions about the chemical quality status than water based monitoring under the Water Framework Directive, despite that the scientific basis for deriving CEMP environmental assessment criteria and WFD environmental quality standards is the same.

Box 9

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 across the OSPAR area. The programme is underpinned by a strong emphasis on monitoring in accordance with agreed guidelines and quality assurance procedures. In addition to chemical monitoring, the CEMP encourages monitoring and reporting of a range of biological effects of hazardous substances in marine organisms. Monitoring is mainly focused on coastal areas because, in many cases, the response of the ecosystem to pollution control measures can be best 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 and does not take place in Region V.

➥ *Online CEMP Monitoring Manual*


©Hartmut Nies

Sediment sampling

Coordinated monitoring provides a reliable and comparable evidence base

The CEMP started with the substances for which key measures and monitoring capabilities were in place by the mid-1990s, *i.e.* the heavy metals cadmium, mercury and lead, and the organic contaminants PAHs and PCBs. Since then, substance coverage has evolved to respond to management needs: In 2003, monitoring of the biological effects of TBT was included in the CEMP to track changes in the marine environment in response to OSPAR, European and international instruments banning TBT as antifoulant in ship paints. More recently, the programme has been expanded to include monitoring of the polybrominated diphenyl ethers and hexabromocyclododecane and work is on its way to introduce coordinated monitoring of dioxins and furans, and PFOS.

A range of biological effects of hazardous substances has been included in the CEMP to demonstrate the link between contaminants and ecological responses (OSPAR, 2007). Although a range of biological measurements are included on a voluntary basis, so far only the effects of TBT on gastropods are monitored in a coordinated manner across the OSPAR area. Over the last decade work to integrate monitoring of contamination levels and their effects on marine life proved a challenge. Approaches have been explored for example in the ICES framework in cooperation with OSPAR, and in projects such as HARBASINS (Box 10).

Box 10

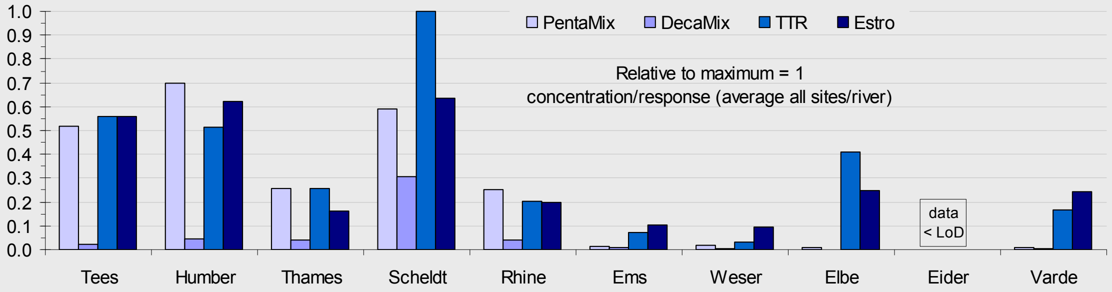
EU HARBASINS: Combining chemical monitoring and bioassay responses

A 2007 one-off survey of the European project for Harmonised River Basins Strategies North Sea (HARBASINS) demonstrates the importance of coordinated and complementary chemical and biological monitoring to inform management strategies across river basins (www.harbasins.org). While chemical analysis targets known substances, biological analysis identifies responses of marine organisms to the exposure to contaminants, whether these are known or not and act individually or in combination, and thus can provide indication of the ecological quality of waters in relation to chemical pollution.

The survey sampled and analysed sediments and seawater in estuaries and coastal waters in the Southern North Sea and compared concentrations of brominated flame retardants (mix of pentaBDEs and decaBDEs) and levels of biological responses (thyroxin-transport receptor (TTR) and oestrogene receptor (Estro)). The comparison showed that highest environmental concentrations and biological responses do not necessarily go hand-in-hand (Figure below).

One reason for this is that other substances than those analysed contribute to the overall effect. Effect-directed analysis tools such as www.MODELKEY.org are under development which can help identifying contributing substances through screening of chemical databases.

Another reason for the difference in chemical and biological monitoring results is the transport with water currents of contaminants which are bound to suspended (sediment) particles and contribute to pollution effects elsewhere. The specific pattern of high/low environmental concentrations provides a chemical's fingerprint and in correlation with results from other monitoring stations can point to contaminant transport across river basins as this was the case in the survey for the transport of pentaBDEs with the residual currents along the UK coast from Tees and Humber to the Thames estuary.



➥ *HARBASINS evaluation report (Klamer* et al.*, 2007)*

Agreed regional assessment approach underpins findings on the quality status

A regionally agreed assessment approach for CEMP data allows assessing observed concentrations and effects of hazardous substances coherently across the OSPAR Regions and in relation to OSPAR's objectives (Box 11).

Assessment of CEMP data for temporal trends tells us whether control measures aimed at ceasing releases are working. The comparison of observed concentrations with agreed threshold levels allows to classify the chemical quality status of the OSPAR Regions for CEMP components by judging whether, in relation to the OSPAR objectives, contamination levels are still elevated, whether they are at levels giving rise to risk of pollution effect, and whether management action is required (Table 5.1). This classification scheme is used throughout section 5 and Annex 1 of this report.

Box 11

A common regional assessment approach

Two sets of agreed threshold levels reflect:

- concentrations close to background or zero; and
- concentrations below which no chronic effects are expected to occur in marine species

Where for the latter threshold suitable ecologically-based assessment criteria are not available, criteria based on other uses of marine resources, such as human food quality standards, are used. Agreed procedures allow combining the observations at individual monitoring stations to provide a picture of overall trends and status for each of the OSPAR Regions.

➥ *CEMP assessment criteria for the QSR 2010 (OSPAR, 2009i)*

➥ *Background Document on CEMP assessment criteria for the QSR 2010 (OSPAR, 2009j)*

➥ *CEMP assessment manual (OSPAR, 2008c)*

➥ *Trends and concentrations in sediments and biota (OSPAR, 2009c)*

Table 5.1 *Colour classification of monitoring data*

Colour	What the colours mean	Possible types of management activity
🟥 RED	*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).	Measures in place or under consideration to address the cause. Regular monitoring to determine status and trends.
🟧 AMBER	*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.	Improve monitoring or assessment criteria
🟩 GREEN	*Status is acceptable.* Concentrations of contaminants (except metals in biota) are at levels where it can be assumed that little or no risks are posed to the environment and its living resource at the population or community level.	Measures generally are not necessary to improve status, but may be required if there is a trend towards a deterioration in status. Appropriate monitoring regime to ensure that there is no deterioration.
🟦 BLUE	*Status is acceptable.* Concentrations are *near background* (metals, PAHs) or *close to zero* (PCBs), *i.e.* the ultimate aim of the OSPAR Strategy for Hazardous Substances has been achieved.	Measures not required. Appropriate monitoring regime to ensure that there is no deterioration.

➥ *Annex 2* of this report compiles national environmental monitoring information on OSPAR priority chemicals not covered by the CEMP or which have been included in the CEMP only recently. It cannot be assumed that this information has been gathered by consistent methodologies or has been assessed against commonly agreed assessment criteria. Therefore the data may not be comparable and no status classification is possible. The data still provide indication of contamination and concern, especially for man-made synthetic substances which would normally be expected not to be found in the marine environment and for which the OSPAR objective is to achieve concentrations close to zero.

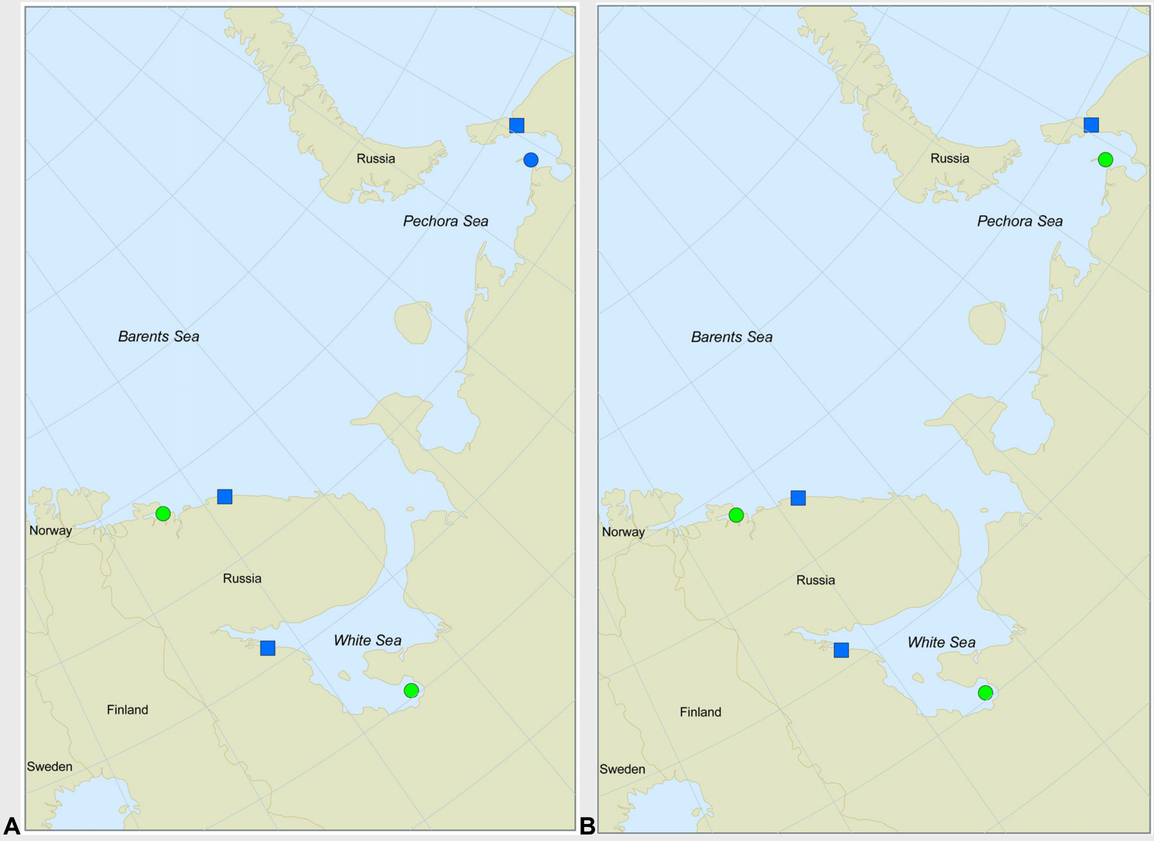
Regular findings under the CEMP for Region I are supported by assessment results for the Russian Arctic from a bi-lateral project between Russia and Norway on harmonised monitoring of hazardous substances based on the CEMP (Box 12).

Box 12

Norwegian-Russian monitoring cooperation in the Russian Arctic

Norway and Russia kicked off a pilot study of monitoring of hazardous substances in 2002 in Northwest Russia as part of a bi-lateral project on harmonisation with the OSPAR Joint Assessment and Monitoring Programme. Following OSPAR monitoring guidelines under the CEMP, Russian monitoring has focused on metals and persistent organic substances including PAHs, PCBs, old pesticides, dioxins and furans, polybrominated diphenyl ethers and polychlorinated naphthalenes. An assessment, based on the agreed OSPAR assessment approach, has been undertaken for observed environmental concentrations of PAHs and PCBs. This illustrates quality status of surface sediment and biota in Russian coastal areas of the Barents Sea, Pechora Sea and White Sea (Figures below). This is a unique contribution of Russian monitoring to OSPAR's assessment work.

Russia has continued monitoring in 2009 and there is an on-going process to maintain the programme in future. This is a positive development to provide a continued assessment of the environmental concentrations of hazardous substances, their temporal trends and of their effects on marine life in a remote part of the OSPAR area.



*A comparison of the selected results from the field studies in 2003 – 2007, using the CEMP assessment criteria, showed that levels of (**A**) PAHs and (**B**) PCBs in the Russian Arctic were in general at background/ zero (blue) in mussels (□) and at acceptable levels, approaching background/zero (green) in sediment (○). It is, however, important to take precautionary action to keep the levels low and to continue monitoring of those contaminants in the Arctic.*

➥ *Annex 3: PCBs and PAHs in the Russian Arctic*

5.2 Levels of metals, PCBs and PAHs in the environment are generally decreasing but still give rise to pollution effects at coastal locations

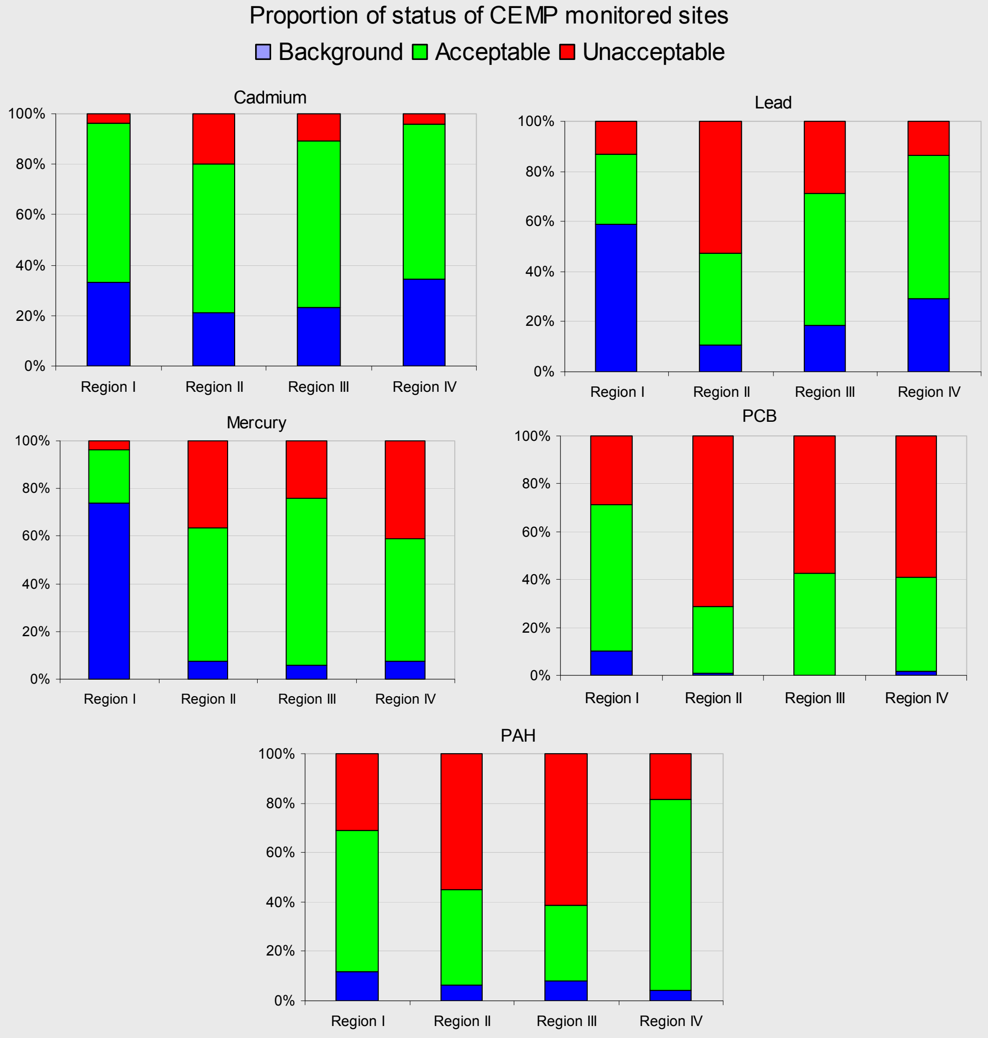
The OSPAR quality objective for priority chemicals are met unevenly between contaminants and Regions (Box 13).

Box 13

Overall status of CEMP monitored sites

The overall environmental status for metals measured at CEMP monitored sites is better in Region I than in the other OSPAR Regions. Unacceptable status of cadmium is mainly observed in Region II but overall cadmium is less a problem in the OSPAR area compared to lead in Regions II and III and mercury in Regions II and IV. In general, less than a third of the monitored sites show heavy metals concentrations near background, with the exception of mercury and lead in Region I. The quality status for metals is generally better than that for PCBs and PAHs.

More than half of the monitored sites in Regions II, III and IV show an unacceptable status for PCBs. Concentrations of PCBs close to zero are found at some monitored sites in Region I. The status of concentrations of PAHs is unacceptable at more than half of the monitored sites in Region II and III. PAH concentrations close to background were found at less than 12% of the monitored sites in the OSPAR Regions. The data indicate that the concentrations of these organic contaminants in the environment represent a widespread potential risk of adverse biological effects and therefore are a continuing cause for concern. ➥ *Table 5.1: Colour classification of monitoring data;* ➥ *Trends and concentrations in sediments and biota: Aggregation process*



Concentrations measured in fish, shellfish and sediments over the past 20 years are generally decreasing in all Regions (Table 5.2). This is particularly apparent in Region II where downward trends can be detected at all levels. By contrast, in Region I, where the concentrations are generally lower, downward trends tend to be found only at monitoring stations close to pollution sources. For a large number of time series, no statistically significant trends could be detected. Because of the high level of natural variation in the marine environment, trends can only be detected over relatively long time frames and many monitoring series are still too short. Continued monitoring to extend these time series will allow trends to be detected in the future. Further monitoring is particularly important to develop a more complete picture of OSPAR Regions III and IV. There are no monitoring data from Region V.

OSPAR Regions	**Statistically pre-dominant trends**			
	By quality status class			Overall trend
	Blue	Green/ Amber	Red	All classes combined
Region I				Down
Region II	Down	Down	Down	Down
Region III		Down		Down
Region IV		Down		Down

Table 5.2: *Statistically pre-dominant temporal trends in contaminant concentrations (Cd, Pb, Hg, PAHs and PCBs) in Regions I – IV, aggregated by quality status class*
➥ Table 5.1 for colour coding

5.3 Heavy metal contamination is decreasing

The trends observed for environmental concentrations of cadmium, mercury and lead is generally consistent with the downward trends seen in their waterborne inputs. However, much of the decrease in inputs of metals occurred before 2000, since when changes in environmental concentrations have been relatively small as concentrations approach, but do not reach, background in large parts of the OSPAR area. In the period 1998 to 2007, downward trends have been more substantial for lead concentrations in fish and shellfish.

The picture for mercury and cadmium is more mixed with concentrations in fish and shellfish having fallen in some locations but risen in others (*e.g.* Dogger Bank and estuarine sites in the UK and on the southern coast of the North Sea). Concentrations of metals bound in sediments respond slower to changes in inputs and provide a continued source for uptake of metals by marine organisms (Box 14).

Box 14

Availability of contaminants in sediments

Marine sediments are in constant movement through wave action, seabed living organisms, which rake in the sand and dig up lower layers, and as a result of human activities (*e.g.* dredging, laying of cables and pipelines, *etc.*). This means that deeper layers with past contamination mix with upper layers of marine sediments, keeping concentration levels up. So contaminants are re-suspended and become available for uptake by marine organisms.

Transport of sediments by wave action and human activities (*e.g.* dumping of dredged material) con-tribute to spreading contaminants in the sea. The diet of benthic and pelagic animals determines their exposure to changes in contaminant loading.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Although there are large parts of the OSPAR area where concentrations of cadmium, mercury and lead in marine sediments, fish and shellfish are close to background, in some coastal areas concentrations pose a risk of pollution effects. High concentrations in biota around Iceland may result from geological factors, *i.e.* localised mineralisation close to the Mid-Atlantic Ridge.

Unacceptable levels of mercury are still observed in Regions II, III and IV

Mercury is extremely toxic to humans and marine life, especially when transformed within the aquatic environment into even more toxic organic compounds (*e.g.* methyl mercury).

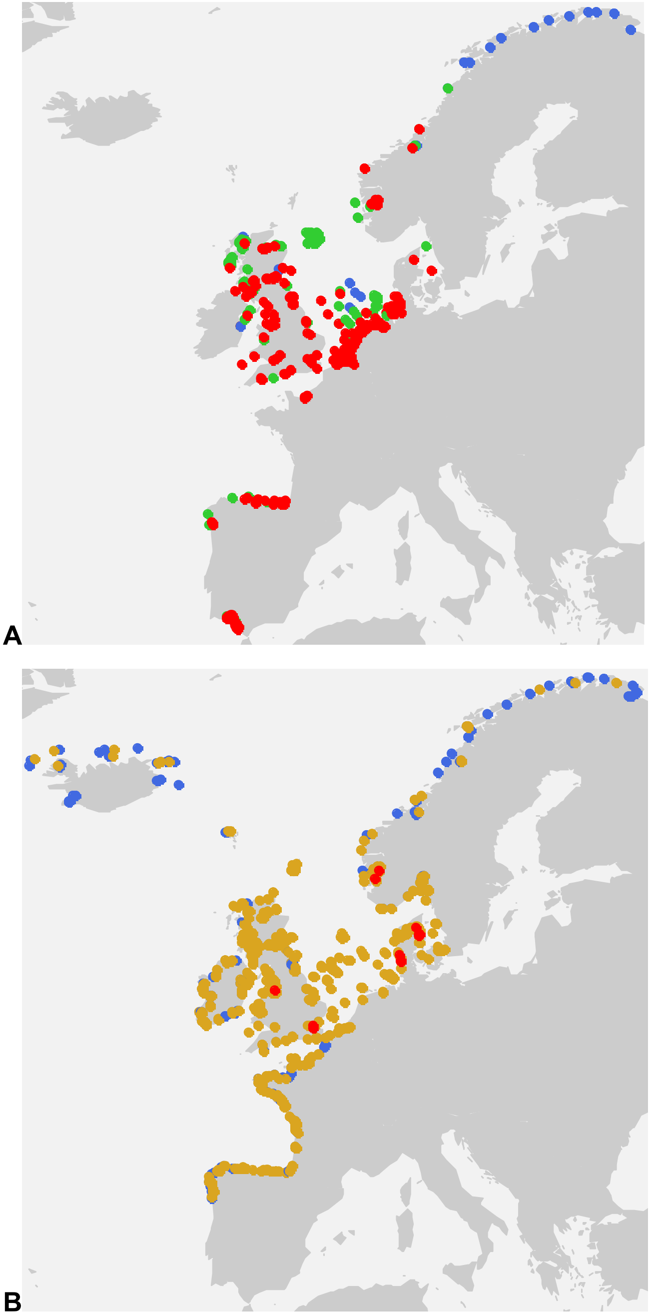


Figure 5.2: *Mercury concentrations in (**A**) sediment and (**B**) biota at background (blue), acceptable (green) or below EU dietary limits (amber), and unacceptable (red). Status indicated for the last year of monitoring in the period 2003 – 2007.*

The consequences of mercury pollution levels can be dramatic for marine life, as illustrated for the Forth estuary, Scotland (Box 15). A long-term study of contaminants in stranded harbour porpoises around the UK found in general higher liver mercury concentrations in animals that died of infectious diseases than of other causes (*e.g.* fisheries by-catch) (Law *et al.*, 2006). This supports associations of contamination levels with increased susceptibility of marine mammals to infections and higher mortality. It suggests that contamination, not necessarily with mercury alone but with a mix of chemicals, is at levels that can cause adverse effects on marine life.

Concentrations of mercury in sediment are at levels giving rise to risk of pollution effects in the southern North Sea, both on the coast and offshore on the Dogger Bank, in the Channel and the Irish Sea and at some locations on the west coast of Norway and near urban industrialised areas in northern and southern Spain (Figure 5.2A).

Concentrations of mercury in fish and shellfish are generally below EU dietary limits other than around the coasts of Denmark and in certain industrialised estuaries in Norway and the UK (Figure 5.2B). Elevated concentrations in biota close to Iceland may be related to geological factors.

Background levels of mercury in fish and shellfish are measured at coastal locations in Regions I, III and IV, but rarely in Regions II. Overall, mercury levels in Region I are lower than in the other OSPAR Regions with more than 75% of monitored sites at background values. There is, however, concern in Region I over accumulating concentrations in some top predators like marine mammals and exposure of the Arctic population to mercury through their diet which traditionally includes for example whales (AMAP, 2009).

OSPAR should actively promote the recently agreed work within the UNEP framework to develop a global legally binding instrument on mercury to reduce emissions and discharges worldwide.

Box 15

Firth of Forth: Recovery of benthic macrofauna

Following drastic reductions of annual loads of mercury to the estuary of the Forth over the last 20 – 25 years, levels of mercury in fish and shellfish are now well below EC dietary limits and benthic macrofauna communities are recovering.

The Forth estuary and its catchment, located on the east coast of Scotland, has been a focus for industrial and commercial activity for many decades. The estuary receives discharges from the manufacture of yeast, paper, chemical and petrochemical industries plus waste water from approximately one quarter of the Scottish population.

Following continuous implementation of waste water treatment and control measures since the 1980s, inputs of mercury to the Forth estuary have drastically declined and contamination of sediments, mussels and fish responded with falling levels. At the same time a continuous increase in the number of recorded taxa in macrofauna species has been observed. However, levels of mercury absorbed to sediments are still high and are decreasing only slowly. It is expected that mercury from the sediments of the Forth will remain available to marine life for decades because the flux of particulate matter out of the estuary is relatively slow. Rs mussels and fish ingest contaminants from sediments, concentrations in biota are expected to remain above background concentrations.

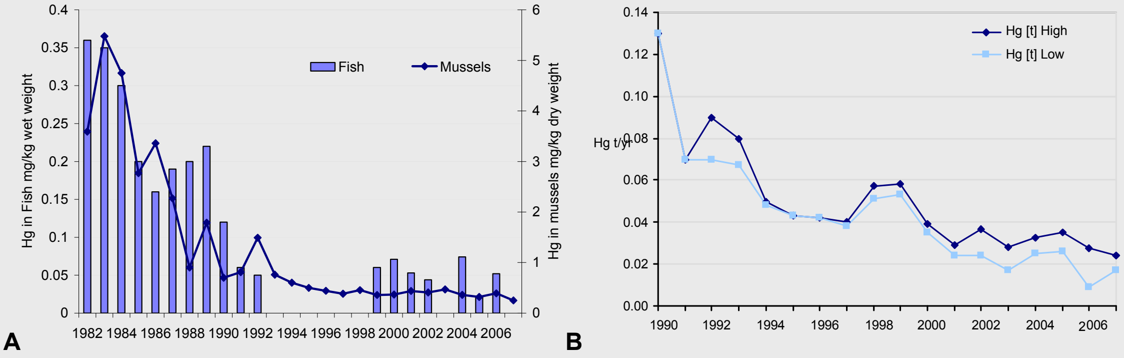


*Figure: (**A**) Mercury concentrations in flounder muscle and mussels decreased drastically in the 1980s and 1990s. This follows (**B**) reductions in annual riverine inputs and direct discharges of mercury (Hg t/yr) to the Forth estuary, but decreased only slightly since 1998. Concentrations were still above background values in 2007.*

➥ Annex 3: Long-term trends in mercury, cadmium and lead in the Forth

Lead concentrations are still at unacceptable levels at many locations in Regions I to IV

Concentrations of lead in sediments give rise to risk of pollution effects over large parts of the southern North Sea, both inshore and offshore, the Channel and the Irish Sea (Figure 5.3A). Scattered high concentrations are also found along the coast of Norway and in some locations near urban industrialised areas in northern Spain. However, concentrations in the northern UK, northern Norway and northern Spain are generally approaching or at background.

Concentrations in biota exceeding EU dietary limits are less widespread, and the locations can generally be linked to urban and industrial activity, *e.g.* around Denmark, several UK estuaries and certain sites in southern Ireland, southern Norway and northern Spain (Figure 5.3B). Concentrations in the offshore area around the Dogger Bank are at near coastal levels. This has been attributed to enhanced fine sediment fraction and riverine humic acids in that area which are carriers for lead.

Lead concentrations in fish and shellfish remain above background over much of the coasts of Regions II, III and IV, although background levels are evident in western Ireland, the north west coast of Norway, and some stations in northern Spain and along the coast of northern France. More than half of the locations measured in Region I are at background. Concentrations above background at sites around Iceland may be the result of volcanic activity. Overall, concentrations of lead in biota show a consistent downward trend across OSPAR Regions. An example of falling environmental concentrations is provided by monitoring in the Nervión estuary in Spain (Box 16).

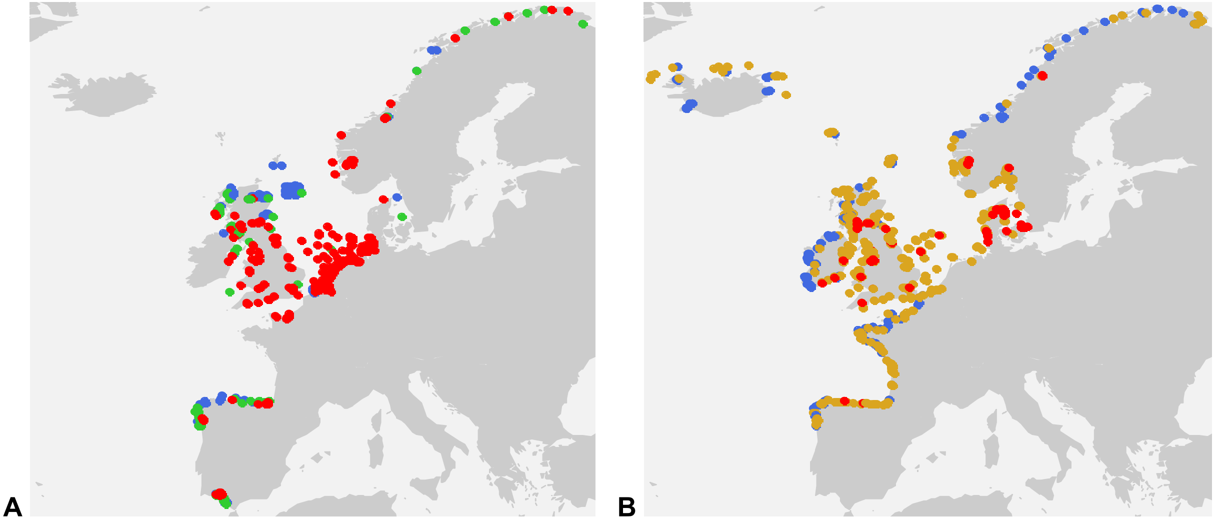


Figure 5.3*: Concentrations of lead in (****A****) sediments and (****B****) biota are at background (blue), acceptable (green) or below EU dietary limits (amber), and unacceptable (red). Status indicated for the last year of monitoring in 2003 – 2007*

Box 16

Environmental quality of the Nervión estuary is improving

Past inputs of lead from mining, steel industries and car exhausts have led to severe pollution in the Nervión estuary in the Basque country of northern Spain. With the closure and transformation of some of the industries, pollution control measures and implementation of sewerage schemes, input levels of lead have drastically decreased. As a result lead concentrations in sediments generally decreased since 1995 but accumulated historic burdens means that concentrations in sediments are still elevated and in some cases above levels giving rise to risk of pollution effects (Figure below). However, recent invertebrate tests suggest in general a low toxicity of the sediments in the estuary. Most measured concentrations in mussels are within EU dietary limits and two thirds of measurements are below concentrations associated with toxicity. However, no statistically significant trends could be observed in concentrations in mussels in 1994 – 2008. Chemical monitoring results are overall consistent with observations of biological communities, especially benthic invertebrates, which have recovered over the past 20 years and reflect the overall improvement of the environmental quality in the estuary.

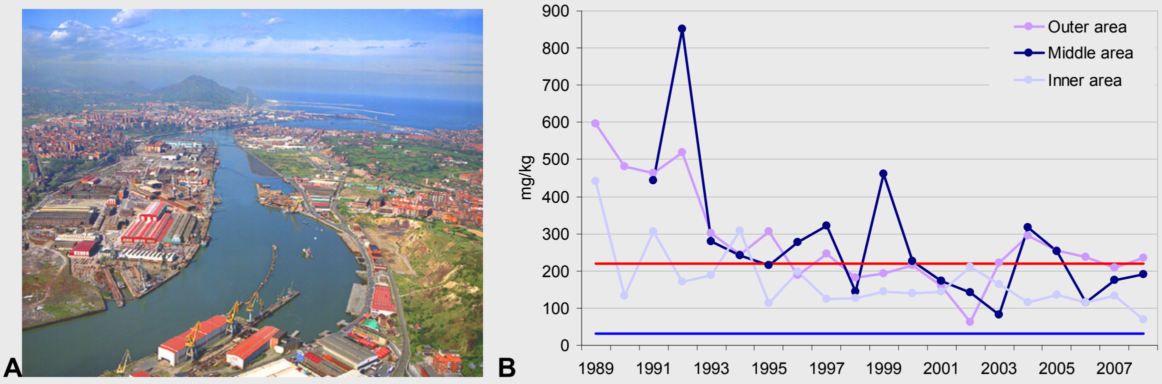


*Figure: (****A****) The Nervión estuary stretches 22 km from Bilbao to the entry of the Bay of Biscay. (****B****) Efforts to reduce pollution in the estuary are reflected in decreasing trends of lead concentrations in surface sediments (mg/kg; measured in the fine fraction) at three sampling stations; the red line represents the threshold value above which there is a risk of pollution effects and the blue line represents the background concentration for lead.* ➥ *Annex 3: Lead in the Nervión estuary*

Cadmium levels are low and approaching background levels in many areas

Concentrations of cadmium in sediments generally present no environmental risk in large, open sea areas in all OSPAR Regions (Figure 5.4A). Levels are mostly approaching or are at background. In some coastal areas, such as the inner German Bight and around the industrial estuaries of the Rhine, Seine, Tyne, Tees and Thames as well as in certain industrialised estuaries in Norway (Inner Sørfjord) and Spain (Ria de Pontevedra) cadmium is at levels which give rise to risk of pollution effects.

Concentrations of cadmium in fish and shellfish are above EU dietary limits around the coasts of Denmark, and at occasional locations in the UK, France, and Norway (Figure 5.4B). High concentrations around Iceland may be related to geological factors. At a number of locations in northern Spain and along the coast of France and Ireland, concentrations are at background.

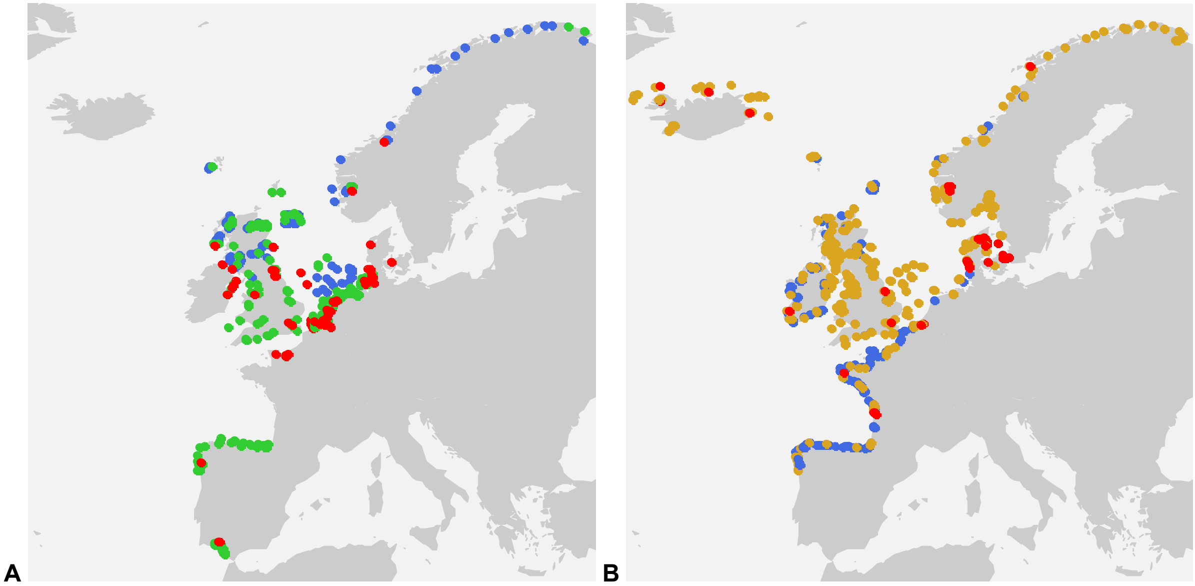


***Figure 5.4**: Cadmium concentrations in (**A**) sediment and (**B**) biota are at background (blue), acceptable (green) or below EU dietary limits (amber), and unacceptable (red). Status indicated for the last year of monitoring in the period 2003 – 2007.*

5.4 PAHs contamination is a concern

Polycyclic aromatic hydrocarbons (PAHs) are natural components of coal and oil. They are toxic, persistent and bioaccumulate, especially in invertebrates, and some PAH compounds are carcinogenic. PAHs are primarily formed as a result of incomplete combustion of carbon-containing fuels (wood, coal, oil *etc.*). The sources of PAHs and pathways to the marine environment are very varied and include riverine and atmospheric inputs from land-based industries, offshore oil industry and operational and accidental spills of oil from shipping. As a result PAHs are one of the most widespread organic pollutants. Long-range atmospheric transport is the predominant pathway of PAHs on a global scale, and acts as a major source to the OSPAR area.

Specific OSPAR control measures have targeted the main industrial point sources including aluminium smelters, the iron and steel industry, and refineries. However, total atmospheric emissions by OSPAR countries have remained relatively constant over the past decade. Given the expected growth of industrial activities, for example in Asia, the relative proportion of PAHs brought to the OSPAR area from long-range transport is likely to increase.

The partial effectiveness of the control measures currently in place is clear from the dominance of downward trends in PAH concentrations in coastal shellfish (mussels) between 1998 and 2007. In contrast, there are relatively fewer temporal trends in sediment concentrations, suggesting that concentrations in sediments respond less rapidly to changes in inputs to the sea than concentrations in biota. This is reflected in widespread concentrations of PAHs in sediments at levels which give rise to risk of pollution effects (Figure 5.5A).

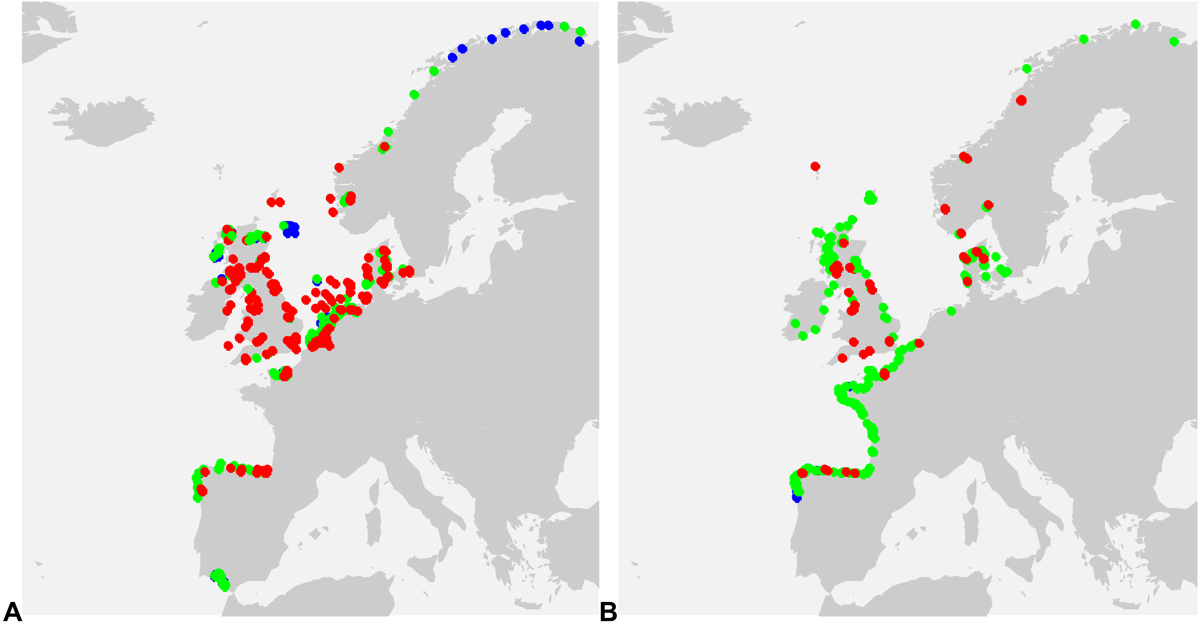
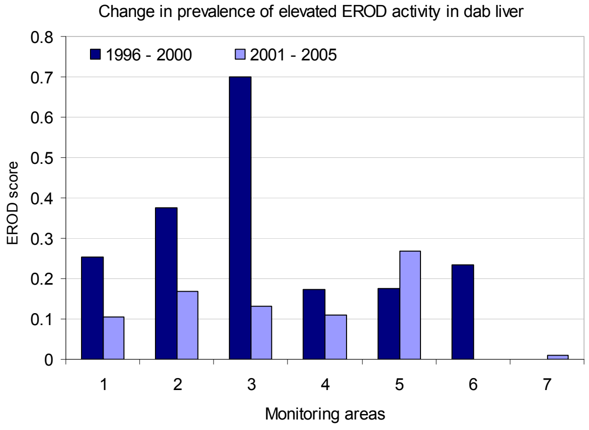


***Figure 5.5**: PAH concentrations in (**A**) sediments and (**B**) biota are at background (blue), acceptable (green), and unacceptable (red). Status indicated for the last year of monitoring in the period 2003 – 2007.*

The implied decrease in exposure of marine life to PAHs is supported by decreases in some observations of EROD activity in fish (dab) liver in Regions II and III (Figure 5.6); this is the measurement in fish of the induction of detoxification enzymes (called EROD) following exposure to planar organic contaminants such as PAHs. However, the failure to achieve background concentrations of PAHs in mussels is evidence of continuing widespread contamination, possibly mediated through atmospheric transport (Figure 5.5B). The scattered occurrence of concentrations which give rise to risk of pollution effects, are often in harbours, estuaries and close to industrial installations.

This suggests that more and better use of emission control technology in combustion processes and further controls on diffuse localised sources will be necessary if the OSPAR objectives are to be achieved.



Monitoring area		Number of samples	
		1995-2000	2001-2005
1	Irish Sea	8	14
2	Scottish coast	2	12
3	East English coast	4	9
4	Dogger Bank	5	8
5	North Dutch, German, Danish coast	24	9
6	South Dutch, Belgian coast, Channel	14	1
7	South English coast, Channel	1	2

***Figure 5.6:** Change in prevalence of elevated EROD activity (EROD score) in dab liver at selected monitoring areas in Regions II and III between 1996 and 2005 (OSPAR, 2009c.)*

5.5 PCB contamination from historical remains a concern at many sites

The production of polychlorinated biphenyls (PCBs) was banned in the mid-1980s. PCBs were used in both “closed” applications, such as in transformers, capacitors and as hydraulic fluids, and “open” uses, such as grouting, sealants and as plasticisers in paints. Production may still be continuing in other parts of the world. PCBs are toxic and bioconcentrate in fatty tissues. 209 forms (congeners) of PCB exist, and display a variety of toxicological properties. Adverse impacts on reproduction and immune systems have been investigated the most. The persistent and lipophilic properties of PCBs lead to biomagnification in the food web, affecting particularly top-predators such as seabirds and marine mammals. It is estimated that some 700 000 tonnes of PCBs have been produced, of which 30% may have been released to the environment so far. The main remaining sources of PCB releases are electrical systems containing PCBs, waste disposal and re-mobilisation of PCB from contaminated sediments.

OSPAR and the EU have specifically targeted pollution from PCBs, requiring that all PCBs and hazardous PCB substitutes are phased out and destroyed in an environmentally safe manner. Substantial reductions in releases and good progress on the phase-out of remaining stocks have been achieved in the period 1998 – 2005 supporting a movement towards the cessation target for PCBs. However, releases of PCBs to air and water continue. The total emissions of PCBs to air reduced by 75% over the period 1998 – 2005 and model calculations suggest a decrease in atmospheric deposition by more than 60% (OSPAR, 2009a). The treatment and elimination of remaining stocks, and processes will provide a continued source for releases to the environment until their phase-out has been completed.

OSPAR environmental monitoring has concentrated on a set of 7 PCB congeners, which cover the range of toxicological properties of the group (CB congeners 28, 52, 101, 118, 138, 153, 180). There are few locations where the concentrations of the target CB congeners in biota are close to zero. These are mainly in northern Norway and in the Russian Arctic (Box 12). However, at many stations remote from industrial activity, concentrations are not yet at levels close to zero, including parts of northern Norway in Region I, northern Scotland and offshore locations in the North Sea (Region II) and some sites on the north coast of Spain (Region IV). In the Arctic, PCBs are among contaminants detected in highest concentration and giving rise to concern for human health and marine life (Box 17). Furthermore, in Regions II, III and IV there are widespread locations where the concentrations of at least one CB congener in fish and shellfish pose a risk of pollution effects, particularly around the coasts of the Bay of Biscay and the Channel, in more populated and industrialised UK estuaries, and in some coastal and estuarine sites in Denmark, Germany and southern Norway (Figure 5.7B). The pattern of contamination in sediments is very similar to that for fish and shellfish (Figure 5.7A). Thus PCBs may still cause risk of pollution effects over large parts of the OSPAR area. This is supported by long-term observations under the UK Cetaceans Stranding Investigation Programme of PCB levels in stranded harbour porpoises along the coasts of the UK which suggest a link between contamination of animals and their susceptibility to infectious diseases and associated death; observed concentrations of PCB in blubber of porpoises that died of infectious diseases were higher than of those animals that died of other causes (*e.g.* fisheries by-catch) (Law *et al.*, 2006).

Concentrations are decreasing at a high proportion of the fish/shellfish stations, particularly along the continental coast of the North Sea, the west of the UK, and Ireland. A small number of stations showed increasing trends.

The legacy of historical use of PCBs remains real today. European-wide action to reduce inputs to the environment has been effective, but not sufficiently to eliminate all inputs. Long-range atmospheric transport is important and requires global action. PCBs were one of the first groups of substances included in the UN Stockholm Convention on Persistent Organic Pollutants in recognition of the need for a globally coordinated approach to measures. The historical contamination of sediments will provide a continuing, but hopefully decreasing source of PCBs for the foreseeable future.

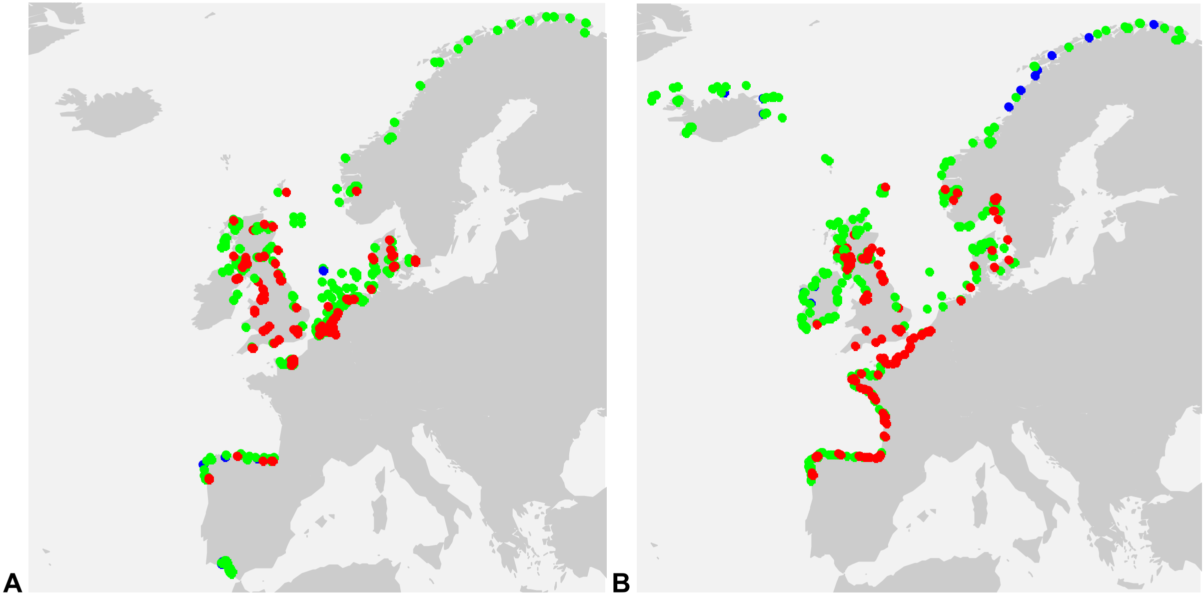


Figure 5.7: *The assessment results of concentrations in (**A**) sediments and (**B**) biota of the 7 individual PCB congeners have been aggregated to provide a simplified presentation of the pollution status for the entire target group of PCBs. Status indicated for the last year of monitoring in the period 2003 – 2007: close to zero (blue), acceptable (green), and unacceptable (red).*

Box 17

Combined effects of persistent organic substances are of particular concerns for the Arctic Region

While PCB concentrations in Arctic species are decreasing, they are still at levels causing concern. They affect the immune system and disturb behaviour and reproduction in birds, fish and mammals and affect the polar bear populations in particular (AMAP, 2009). However, organic pollutants are always present in mixtures. Even if levels of an individual substance are low, other persistent substances add to the total effect levels in marine life. Their combined impacts may be higher in the vulnerable Arctic environment than in temperate regions. It is therefore important to take precautionary action to keep levels of organic pollutants low and to continue monitoring their presence in the marine environment.

For example, in the Faroe Islands regular monitoring of environmental pollutants in long-finned pilot whales (photo), a valued traditional food-source, began in the mid 1990's. Decreases in the pesticide DDT and in PCBs seen in several areas in the OSPAR region are beginning to become visible in pilot whales. However, these animals appear to be burdened with a range of anthropogenic substances, raising concern for their health and representing a substantial dietary source of mercury and PCB and other persistent and lipid-soluble pollutants to the human population. The Faroese government has initiated a risk management process.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5.6 Widespread pollution from persistent organic chemicals

Several other OSPAR chemicals for priority action which have come under the regulatory focus over the past ten years show a similar tendency as PCBs for persistency and long-range transport, especially through air, leading to concern for contamination of areas remote from pollution sources. Examples include brominated flame retardants, perfluorinated substances, short-chained paraffins and old pesticides such as endosulfan and lindane. The potential for long-range transport of those substances increases the relevance of sources outside the OSPAR area, especially for the more pristine areas of Region I, where these substances can bio-accumulate in higher mammals and affect humans through their diet (Box 17). Some chemicals (octaBDE, pentaBDE, PFOS, and lindane) have recently been included for elimination worldwide under the UN Stockholm Convention on Persistent Organic Pollutants, others (SCCPs, endosulfan and HBCD) are still awaiting decision of their POP status under the Stockholm Convention (see section 2.1). It is important, not only that this process is brought to a satisfactory conclusion, but also that remaining sources of releases for other persistent substances are addressed.

Brominated flame retardants are found in all environmental compartments in the OSPAR area

Brominated flame retardants are a group of substances that have been used to prevent fabrics and plastics from burning and which have come under regulation during the last pen years (Box 8). Included in this group are the substances polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecane (HBCD) which are toxic and bioaccumulative and can be subject to long-range transport. Over the period 2000 – 2005, PBDEs and HBCD have been found in sediment and biota throughout OSPAR Regions I to IV in all components of marine ecosystems ➥ *Annex 2*.

In Region I, PBDEs have been measured in fish, seabirds, predatory birds and polar bears indicating widespread contamination. PBDEs have been detected in seabirds in such diverse locations in Region I as northern Norway, Svalbard and southern Greenland. In Region II, congeners found in the more toxic lower brominated PBDEs can be detected in sediment, fish and mussels from the coastal zone and the open sea at reference locations distant from known sources and in elevated concentrations in the blubber of harbour porpoise and the harbour seal. PBDEs have also been detected in stranded dolphins and whales in Regions II and III and in mussels in Region IV. The less regulated decaBDE has been measured in the coastal zone and open sea of the North Sea and has also been detected in birds' eggs in Region I.

HBCD has been measured in shellfish, fish, seabirds and mammals at locations distant from major sources. In the Norwegian Arctic, HBCD has been found in all analysed polar bears both in adipose tissue and blood samples (SPFO, 2004). The concentration in the adipose tissue had a mean of 25 ng/g wet weight, similar to those measured in glaucous gulls from Bjørnøya. A study of dead and dying seabirds from Bjørnøya reported higher levels of several contaminants, including HBCD, in brain and liver compared to living birds (SPFO, 2007). A significant increase of contamination of HBCD has been found in recent studies of seabird eggs in the period 1983 – 2003 in Region I, but other studies showed highest levels in samples from 1980's (Figure 5.8). While observed contamination of sediments and marine organisms are below effect levels and lower than concentrations of PCBs and polybrominated diphenyl ethers (PBDEs) in the Norwegian Arctic, HBCD contributes to the overall contamination burden and gives rise to concern over the combined effects of persistent substances on marine life. Regular monitoring of these substances in the marine environment, which commenced at an OSPAR scale in 2008, needs to be continued to evaluate whether any of the actions that have been taken so far are effective in terms of reducing this burden on the marine environment.

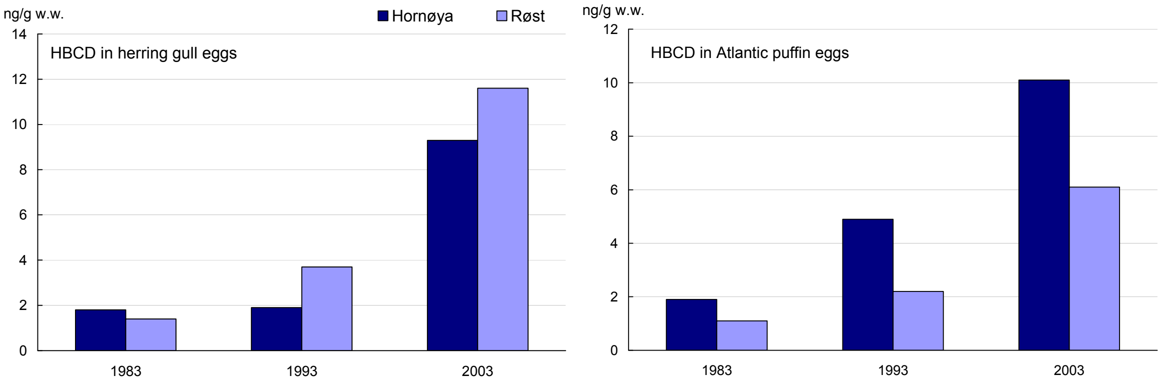

Figure 5.8: *Observed concentrations of HBCD in seabird eggs at stations in the Norwegian Barents Sea (Hornøya) and the Norwegian West coast (Røst) in Region I show increasing concentrations in the period 1983 – 2003 (based on Knudsen et al., 2005).*

Observed perfluorooctane sulphonates (PFOS) in high trophic levels are of concern

PFOS related substances are a group of perfluorinated substances which have been used as stain repellants and in fire fighting foams and have come into focus on account of their extreme persistence and toxicity. Due to environmental concerns, manufacture and use of PFOS related substances has declined in Europe and North America and main uses have been restricted at EU level since 2008. PFOS related substances have been reported to be found in all environmental compartments in the Arctic and Greater North Sea Regions at reference and polluted sites ➥ *Annex 2*.

Concentrations in sediments ranged from 0.5 µg/kg dry weight at reference sites to 3.7 µg/kg dry weight at contaminated sites. Concentrations of PFOS in biota (shrimp, shellfish, fish, mammals and seabird eggs) were found at levels up to 26 µg/g wet weight (Guillemot egg) at reference sites and up to 2420 µg/g wet weight (porpoise liver) at contaminated sites in Region II. The pattern of PFOS contamination in marine life varies greatly among species and geographical locations.

Monitoring data from seabird eggs from Northern Norway suggest that PFOS concentrations levelled off in 1993 – 2003 and have decreased since then possibly reflecting declining use. However, Swedish time series for guillemot eggs for 1968 – 2003 suggest a continuous increase at an average of 7 – 11% per year. Concentrations in ringed seal liver (1985 – 2003) and polar bears (1984 – 2006) from Greenland suggest high annual increases in PFOS concentrations.

The widespread presence of PFOS in the environment and the observed levels at higher trophic levels are of concern. Biological and ecosystem effects of measured PFOS levels are not fully understood, but laboratory studies of chronic exposure of seabird species to PFOS indicate adverse effects on reproductivity, hatchability and pathological changes. In the environment the potential for combined effects from an organohalogen contaminant mix cannot be ruled out. Even with the recent global ban of PFOS under the UNEP Stockholm POPs Convention, the legacy of PFOS in the environment may be expected to contribute to exposure and bioaccumulation in future due to the substances' extreme persistence and high production and application volumes in the past.

Short-chain chlorinated paraffins (SCCPs) are of regional and global concern

Short-chain chlorinated paraffins are a further group of highly persistent and toxic substances that are found to be widespread in the marine environment ➥ *Annex 2*. In the period 2000 – 2006 around the North Sea, SCCPs have been found in sediments, fish and mussels at sites away from direct pollution sources. SCCPs have also been found in Arctic biota (fish, seabirds and marine mammals, including polar bears). Some measurements in remote areas (Arctic char from Bear Island, Norway) have shown levels comparable to concentrations in cod reported for the North Sea and the Baltic Sea. The widespread presence of SCCPs and observed levels in mammals confirm concerns that SCCPs are of significance at a regional and potentially global scale. Consumption in Europe has dropped by 75% since 1998 but available data do not allow conclusions on trends of SCCPs in the environment since this time. Efforts continue to phase out remaining uses and SCCPs are now being considered for inclusion under the Stockholm POPs Convention.

Endosulfan still measured in Arctic atmosphere

Endosulfan is a persistent and toxic substance which has been used as a pesticide since the 1950s mainly in southern Europe. It has been gradually phased out over the past 20 years in the OSPAR area and, under EU legislation, all uses ceased by 2007. Norway reports levels in the Arctic atmosphere to range between 5 – 13 pg/m^3 in 2007, and, referring to Canadian data, assumes no increase compared to early 1990s when endosulfan, deposited from atmosphere, were reported at 2 – 10 pg/l in seawater (seasonal variation) and 1 – 10 µg/kg in blubber of whales in Greenland and Lofoten area (NILU, 2007). In contrast to other persistent substances, endosulfan has not been found in marine Arctic sediments. However, the elevated atmospheric concentrations indicate that uses of endosulfan continue in other parts of the world and that the substance can travel long distances to the OSPAR area. Endosulfan is now being considered for inclusion under the Stockholm POPs Convention.

5.7 Effects of TBT are decreasing but concerns remain in some areas

Existing national and international measures have resulted in a continuous phase-out of paints containing tributyltin (TBT) in the OSPAR area and their use on vessels, aquaculture and underwater structures over the last decade. The global ban of TBT in antifouling systems on large vessels under the International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS Convention) took effect in 2008 and addresses the main TBT-related pressure on the marine environment.

Marine snails are extremely sensitive to harmful effects of TBT, developing non-functional male characteristics (termed imposex). These can be used as an indicator of the extent of impact on the marine ecosystem (Box 18). A small yacht painted with a TBT-based antifoulant could release enough TBT in the course of a season to give theoretically ten million cubic meter water a TBT concentration sufficient to affect sensitive gastropod species. A similar amount could be leached from a large taker in an hour.

Since 2003, imposex and related effects of TBT in gastropods have been regularly monitored in OSPAR Regions I, II, III and IV. In the period 1998 to 2007, a reduction in imposex has been evident at the vast majority of monitoring locations. No locations that have been monitored show a significant upward trend in the level of imposex (Figure 5.9).

Box 18

Ecological Quality Objective for TBT related effects in the North Sea

As an ecological quality objective for TBT related biological effects in the North Sea, OSPAR has agreed that the level of imposex in a sample of not less than 10 female dogwhelks (*Nucella lapillus*) should be consistent with exposure to TBT concentrations that do not pose a risk of significant biological effects. Where *Nucella lapillus* does not occur naturally or where it has become extinct, other species may be used. Such a situation indicates however, that the sensitive species may already have disappeared.


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➥ *Evaluation of the OSPAR North Sea EcoQOs (OSPAR, 2009k)*

Although the overall status is improving, gastropods still show pollution effects from TBT over large parts of the OSPAR area, especially Regions II, III and IV. There is a clear relationship between shipping and imposex with levels high in the vicinity of some large harbours (*e.g.* Rotterdam, Clydeport, Vigo). The situation is markedly better where there is less large vessel traffic *e.g.* the west coast of Scotland and in the northern part of Norway. However, even in these areas, harbours can have a detectable impact, highlighting the importance of local factors.

These results emphasise the need to continue marine monitoring. This will provide surveillance against illegal use of stocks of TBT containing antifouling, and losses of TBT from dockyards, boatyards and vessel maintenance activities (*e.g.* sandblasting). It should also promote good practice in dealing with historical contamination of sediment, particularly from harbours, which continues to present a problem.

The use of the main substitutes for TBT, copper and Irgarol (Cybutryne), started on smaller vessels and has now continued for over a decade. These new antifoulants, though not as detrimental as TBT, can have certain adverse effects on biota. For example, Irgarol has been shown to reversibly affect the growth rate of marine algae (Buma *et al.*, 2009). The rapid growth in use of copper-based antifoulants in aquaculture over the past decade has markedly increased the release of copper to the sea in northern Scotland and west and north Norway. It is necessary for OSPAR surveys and environmental monitoring programmes to be aware of, and adapt to, the changing uses of the sea and the chemicals involved.

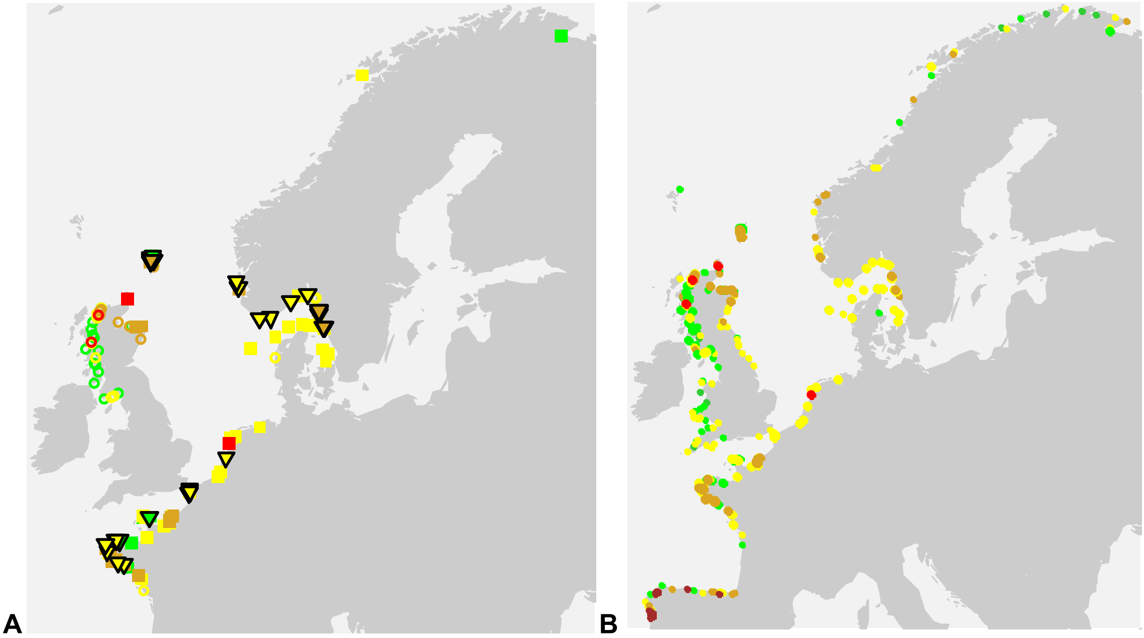


Figure 5.9 *The colour coding refers to the six assessment classes for TBT effects with dark and light green indicating that the OSPAR EcoQO on imposex in dogwhelks and other related gastropods is met (good status). All other observed effects levels are above the EcoQO from light and dark yellow (moderate status) to light and dark red for highest effects levels (bad status). Panel A shows significant downward trends (triangle) of imposex in the period 1998 – 2007; circles indicate insufficient data to assess trends. Panel B shows the status of imposex measurements; large symbols = 3 or more years of data; smaller symbols = 1 or 2 years of data.*

➥ *Trends and concentrations in sediments and biota (OSPAR, 2009c)*

5.8 Regulation of pesticides is working

OSPAR has prioritised six pesticidal and biocidal substances for priority action: dicofol, endosulfan, hexachlorocyclohexane (namely lindane), methoxychlor, pentachlorophenol (PCP) and trifluralin. All are toxic to aquatic organisms, highly bioaccumulative and very persistent. Dicofol, endosulfan and methoxychlor are also suspected endocrine disruptors. Some of these substances can be transported by air over long distances. The various uses of the six pesticides have been phased out progressively since 1998 and have ceased for almost all substances by 2009. The positive effect of the phase-out of the pesticides is illustrated and confirmed by lindane whose atmospheric deposition to the OSPAR area and environmental concentrations clearly declined.

Observations under the OSPAR Comprehensive Atmospheric Monitoring Programme (CAMP) suggest that by 2007, approximately a decade after the peak, atmospheric deposition levels in the southern North Sea had fallen by a factor of up to 50, as they had also done on the coasts of Iceland. However, during this decade the southern North Sea depositions have only just fallen to the levels seen in Iceland at the peak ten years ago. Moreover, a clear seasonal pattern persists with a spring peak to depositions each year. This suggests that lindane was still in use after 2000, for example as stockpiles were rundown. Lindane is still found in the atmosphere today. One explanation is continued European use, as is continental-scale transport from continuing uses in Asia. Re-release from the environment also occurs: one potential pathway being releases as ice melts in the high Arctic. ➥ *Trends in atmospheric concentration and deposition (OSPAR, 2009a)*

There is evidence that lindane is still released to water partly from historic uses, partly from the organic chemical industry (20 kg reported for 2004 to the European Pollution Register (EPER)). Measurements for estimating riverine transport of lindane are patchy and often below detection limit.

Monitoring data collected and treated in accordance with CEMP requirements show a general reduction in contamination of fish and shellfish across the OSPAR area. Concentrations have reached levels close to zero in some areas, for example western and northern Norway, parts of Ireland, France and Iceland. However, concentrations remain at levels where there is a risk of pollution effects in a number of other areas in particular the coast of Brittany, the German Bight, and certain northern UK estuaries (Humber, Clyde, Forth, Tay) (Figure 5.10). The localised nature of these hotspots, which may persist for years to come, may reflect historical use in adjacent areas.

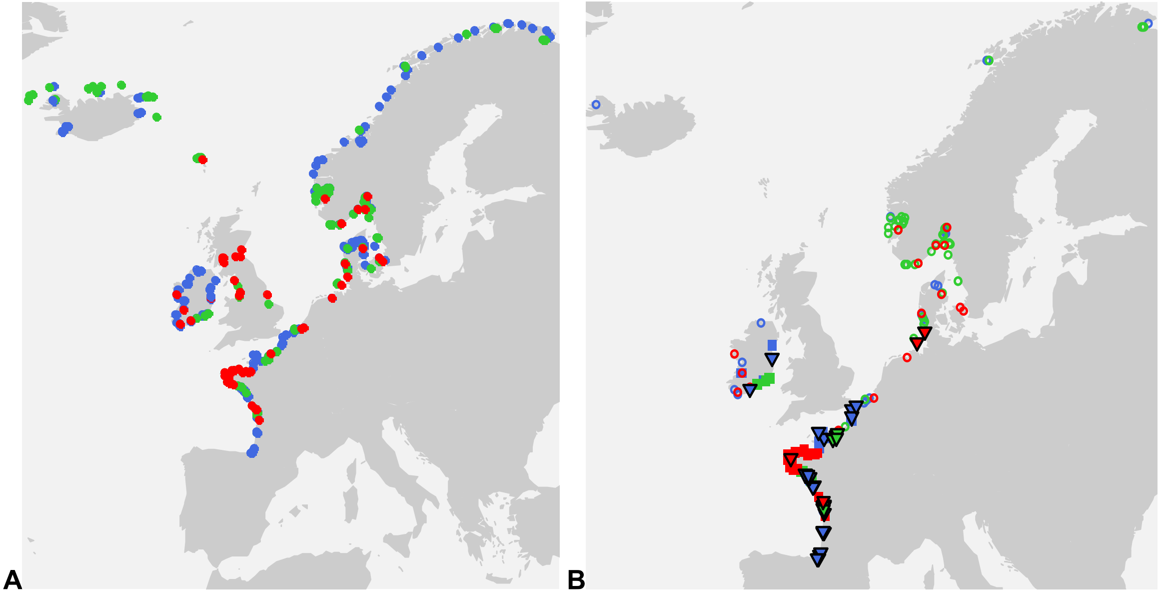


Figure 5.10: (***A***) *Status of lindane in biota indicated for the last year of monitoring in the period 2003 – 2007: close to zero (blue), acceptable (green) and unacceptable (red). (**B**) In general, statistically significant trends in 1998 – 2007 are downwards (triangle); circles indicated where insufficient data are available to assess trends.*

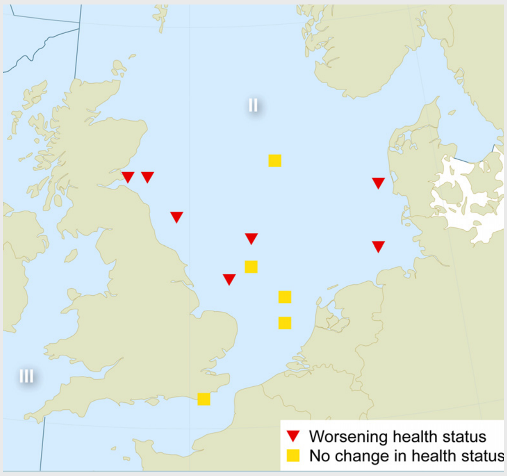
5.9 Some evidence of adverse effects of hazardous substances on marine life

Measurements of biological effects of contaminants provide a link to their impact on the marine ecosystem. A fully coordinated monitoring programme has not yet been implemented. Available measurements of enzyme activity induced by contaminants such as dioxins, PAHs and planar CBs (called EROD) in the Western part of the North Sea indicate a lower level of this effect in dab and flounder in the 2000s compared to the 1990s, consistent with a decrease in exposure (cf. section 5.4). Some measurements based on a fish disease index indicate a worsening of fish health status in Region II while recent studies of individual fish diseases have decreased in some areas of Region II (Box 19). Integration of chemical and biological monitoring data is not yet sufficient to develop overall conclusions of the impact of contaminants on ecosystem functioning at a regional scale.

Box 19

Mixed results of fish disease monitoring

Fish disease data are collected under the Coordinated Environmental Monitoring Programme (CEMP) as a potential tool for assessing fish health and to evaluate the impact of human-induced stresses on wild fish. Samples of dab collected from the southern North Sea and adjacent areas show that its disease status has worsened in most of the areas assessed in the period 2002 – 2007 compared to 1992 – 2001 (see Figure) (ICES, 2009). The trial of the fish disease index was based on the occurrence of various external disease symptoms, infections caused by external parasites and visible growth of liver tumours. 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 still to be investigated. Factors causing fish diseases may range from exposure to contamination to physical injury by fishing gear.



Evaluations of longer time series of CEMP monitoring data on *individual* disease signs show higher prevalence rates in the 1980s and a general decline since the early 1980s for some external diseases (lymphocystis, epidermal hyperplasia/papilloma) in dab (southern North Sea) and also flounder (Dutch coastal waters). Further, in accordance with the decrease in exposure to organic pollutants, such as genotoxic/carcinogenic PAHs, by the end of the 1980s, there was a concomitant decrease in liver tumors (neoplasms) in dab and flounder from the southern North Sea (Vethaak *et al.*, 2009; Hylland *et al*. 2006; Lang and Wosniok, 2003).

5.10 Understanding endocrine disrupting effects still needs to improve

It is recognised that exposure to both natural compounds (*e.g.* 17β-oestradiol, oestrone) and synthetic substances (*e.g.* 17α-ethynyloestradiol, alkylphenols, phthalates, some brominated flame retardants) can produce additive oestrogenic responses in fish. It has also been recognised that more information is needed on endocrine disrupting effects other than oestrogenic effects. Since the Quality Status Report 2000, there has been relatively limited improvement in our knowledge on the range of concentrations of potentially endocrine disrupting chemicals released to the marine environment.

Recent work has highlighted the potential for man-made chemicals to disrupt immune systems and chemical communication between organisms. Research in this field is expanding at a rapid rate, but the most studied and understood aspect of endocrine disruption remains the effects on sex hormone systems and reproduction in fish.

OSPAR has developed guidelines for monitoring endocrine disrupting effects in fish. Although not a formal part of the OSPAR monitoring programme, the data allowed surveys of vitellogenesis and intersex in male fish which present considerable evidence that oestrogenic exposure occurs in the OSPAR marine environment, although the extent, severity, and consequences of this are not clear. Male flounder from the estuaries in the UK, Denmark, Netherlands, Belgium, France and Germany have been shown to have elevated concentrations of plasma vitellogenin, as have cod from both North-East Atlantic and from Norwegian inshore waters, and dab from offshore waters of the North Sea. There is some limited evidence that plasma concentrations of vitellogenin in male flounder from some UK estuaries may be declining.

6. Taking OSPAR's Strategy objectives forward

6.1 Changes in market conditions and other factors influence progress

Market conditions, production methods, production volumes and technological developments have contributed to structural changes in some major land-based and offshore industries in the OSPAR area. Some industries have ceased, others emerged, while a considerable part of manufacturing has moved to other parts of the world (*e.g.* Asia). Fast developing economies and associated industrial development and energy demand outside the OSPAR area have a growing effect on the North-East Atlantic through long-range atmospheric transport of pollutants (*e.g.* mercury, PAHs). Moreover, some imported goods may contain hazardous substances that can reach the sea during use and through waste streams (*e.g.* lindane, nonylphenol, brominated flame retardants). In general the steady growth in use of manufactured goods and resulting waste streams is a growing source of potential pollution that needs to be tackled in the coming years. The European Commission estimates that generation of municipal solid waste could increase by more than 40% by 2020 compared to levels in 1995. Although a smaller waste stream, the generation of hazardous waste is also growing (by 13% between 1998 and 2002 in the EU).

Achieving the cessation target will be difficult for many substances with sources which are beyond full control like diffuse pollution from consumer products, historic pollution and natural and human-induced releases from combustion processes. There are also technical and financial impediments in addressing the remaining point and diffuse sources.

Also climate change can interfere with the efforts as expected increased rainfall could result in more flooding which would leach more contaminants from the soil. Increased temperature is expected to increase the mobility and transformation of some contaminants. This is partly reflected in the "grasshopper" effect in the Arctic (Wania and McKay, 1996; AMAP, 2004).

6.2 Problems to be tackled in OSPAR Regions differ

With current efforts continuing, the cessation target is in reach for 8 priority (groups of) chemicals, the two brominated flame retardants pentaBDE and octaBDE and the organic tin compound TBT ➥ *Table 6.1*. OSPAR's assessments indicate that atmospheric and waterborne inputs to the sea of heavy metals and some organic pollutants have decreased considerably in the last 20 years. Progress in reducing air emissions and atmospheric inputs of heavy metals and PAHs and waterborne inputs of heavy metals has slowed down in the past decade. Most OSPAR priority chemicals are thought to be still being released to the environment. In most cases no complete quantitative picture can be drawn and a clear trend statement on releases is not possible.

Coordinated monitoring of concentrations of heavy metals and PAHs in water, sediment and biota have shown a downward trend over the period 1998 – 2007, although the rate of decrease has been less than in the previous decade. Problems from elevated concentrations persist for many contaminants especially in coastal areas near the main sources. PCBs and lindane show the most coherent downward trend with inputs and concentrations in sediments and biota. One reason could also be that the physico-chemical behaviour of these lipophilic compounds match better with the assessment method (normalisation) than other assessed chemicals. For other substances which have been more recently regulated (*e.g.* brominated flame retardants, PFOS), existing monitoring and surveys show that the presence of these substances are widespread across all Regions.

Regional differences in status and trend of the environmental quality and pressures require different emphasis of future actions in the OSPAR Regions.

Region I: Contamination levels are lower than in other Regions but expected trends in pressures give rise to concern

Region I: Percentage of CEMP monitored sites with unacceptable status	
Cadmium	4%
Lead	13%
Mercury	4%
PAHs	31%
PCBs	29%
Based on CEMP results (Figure 5.1)	

Region I is characterised by a short coastline and sparse population and industry. It receives contaminants from some local sources but also from sources far outside the Arctic through long-range transport especially by wind.

In recent years input levels of copper increased in the region due to discharges from antifouling agents on fish-farming equipment. Overall, contamination levels of heavy metals and PAHs and PCBs in Region I are lower than in the other OSPAR regions, reaching background values for metals at many monitored sites. However, widespread contamination of top predators with mercury and a variety of persistent organic pollutants, including SCCPs, PFOS and brominated flame retardants, is of concern. The focus is less on individual substances and their levels than the mix of contaminants and their combined effects on marine life. While human exposure to contaminants is decreasing, marine mammals remain a dietary source for mercury and POPs (AMAP, 2009).

There is concern that as result of climate change induced rise of temperature the pressure from long-range transport of contaminants will increase and that melting ice in the high Arctic could possibly release trapped contaminants. The ice retreat opens new offshore areas to human activities such as oil production, shipping, and tourism. This means a possible increase in associated pressure from contaminant inputs.

Emphasis in Region I should be given to actions to control releases of mercury and POPs worldwide, continued monitoring of changes in contamination of the marine environment in the Region, and strategies to manage increasing human offshore activities and their associated pollution.

Summary	Towards the cessation target 2020	Status relating to background /zero	Trend in status 1998-2006	Key factors and pressures	Outlook for trend in pressures	Confidence (status)
Region I	Some progress	Some problems	Mixed	Long-range air transport Sea-based activities	Increasing	High

Regions II and III: Contamination levels give rise to risk of pollution effects in many areas

Regions II and III: Percentage of CEMP monitored sites with unacceptable status

	Region II	Region III
Cadmium	20%	11%
Lead	53%	29%
Mercury	37%	24%
PAHs	55%	61%
PCBs	71%	57%

Based on CEMP results (Figure 5.1)

Region II is a highly populated area with important industrial centers in the OSPAR catchments, some of the busiest harbours and shipping routes in the OSPAR area, and numerous offshore and coastal activities. Highest activities in Region III are in and around the Irish Sea.

Inputs of contaminants from land-based point and diffuse sources are still the main pressure in both Regions. Atmospheric emissions and deposition of heavy metals and PAHs from combustion processes also remain to be further addressed. The decrease of environmental concentrations is more marked in Region II than in other Regions, as is illustrated for mercury in the German Bight (Box 20). The contamination status for heavy metals, PCBs and PAHs is still unacceptable at many monitored locations in Regions II and III, especially close to point sources. Effects of TBT along shipping routes and close to harbours are still of concern, but effects on sensitive marine snail species have been decreasing in both regions with overall higher impact levels in Region II than Region III. There is some evidence of adverse of effects of contaminants on fish and marine mammal health in both Regions.

It is expected that it will become technically and economically more difficult in future to further reduce releases from point sources within the OSPAR area. It is expected that releases from outside the OSPAR area, such as of mercury and PAHs, become increasingly important. The relative importance of land-based inputs from wastes containing hazardous substance is increasing. Pollution legacies in estuarine and marine sediments are expected to provide a continued source of releases of persistent contaminants over the next decade.

Emphasis in Regions II and III should be given to actions to further reduce releases from point sources, especially of heavy metals and PAHs from combustion; control releases of mercury and POPs worldwide; control losses of hazardous substances from waste streams; implement and enforce the ban of TBT containing paints on ships; and to continue monitoring changes in contamination in the marine environment.

Summary	Towards the cessation target 2020	Status relating to background /zero	Trend in status 1998-2006	Key factors and pressures	Outlook for trend in pressures	Confidence (status)
Region II	Some progress	Many problems	Mixed	Land-based inputs Long-range air transport Sea-based inputs	Unclear	High
Region III	Some progress	Some problems	Mixed	Land-based inputs Long-range air transport Sea-based inputs	Unclear	High

Box 20

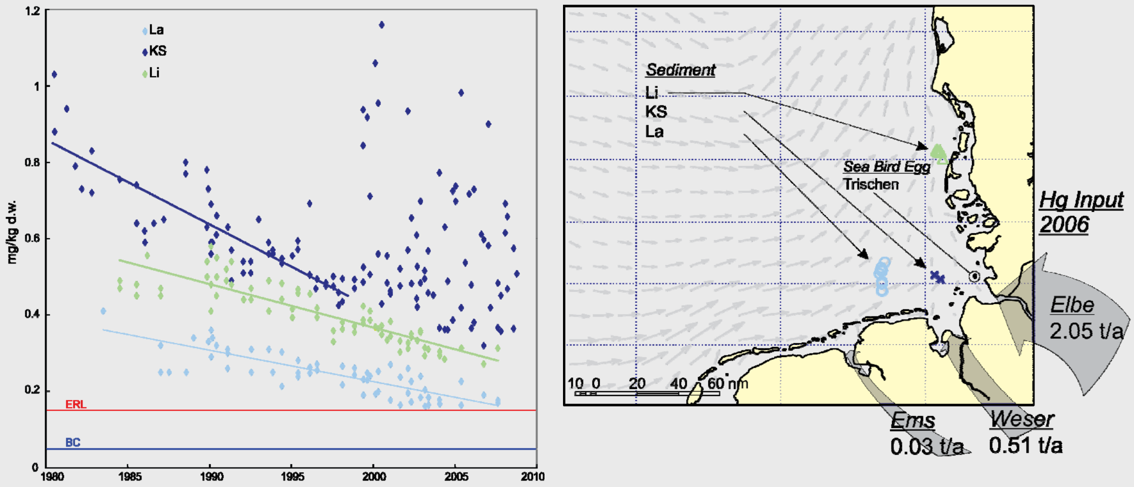
Measures to combat mercury pollution in the German Bight show clear effects

Historically the German Bight has been a region of elevated mercury concentrations. It receives riverine inputs from the rivers Ems, Weser, Elbe and Eider and possibly inputs via the North Sea current systems originating from the southern coast of the continent and British river systems. The river Elbe drains much of eastern Germany's industrial heartland and has been a particular important pathway for mercury to the marine environment.

In 1990, the International Conference on the Protection of the North Sea agreed to achieve, by 1995, substantial reductions of mercury inputs of the order of 70% compared to input levels in 1985, encompassing all input pathways to the North Sea. The required reductions were achieved in Germany through the application of the German Federal Water Act and, following German unification in 1990, through the closure of major industrial facilities in the East German part of the Elbe catchment which couldn't be retrofitted.

As a result, mercury inputs by German river systems to the North Sea reduced significantly. By 2005, a reduction of mercury discharges to surface waters of 92% relative to 1985 have been achieved. Emissions to air have been reduced by 81% since 1995. This is reflected in a decrease of environmental concentrations of mercury. For example, the mercury concentration at the surface of the Elbe sediments decreased by almost 90% during the period from 1990 to 2007, and concentrations in seabird eggs collected on Trischen Island in the outer Elbe estuary followed a similar temporal trend.

Although mercury concentrations in the inner German Bight (KS station: ~0.45 mg/kg in fine sediments) exceed the OSPAR background concentration by about a factor of 5, almost the entire north-west part of the German Exclusive Economic Zone is now close to background concentrations. Recently a 10% average increase in mercury concentrations as well as a significantly increased variability in the sediment burden were observed in the outer Elbe estuary (stations KS). There is evidence that this is likely to be due to mobilisation of historically contaminated deeper sediment layers.



Left figure: Mercury concentrations in surface sediment (fine fraction) at three sampling sites in the inner German Bight during the period 1980 to 2008. Each local data set is superimposed by a linear trend line. The horizontal bars show the agreed OSPAR assessment criteria for Background Concentration (BC, blue) and Effect Range Low (ERL, red). Right figure: Spatial representation of the sampling sites in the German Bight. Annual (2006) mercury inputs via German river systems. Vector mean seasonal surface circulation (January, February and March 2008) in the German Bight.

➥ *Annex 3: Mercury in the German Bight*

Region IV: Contamination levels in some areas show risk of pollution effects but picture of the Region is incomplete

The coasts of Region IV are highly populated and industrialized. Most river systems discharge in the northern part of the Region. As a result waterborne inputs of heavy metals from land-based sources is more dominant in the Bay of Biscay than on the Iberian coast where atmospheric inputs are also an important pathway. Available monitoring information on inputs and environmental concentrations has improved, but is still lacking in many parts along the Iberian coast and offshore.

Region IV: Percentage of CEMP monitored sites with unacceptable status	
Cadmium	4%
Lead	13%
Mercury	41%
PAHs	19%
PCBs	59%
Based on CEMP results (Figure 5.1)	

The highest proportion of CEMP monitoring stations with unacceptable levels of mercury in the OSPAR area is in Region IV. Also PCBs are still at unacceptable levels at many monitored sites. Concentrations of cadmium, lead and PAH in the marine environment are low compared to Regions II and III, approaching but not yet reaching background values in many areas. The situation of TBT is comparable to Regions II and III and mainly confined to the vicinity of harbours and shipping routes where high impact levels on marine snails are still observed at some locations.

Expected trends in pressures are similar to Regions II and III. Emphasis in Regions IV should be given to actions to further reduce releases from point sources, especially of mercury; control releases of mercury and POPs worldwide; control losses of hazardous substances from waste streams; implement and enforce the ban of TBT containing paints on ships; and to continue and extend monitoring of changes of contamination in the marine environment.

Summary	Towards the cessation target 2020	Status relating to background /zero	Trend in status 1998-2006	Key factors and pressures	Outlook for trend in pressures	Confidence (status)
Region IV	Some progress	Some problems	Mixed	Land-based pollution Long-range air transport Sea-based pollution	Unclear	High

Region V: Knowledge of contamination in the Wider Atlantic is very limited

Region V is a huge open sea area with no coasts except the Azores. It receives contaminants through long-range atmospheric transport and deposition from sources within and outside Europe and from offshore activities. Lead and cadmium modelled input in Region V shows an unexplained increase in 2006. Atmospheric deposition levels of heavy metals, PCBs and lindane are however low compared to estimates for the other OSPAR Regions. Region V is not covered by national CEMP monitoring programmes. Studies in different parts of the world's oceans have found evidence that contaminants such as TBT, PCBs and brominated flame retardants can find their way into the deep-sea food web (*e.g.* Unger *et al.*, 2008). In the absence of collected data no conclusions can be drawn on status and trends in marine contaminant concentrations and effects in the Wider Atlantic.

It is expected that the pressures from long-range atmospheric transport will increase in the next decade. It is not clear whether pressures from offshore activities will increase *e.g.* through expansion of the hydrocarbons industry into deeper water. Emphasis in Region V should be given to actions to improve knowledge about contamination levels and their effects in the region.

Summary	Towards the cessation target 2020	Status relating to background /zero	Trend in status 1998-2006	Key factors and pressures	Outlook for trend in pressures	Confidence (status)
Region V	Some progress	No information	Not assessed	Long-range air transport Sea-based pollution	Unclear	---

6.3 Further action is needed to address pollution from OSPAR priority chemicals

For most OSPAR priority chemicals further action is needed ➥ *Table 6.1*. Abatement at source is still important, based on the precautionary approach and the principle of prevention. Best available techniques and best environmental practice must continue to be applied.

Full implementation of existing measures is a priority in order to move towards the cessation target. This includes measures especially required under the

- EU Integrated Pollution Prevention and Control Directive (IPPC Directive 2008/1/EC)
- EU Water Framework Directive (2000/60/EC) and its daughter directive (Directive 2008/105/EC)
- EU Marine Strategy Framework Directive (2008/56/EC)

OSPAR should work with the EU on further actions on secondary sources (*e.g.* lead and mercury) and uses in products not yet regulated (*e.g.* di-substituted organotins, HBCD).

OSPAR assessments have confirmed that OSPAR priority chemicals can reach the North-East Atlantic through atmospheric transport and via waste streams of imported products (*e.g.* NP/NPEs, BFRs). OSPAR should actively support global actions to support OSPAR and EU efforts to regulate and control releases of OSPAR priority chemicals including:

- in the framework of UNEP the establishment of a global legally binding instrument to control and reduce mercury releases worldwide, and inclusion of additional persistent organic chemicals (*e.g.* decaBDE, HBCD, SCCPs and endosulfan) for elimination under the Stockholm Convention on Persistent Organic Pollutants,
- in the framework of the UNECE Convention on Long-Range Transboundary Air Pollution support of measures on heavy metals and POPs under the Aarhus Protocols.

6.4 Lessons learnt for future monitoring and assessment

OSPAR should continue its key role in setting up and implementing monitoring strategies to track progress on controlling hazardous substances, especially the development of quality status. The Coordinated Environmental Monitoring Programme has provided well tested, quality assured, methodologies and standards for environmental monitoring which can contribute to the evaluation of good environmental status under the Marine Strategy Framework Directive and good chemical status under the Water Framework Directive. Future assessment and monitoring need to be supported by:

- improved understanding of the effects of hazardous substances, particularly cumulative effects and endocrine disruption;
- improved biological effects monitoring, integrated, where appropriate, with chemical monitoring. Novel techniques such as passive sampling could support integrated monitoring (Box 21);
- extending datasets further offshore beyond the densely populated and industrialised coasts;
- co-ordinating and expanding the contaminant coverage of the OSPAR monitoring programmes;
- improved information collection on the production, uses and various pathways to the marine environment, especially for substances where monitoring in the marine environment is not practical;
- use of research results on concentrations and effects of hazardous substances on deep-sea species and ecosystems.

Box 21

Passive sampling can support cost-efficient monitoring

Passive sampling has been used in research for more than a decade and is now growing rapidly in importance as a monitoring technique, especially for hydrophobic contaminants, such as PCBs. The uptake of the contaminants from water by passive samplers allows estimation of the freely dissolved concentrations in the water; the key parameter for risk assessment of the effects of exposure to contaminants on aquatic organisms. Freely dissolved concentrations of hydrophobic contaminants are very low in surface waters and difficult to quantify with classical sampling techniques. Passive sampling polymers mimic the partitioning of contaminants into organisms. The long sampling period (typically 4 – 6 weeks) provides temporal averaging, and the samplers accumulate easily detectable amounts of contaminants. Passive sampling monitoring in concert with deployed mussels revealed a strong relationship between tissue and freely dissolved concentrations, and confirms the real relevance of passive samplers to bioavailability.

A European wide survey and intercalibration was organised by expert groups of the International Council for the Exploration of the Sea. Samplers were exposed by 13 laboratories at 30 stations. Freely dissolved concentrations of priority hazardous hydrophobic substances could be estimated at virtually all stations, and the data showed good analytical comparability. The results demonstrate the huge potential of passive sampling to address the key questions of the significance of contaminants in water and sediment, showing clear routes to unified assessments of environmental quality. Passive samplers can help to solve fundamental questions of environmental risk.

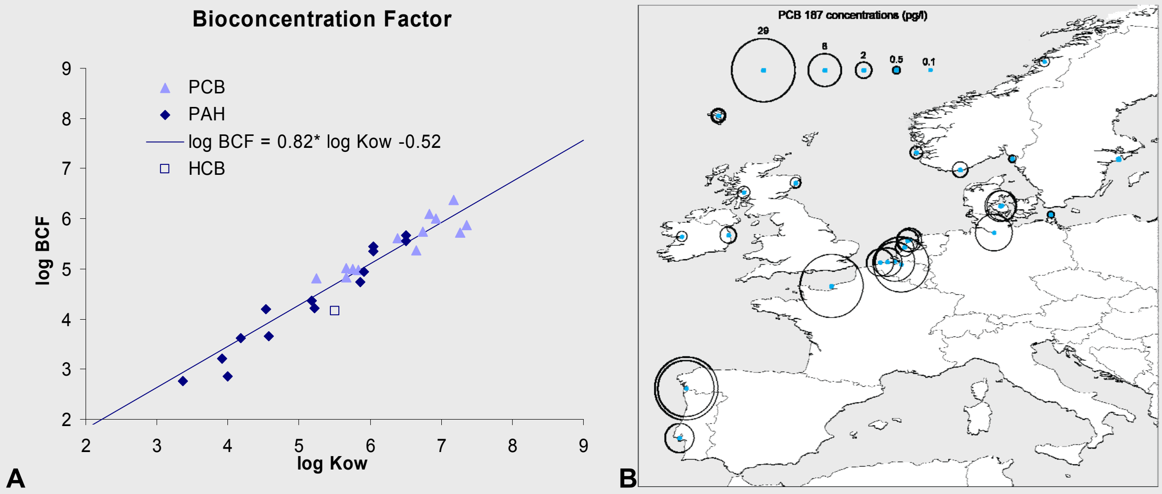


*Figure: (**A**) Relation of bioconcentration factor (BCF) measured using passive samplers with the octanol-water partition coefficient (K_{OW}) representing the hydrophobicity of the contaminants. (**B**) Freely dissolved concentrations of PCB 187 (pg/l) at different stations in Europe measured using passive samplers.*

➥ *Monitoring with passive sampling: Smedes (2007a), Smedes (2007b)*

6.5 Cooperation with European initiatives on identifying, selecting and managing substances of concern should continue

OSPAR has identified possible 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 continue to actively generate input to the EU on the identification, selection and prioritisation of hazardous substances which are of concern for the marine environment (*e.g.* for the list of priority (hazardous) substances under the Water Framework Directive) and promote actions under REACH and other relevant EU legislation to control and reduce their risks for the marine environment.

OSPAR should continue to focus on substances posing risks to the marine environment that are not yet adequately covered by the EU and other appropriate international fora. This includes keeping a watch to see if there are new substances of concern for the environment that are not being regulated through EU or other mechanisms. These may be substances with a “traditional” PBT profile or those having properties that raise a similar level of concern. This concerns for example:

- the full effects of properties such as endocrine disruption which remain a concern and need to be tracked;
- the behaviour of some pharmaceuticals in the environment which is not fully understood.

Continued cooperation by OSPAR with industry on the identification of substances of concern is important.

Table 6.1: *Summary conclusions for each OSPAR priority chemical*

Confidence: *** high: mainly (coordinated) monitoring; ** moderate: monitoring and qualitative information; * low: mainly qualitative information. ? = lack of information

OSPAR priority (groups of) chemicals (click on substance to link to summary sheet at Annex 1)		Are existing efforts expected to deliver the cessation target in 2020?	Are environmental concentrations above background/ zero?	Is there evidence of pollution effects of one or combined substances?	What to do next?
Metals	Cadmium	No**	Some areas***	?	▪ Implement EU Water Framework Directive for heavy metals ▪ Improve technology to further reduce emissions *e.g.* in combustion processes ▪ Assess uses in products not yet regulated and the need for action ▪ Support development of global convention on mercury in UNEP framework ▪ Continue environmental monitoring
	Lead, organic lead compounds	No**	Many areas***	?	
	Mercury, organic mercury compounds	No**	Many areas***	Yes**	
Organometals	Organic tin compounds	Group: No* TBT: Yes*	Many areas***	Yes***	▪ Complete implementation of IMO Convention on antifouling systems ▪ Implement EU Water Framework Directive for TBT ▪ Adopt measures as follow-up to EU risk assessment on organotins in consumer products ▪ Continue environmental monitoring
Oragnohalogens	Short-chain chlorinated paraffins	Yes*	Many areas**	?	▪ Support measures under the Stockholm POP Convention and the UNECE POP Protocol
	PFOS	No*	Many areas**	?	▪ Implement recently adopted EU marketing and use measures ▪ Assess effectiveness of those measures to inform direction of further actions ▪ Support measures under the Stockholm POP Convention and the UNECE POP Protocol ▪ Continue environmental monitoring
	Polychlorinated dibenzodioxins and dibenzofurans (PCDDs, PCDFs)	No**	Many areas**	Yes**	▪ Address remaining releases through EU Strategy on dioxins and PCBs ▪ Continue environmental monitoring
	Polychlorinated biphenyls (PCBs)	No**	Many areas***	Yes**	▪ Address remaining releases (*e.g.* unintended production) within EU framework
	Brominated flame retardants	Group: No* octaBDE, pentaBDE: Yes*	Many areas **	Yes**	▪ Implement EU Water Framework Directive for all brominated flame retardants ▪ Promote additional measures in the EU on DecaBDE and HBCD ▪ Implement Directive 2002/95/EU on the use of hazardous substances in electrical and electronic appliances ▪ Support measures under the Stockholm POP Convention and the UNECE POP Protocol ▪ Continue environmental monitoring
	Tetrabromobisphenol-A	No*	Many areas**	?	▪ Support EU marketing and use measures under development
	Trichlorobenzenes	No*	Some areas**	?	▪ Assess effectiveness of EU marketing and use measures to inform direction of further actions ▪ Implement EU Water Framework Directive for trichlorobenzenes
Pesticides/biocides	Endosulfan	Yes*	Few areas*	?	▪ Support measures under the Stockholm POP Convention and the UNECE POP Protocol
	HCH isomers (incl. lindane)	Yes*	Some areas**	?	▪ Continue environmental monitoring
	Dicofol	Yes*	?	?	▪ Continue existing efforts
	Methoxychlor	Yes*	?	?	▪ Continue existing efforts
	Pentachlorophenol (PCP)	Yes*	?	?	▪ Continue existing efforts
	Trifluralin	Yes*	Some areas*	?	▪ Continue existing efforts
Phenols	2,4,6-tri-*tert*-butylphenol	?	Some areas*	?	▪ Collect and assess information to inform right direction of actions
	Nonylphenol-ethoxylates	Yes*	Some areas*	?	▪ Continue existing efforts
	Octylphenol	No*	Some areas*	?	▪ Assess whether measures for nonylphenol-ethoxylates will result in the cessation of octylphenol to inform right direction of actions
Phthalates	dibutylphthalate (DBP), diethylhexyl-phthalate (DEHP)	No*	Some areas*	?	▪ Implement EU Water Framework Directive for DEHP ▪ Support marketing and use measures for DEHP in EU ▪ Collect and assess recent information on production, sales, import and export for DEHP and DBP to inform direction of actions
Polycyclic armomatic	Polycyclic aromatic hydrocarbons (PAHs)	No*	Many areas***	Yes**	▪ Improve technology to further reduce emissions from combustion processes ▪ Fully implement Water Framework Directive obligations for PAHs ▪ Continue environmental monitoring
Pharmaceuticals, personal care, and other substances	Clotrimazole	No*	Few areas*	?	▪ Implement the EU regulatory framework ▪ Assess effectiveness of measures by means of a one-off survey of effluents of waste water treatment plants to inform right direction of actions
	Musk xylene	No*	?	?	▪ Assess effectiveness of EU marketing and use measures in development ▪ Assess outcome of the evaluation of the REACH Annex XV dossier ▪ Assess effectiveness of the outcome of the evaluation under the EQS Directive (under WFD) by means of a one-off survey of effluents of waste water treatment plants
	4-(dimethylbutylamino) diphenylamine (6PPD)	?	?	?	▪ Collect and assess information to inform right direction of actions
	Neodecanoic acid, ethenyl ether	?	?	?	▪ Finalise preparation of OSPAR background document with agreed actions

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8. Glossary and acronyms

6PPD	4-(dimethylbutylamino) diphenylamine
AFS Convention	2001 IMO International Convention on the Control of Harmful Antifouling Systems on Ships. Entry into force on 17 September 2008. (http://www.imo.org)
BAT	‘Best Available Techniques’ means the latest stage of development (state of the art) of processes, of facilities or of methods of operation which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste
BBP	butylbenzyl
BDEs	brominated diphenyl ethers
BEP	‘Best Environmental Practice’ means the application of the most appropriate combination of environmental control measures and strategies
BFR	‘Brominated Flame Retardants’ covers a range of brominated chemicals used for example in plastics and other products to reduce the potential for burning
bioaccumulation	The accumulation of a substance within the tissues of an organism. This includes ‘bioconcentration’ and uptake via the food chain.
bioconcentrate	The general term describing a process by which chemicals are absorbed by an animal or plant to levels higher than the surrounding environment.
biomagnify	The process in which chemical levels in plants or animals increase from transfer through the food web (eg, predators have greater concentrations of a particular chemical than their prey).
biocide	Chemical used to kill living organisms for other purposes than for plant protection
Biocides Directive	Directive 98/8/EC of the European Parliament and of the Council of 16 February 1998 concerning the placing of biocidal products on the market, OJ L 123, 24.4.1998, p. 1, as amended (*cf.* http://eur-lex.europa.eu for latest consolidated version)
CAMP	OSPAR Comprehensive Atmospheric Monitoring Programme (OSPAR agreement 2001-7, as amended)
CEMP	OSPAR Coordinated Environmental Monitoring Programme (latest update OSPAR agreement 2008-8)
CEFIC	European Chemical Industry Council (http://www.cefic.be)
CMR	Chemicals which are ‘Carcenogenic, Mutagen and Retrotoxic’
closed application	Application where – in principle – a substance cannot be released to the environment during use
Contracting Parties	The 16 OSPAR Contracting Parties comprise the states Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom, and the European Community
DBP	dibutylphthalate
DBT	dibutyltin
DecaBDE	deca brominated diphenyl ether
DEHP	di(2-ethylhexyl) phthalate
DIDP	di(isodecyl)phthalate
DINP	di(isononyl)phthalate

d.w.	dry weight
DYNAMEC	Dynamic Selection and Prioritisation Mechanism for Hazardous Substances - The DYNAMEC mechanism consists of a variety of interrelated steps and procedures. See DYNAMEC manual, OSPAR publication 256/2008.
EMEP	Co-operative Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe
endocrine disruptor	An exogenous substance that causes adverse health effects in an intact organism, or its progeny, consequent to changes in endocrine function. In applying this definition to the marine environment it will be necessary to consider substances that are likely directly or indirectly to affect the hormonal regulation in whole organisms by the mimicking of hormones or by affecting enzyme systems responsible for hormone equilibria
EPER	'European Pollutant Emission Register' set up by Commission Decision 2000/479 to meet the requirements of the EU Integrated Pollution Prevention and Control (IPPC) Directive. EPER will be replaced by E-PRTR.
EU	European Union
HARBASINS	Harmonised River Basins Strategies North Sea
hazardous substances	For the purpose of the OSPAR Hazardous Strategy, substances which fall into one of the following categories: (i) substances or groups of substances that are toxic, persistent and liable to bioaccumulate; or (ii) other substances or groups of substances which are assessed by OSPAR as requiring a similar approach as substances referred to in (i), even if they do not meet all the criteria for toxicity, persistence and bioaccumulation, but which give rise to an equivalent level of concern
HBCD	hexabromocyclododecane
HCB	hexachlorbenzol
HCH	hexachlorcyclohexan
IMO	International Maritime Organisation (http://www.imo.org)
IPPC Directive	Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning integrated pollution prevention and control (codified version), OJ L 24, 29.1.2008, p. 8. This codifies the IPPC Directive (91/61/EEC)
JAMP	OSPAR Strategy for a Joint Assessment and Monitoring Programme (OSPAR agreement 2003-22)
LRTAP	1979 UNECE Convention on Long-Range Transboundary Air Pollution. Entry into force in 1983. (http://www.unece.org)
l.w.	lipid weight
Marine Strategy Framework Directive	Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive), OJ L 164, 25.6.2008, p. 19, as amended (*cf.* http://eur-lex.europa.eu for latest consolidated version)

Marketing and Use Directive	Council Directive 76/769/EEC of 27 July 1976 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, OJ L 262, 27.9.1976, p. 201, as amended (*cf.* http://eur-lex.europa.eu for latest consolidated version)
octaBDE	octa brominated diphenyl ether
NP	nonylphenol
NPE	NP ethoxylates
OP	octylphenol
OECD	Organisation for Economic Co-operation and Development (http://www.oecd.org)
open use	Quantities of hazardous substances used in open applications are especially difficult to retrieve and estimate. All open applications can be considered uncontrolled.
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 Convention	Convention for the Protection of the Marine Environment of the North-East Atlantic, was opened for signature on 22 September 1992 and entered into force on 25 March 1998. It replaces the Oslo Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft signed in Oslo on 15 February 1972, and the Paris Convention for the Prevention of Marine Pollution from Land-based Sources, signed in Paris on 4 June 1974
OSPAR area	The area of the OSPAR Convention is divided into five regions: Region I – Arctic Waters, Region II – Greater North Sea, Region III – Celtic Seas, Region IV – Bay of Biscay and Iberian Coast and Region V – Wider Atlantic
OSPAR Hazardous Substances Strategy	OSPAR thematic strategy to address hazardous substances. Adopted by OSPAR 1998 and revised in 2003 as part of the revised Strategies of the OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic. OSPAR agreement 2003-21.
OSPAR priority chemicals	Substances listed on the OSPAR List of Chemicals for Priority Action (OSPAR agreement 2004-12, as amended)
PAH	polycyclic aromatic hydrocarbons
PARCOM	Paris Commission established under the Paris Convention for the Prevention of Marine Pollution from Land-based Sources. Decisions and Recommendations of the Paris Commission form an integral part of the *acquis* of the OSPAR Convention
PBB	polybrominated biphenyls
PBDEs	polybrominated diphenyl ethers
PBT criteria	The intrinsic properties of individual substances, specifically whether they are persistent (P), toxic (T) or liable to bioaccumulate (B), determine whether they fall within the definition of hazardous substances given in the OSPAR Strategy with regard to Hazardous Substances
PCBs	polychlorinated biphenyls
PCP	pentachlorophenol
pentaBDE	penta brominated diphenyl ether
Pesticides Directive	Council Directive 91/414/EEC of 15 July 1991 concerning the placing of plant protection products on the market, OJ L 230, 19.8.1991, p. 1, as amended (*cf.* http://eur-lex.europa.eu for latest consolidated version)

PFA	perfluroalkylated acid
PFOS	perfluorooctane sulphonate
pg	pico gramme (10^{-12})
PNEC	Predicted No-Effect Concentration
POP	Persistent Organic Pollutants
REACH Regulation	Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, OJ L 136, 29.5.2007, p. 3, as amended (*cf.* http://eur-lex.europa.eu for latest consolidated version)
RID	OSPAR Comprehensive Study on Riverine Inputs and Direct Discharges (OSPAR agreement 1998-5)
Stockholm POP Convention	2001 UNEP Stockholm Convention on Persistent Organic Pollutants. Entry into force 18 February 2004. (http://www.pops.int)
SCCPs	short-chained chlorinated paraffins
TBBP-A	tetrabromobisphenol-A
TBT	tributyltin
TCBs	trichlorobenzenes
TEF	Toxic Equivalency Factor (TEF)
TEQ	Toxic EQuivalent scheme
TPT	triphenyl tin
UNECE	United Nations Economic Commission for Europe (http://www.unece.org)
UNECE POP Protocol	1998 Protocol on Persistent Organic Pollutants, which was adopted as a protocol to the Convention on Long-Range Transboundary Air Pollution. Entry into force on 30 December 2003. (http://www.unece.org)
UNEP	United Nations Environmental Programme (http://www.unep.org)
vitellogenesis	Vitellogenesis (also known as *yolk deposition*) is the process of yolk formation via nutrients being deposited in the oocyte, or female germ cell involved in reproduction
Waste Electrical and Electronic Equipment Directive	Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE)
Water Framework Directive	Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, OJ L 327, 22.12.2000, p. 1, as amended (*cf.* http://eur-lex.europa.eu for latest consolidated version)
w.w.	wet weight.

Annex 1

Status and trend of marine pollution with OSPAR priority chemicals

The evaluation of status and trends of marine pollution with OSPAR priority chemicals and progress towards the OSPAR objectives for hazardous substances is based on data collected under OSPAR monitoring programmes and data and information collected from external sources relevant for the OSPAR area and with an emphasis on the period 1998 – 2008. This is based on the monitoring strategies for OSPAR priority chemicals which are part of each chemical's Background Document and summarised in OSPAR agreement 2004-14. An overview of the monitoring requirements and data/information collected is given in Table A1.1.

In the following, a summary is given for each OSPAR priority chemical summarising their risk for the marine environment ➥ *relevant Background Document at http://www.ospar.org*, measures taken to control the risk and progress made towards the OSPAR objectives to cease their releases by 2020 ➥ *Towards the cessation target (OSPAR, 2008a)* and to achieve background concentrations or zero for manmade substances in the marine environment ➥ *Trends and concentrations in sediments and biota* and ➥ *Annex 2 of this report*.

Table A1.1: *Overview of data and information sources for the assessment*

White areas indicate the information to be collected under the monitoring strategies for priority chemicals as set out in OSPAR agreement 2004-14
● data collected; ○ not available;

OSPAR chemicals for priority action		**Production, sales, use figures (where relevant import/ export)**			**Discharges, emissions and losses**							**Riverine and atmospheric inputs**				**Concentrations and effects in the marine environment**					**National environmental information (Annex 2)**
		Implementation reporting EU and OSPAR	CEFIC and ECPA	Update of Background Documents	EPER	EMEP	Dum-ping	Specific industry reports	One off survey	Other one off activity	Additional voluntary activity	RID	WFD	CAMP (incl. EMEP)	One-off survey	CEMP	WFD	one-off surveys	One off activity	Additional voluntary activity	
Metals	**Cadmium**	●		○	●	●	●	○			●	●	○	●		●	○				
	Lead	●		○	●	●	●	○			●	●	○	●		●	○				
	Mercury	●		○	●	●	●	●			●	●	○	●		●	○		●	●	
Organometals	**Organotins**	●			●		●						○		○	●	○				
Organo-halogens	**SCCPs**	●	●		●	●							○				○	○			●
	PFOS	○	○													○				○	●
	Dioxins/furans	○			●	●										○		○			●
	PCBs	○				●	●			○		○		●		●			○		
	BFRs	○														●			●		●
	TBBP-A	○														○		○		○	●
	TCBs	○	●	○	●								○				○			○	●
Pesticides/ Biocides	**Endosulfan**	○	●										○	○			○	○			●
	HCH/lindane	○				●						○	○	●		●	○			●	●
	Dicofol	○	○								○										
	Methoxychlor	○									○										
	PCP	○	●			●							○				○				
	Trifluralin	○	●										○		○		○	○			●
Phenols	**2,4,6-TTBP**	○	○					●										○			●
	Nonylphenol-ethoxylates	○											○				○				●
	Octylphenol	○						●					○				○				●
Phthalates	**phthalates**	○	○										○				○				●
Polycyclic aromatics	**PAHs**	●		○	●	●	●				●	○	○	○		●	○			○	
Pharmaceuticals, personal care, and other substances	**Clotrimazole**	○		○					○										○		
	Musk xylene	○	○						○	○											
	6PPD			○							○										

1. Heavy metals

1.1 Cadmium

Cadmium occurs naturally in geological ores and is found at background levels in the marine environment. Cadmium for industrial or commercial use is derived from mining, smelting and refining of zinc. Its main use in batteries has almost ceased in Europe. It is still used as intermediate and catalyst for electroplating, in pigment in paint, in stabilizer for plastic, in photographical processes and in dyes.

What is the problem?

Cadmium is toxic and liable to bioaccumulate and thus is a contaminant of concern both for the marine environment and for human consumption of fish and other seafood. The main sources of cadmium to the environment are emissions from combustion processes primarily in power plants and industry, but also other commercial and domestic sources. Other relevant sources are releases to water and air including from the metallurgical industry, road transport and waste streams. The main pathway of cadmium to the sea is via air by which it can be carried long distances from its source. With the closure of cadmium refineries in Europe in response to marketing and use restriction regulations, diffuse sources, especially waste streams, are gaining relative importance.

What has been done?

OSPAR measures and subsequent EU measures regulate the main industrial sources for cadmium releases to the environment. Specific marketing and use restrictions in the EU framework restrict the use of cadmium in batteries and in a variety of uses, applications and consumer products, including for example fertilisers, sewage sludge, metal plating, toys and packaging and packaging waste.

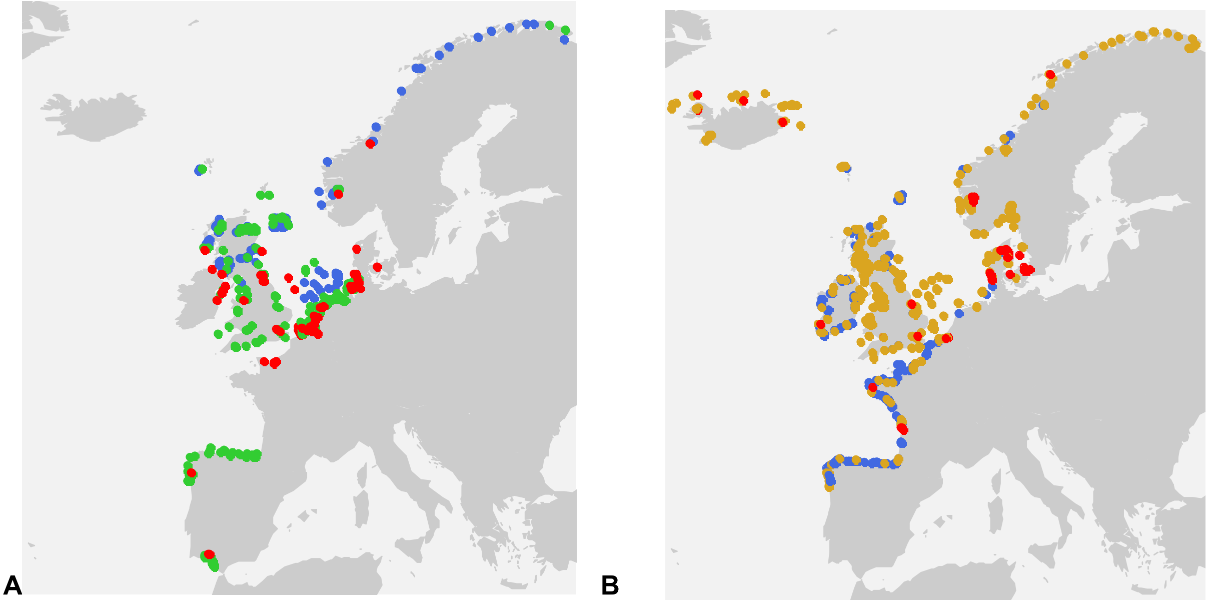
Did it work?

Since 1998, there has been a general reduction in air emissions from OSPAR Contracting Parties. In the period 1998 – 2006, measured atmospheric concentrations of cadmium have decreased in the North Sea area and have also decreased at stations in the Arctic Region and Spain. There have been small reductions in atmospheric deposition of cadmium to the North-East Atlantic over the period 1998 – 2006. Loads of cadmium entering the sea through riverine inputs and direct discharges have also decreased. In Region II and Region III waterborne inputs exceed those from atmospheric deposition. This may also be the case for Region IV. Atmospheric inputs remain the most significant input route to Region I.

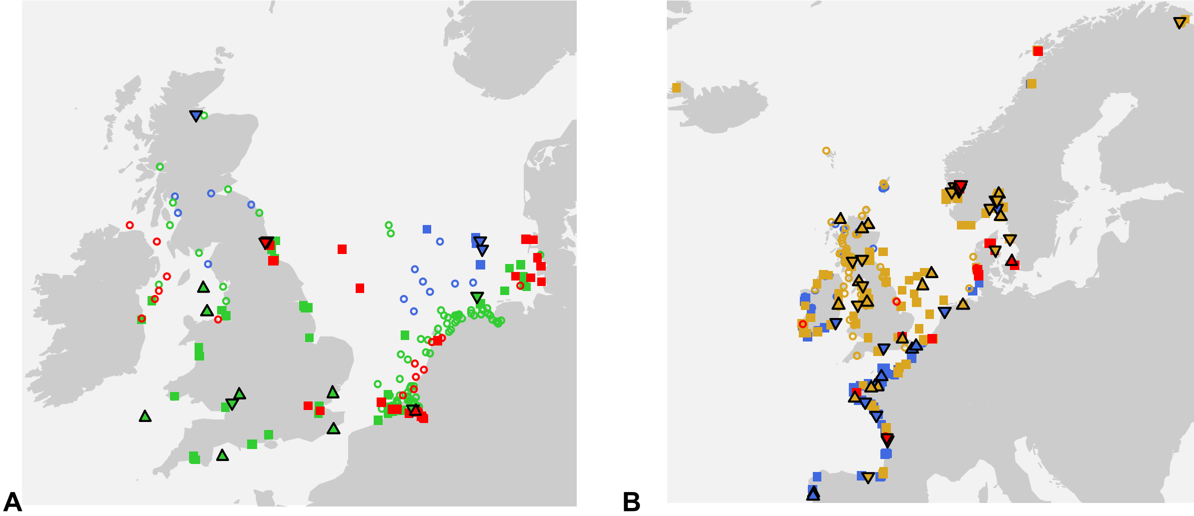
How does this affect the marine environment?

Concentrations of cadmium in the marine environment have generally decreased over the period 1990 to 2007 where trends can be detected, but have not been consistently upwards or downwards over the period 1998 – 2007. However, concentrations remain above background in many areas and in some areas are still at levels where there is potential for significant adverse effects to the environment, or to human health. In sediment, concentrations of cadmium are generally near or just above background. However, concentrations in some areas, such as around the industrial estuaries of the Rhine, Seine, Tyne, Tees, Thames as well as in certain industrialised estuaries in Norway (Inner Sørfjord) and Spain (Ria de Pontevedra) and the inner German Bight are at levels which may pose a significant risk of pollution effects.

Concentrations of cadmium in fish and shellfish were above EU dietary limits in some of these areas. The high concentrations are mainly found around the coasts of Denmark, and at occasional locations in the UK, France, and also in Iceland and Norway where geological factors are likely to increase concentrations locally. Concentrations in fish and shellfish are at or below background at a good proportion of sites in Northern Spain, the Bay of Biscay, the Channel coast of France and parts of Ireland and Scotland. Elsewhere, concentrations are above background. Monitoring data from OSPAR Region V is scarce.



Status of cadmium concentrations in (A) sediments and (B) biota: background (blue), acceptable (green) or below EU dietary limits (amber), and unacceptable (red)



Temporal trends of cadmium concentrations in (A) sediment and (B) biota: downward ▽, upward △, insufficient data for trend assessment ○

1.2 Lead

Lead occurs naturally in the environment and it is a vital element in everyday life. Mining, smelting and industrial use of lead has led to the widespread elevation of environmental lead concentrations. Lead for industrial or commercial use is derived from mining, smelting and refining of geological ores. Its main use worldwide has been for lead-acid batteries for vehicles, emergency systems and industrial batteries. It is also used in accumulators, lead shots, boat keels, building products such as paint, leaded petrol, glass, electronic and electrical equipment, plastic, and ceramic products.

What is the problem?

Lead is persistent and an acute toxic compound for mammals and aquatic organisms and thus is a contaminant of concern both for the marine environment and for human consumption of fish and other seafood. The main sources of lead to the environment are primary production processes such as ferrous and non-ferrous metal production and mining. Other relevant sources are transport, glass production and recycling processes, ceramics production, offshore industry, and waste incineration and disposal. The main pathway of lead to the sea is via air and it can be carried long distances from its source.

What has been done?

OSPAR measures and subsequent EU measures regulate the main industrial sources for lead releases to the environment. Specific restrictions in the EU framework promote the substitution of lead in paints, PVC products and in various other products and articles, include limit values for lead in ambient air and prohibit marketing of leaded petrol.

Did it work?

Lead production in Europe has risen steadily over the period 1998 – 2006 in response to increasing consumption. By 2006, 50% of the total lead production in Europe was from recycling. Important remaining sources of lead emissions and discharges are primary production processes such as ferrous and non-ferrous metal production, mining, glass production and recycling processes, ceramics production, offshore industry, and waste incineration and disposal. As many primary pollutant sources are regulated, the need to assess secondary sources increases. In this context, contaminated sediments and hazardous waste sites on the coast are especially important as long-term sources.

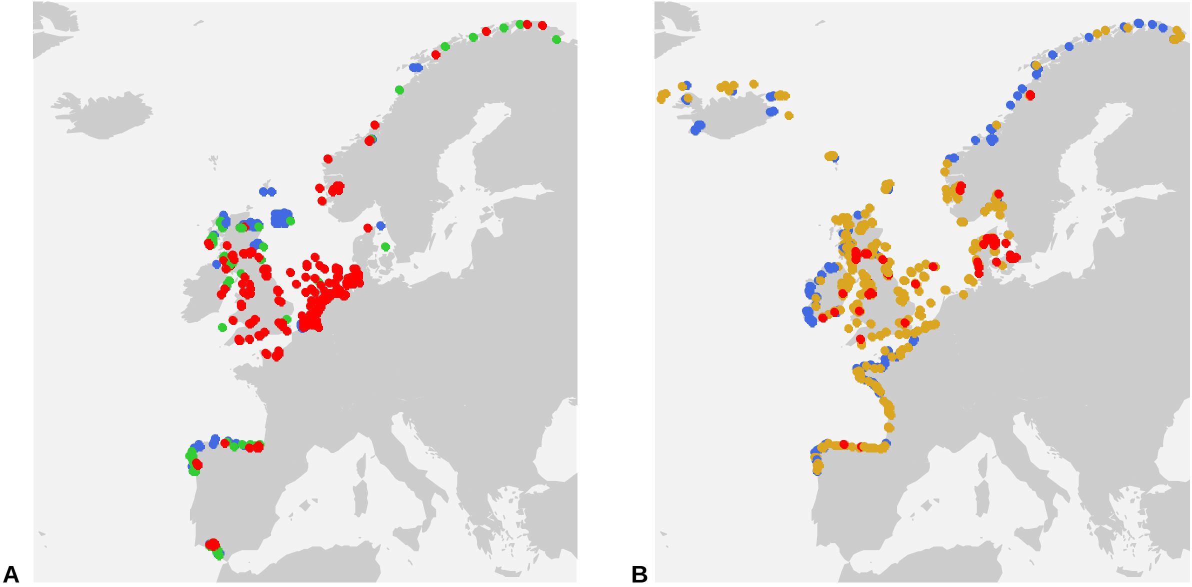
Since 1998, total emissions of lead to air have decreased by more than two thirds according to data reported to EMEP. By 2005, emissions from combustion in power plants and in industry and industrial process were the main contributors to total atmospheric deposition of lead. The most significant reduction in the OSPAR area of around 90% has been achieved in emissions from road transport through the phase-out of leaded petrol in the OSPAR Convention area. However, by 2005 road transport still accounted for 25% of the total emissions being the second largest emission source after combustion in power plants and industry and before industrial processes. Over the same period, emissions from air transport have increased by one third and reductions for industrial and combustion processes were less pronounced. Waterborne inputs have gained more relative significance as atmospheric inputs to the sea have reduced over the period 1990 – 2006 and, in Region II, may now account for approximately 50% of lead inputs.

How does this affect the marine environment?

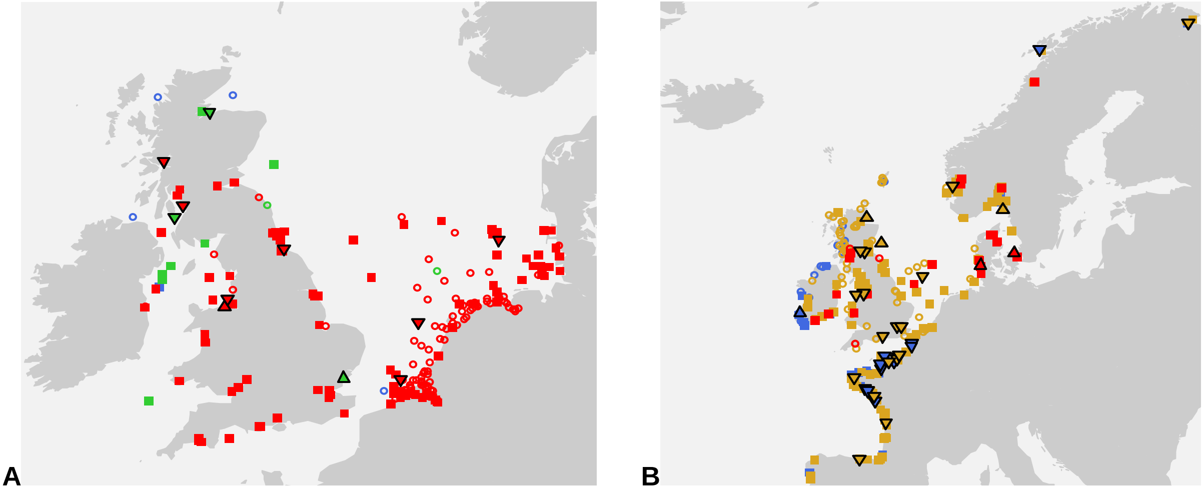
Where they can be detected trends in lead concentrations over the period 1990 – 2006 are generally downward. The picture of downward trends since 2000 is slightly more significant than for cadmium and mercury.

Concentrations of lead in sediment are at levels which may pose a unacceptable risk of pollution effects over large parts of the southern North Sea, both inshore and offshore, the Channel and the Irish Sea. Scattered high concentrations are also found along the coast of Norway and in some locations near urban industrialised areas in northern Spain. However, concentrations in the northern UK, northern Norway and northern Spain are generally approaching or at background.

Concentrations in biota exceeding EU dietary limits are less widespread, and the locations can generally be linked to urban and industrial activity, *e.g.* around Denmark, several UK estuaries and certain sites in southern Ireland and northern Spain. Concentrations in the offshore area around the Dogger Bank are at near coastal levels. This has been attributed to enhanced fine sediment fraction and riverine humic acids in that area which are carriers for lead. Lead concentrations in fish and shellfish remain above background over much of the coasts of Regions II, III and IV, although background levels are evident in western Ireland, the north west coast of Norway, the west of Ireland, and some stations in northern Spain and along the coast of northern France. Concentrations above background at sites around Iceland may be the result of natural geological factors.



Status of lead concentrations in (A) sediments and (B) biota: background (blue), acceptable (green) or below EU dietary limits (amber), and unacceptable (red)



Temporal trends of lead concentrations in (A) sediment and (B) biota: downward ▽, upward △, insufficient data for trend assessment ○

1.3. Mercury

Mercury is an extremely rare element in the earth's crust but occurs in concentrated ores in young geologically active areas *e.g.* often in hot springs or volcanic regions. It is obtained commercial from the ore cinnabar. Industrial and commercial use of mercury has led to the dispersion of mercury and the elevation of environmental mercury concentrations in certain locations. Due to its heavy liquid state, mercury has specific technical applications in a number of products including dental amalgam, batteries, industrial control instruments, laboratory and medical instruments and lighting appliances.

What is the problem?

Mercury is extremely toxic to both man and biota and can be transformed within the aquatic environment into more toxic organic compounds (*e.g.* methyl mercury). A main pathway of mercury to the sea is atmospheric and it can be carried long distances from its source. The main sources of mercury to the environment are natural atmospheric emissions from volcanoes and anthropogenic emissions from coal-fired power stations and metal production and cement production. Mercury also enters into the environment through the disposal products containing mercury including: car parts, batteries, fluorescent bulbs, medical products, thermometers, and thermostats. Emissions from crematoria are a small but widespread source. Many of the releases of industrial mercury during the 1900s came from the mercury cell chlor-alkali process used to produce chlorine. Due to the introduction of new technology, this source has largely been phased out over the last twenty years.

What has been done?

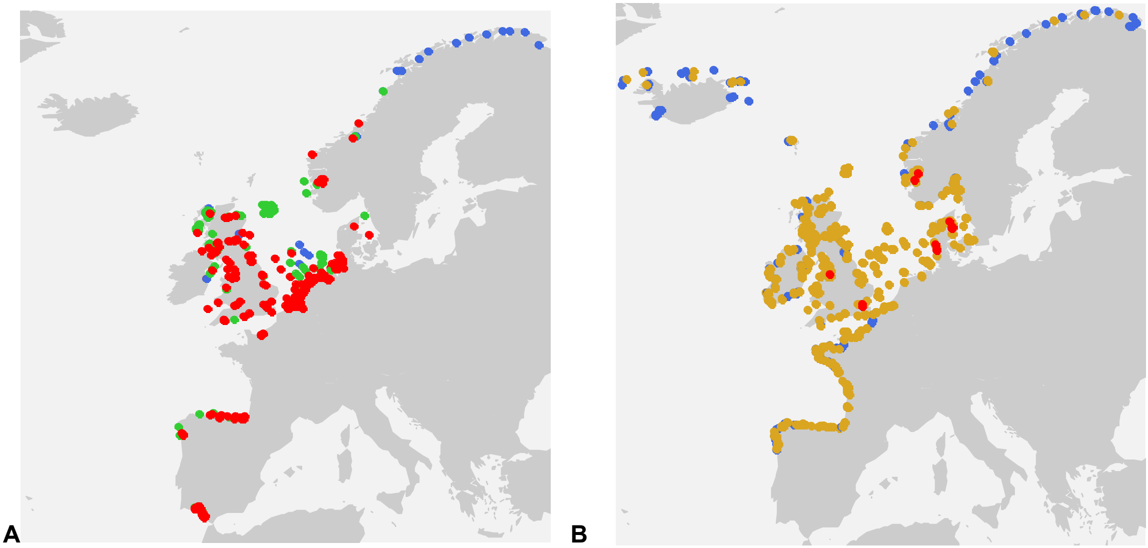
OSPAR measures and subsequent EU measures regulate the main industrial sources for mercury releases to the environment. A suite of OSPAR measures control mercury emissions and discharges from the chloralkali industry, including the complete phase-out of mercury cell chlor-alkali plants by 2010. Other OSPAR measures address a variety of important sources for mercury including dentistry, thermometers, batteries and dental filters, crematoria and other diffuse sources. OSPAR has promoted actions in other international forums, especially the EU, *e.g.* call for actions to prevent pollution from the disposal of large amounts of pure and waste mercury arising from the closure or conversion of mercury cell chlor-alkali plants and for control measures on the use and marketing of mercury in various products. Other measures in the EU address a series of other uses including in biocides, plant protection products and batteries, toys and ceramics. The initiative in the UNEP framework to develop a legally binding global instrument to reduce mercury releases worldwide will support the OSPAR's cessation target for mercury.

Did it work?

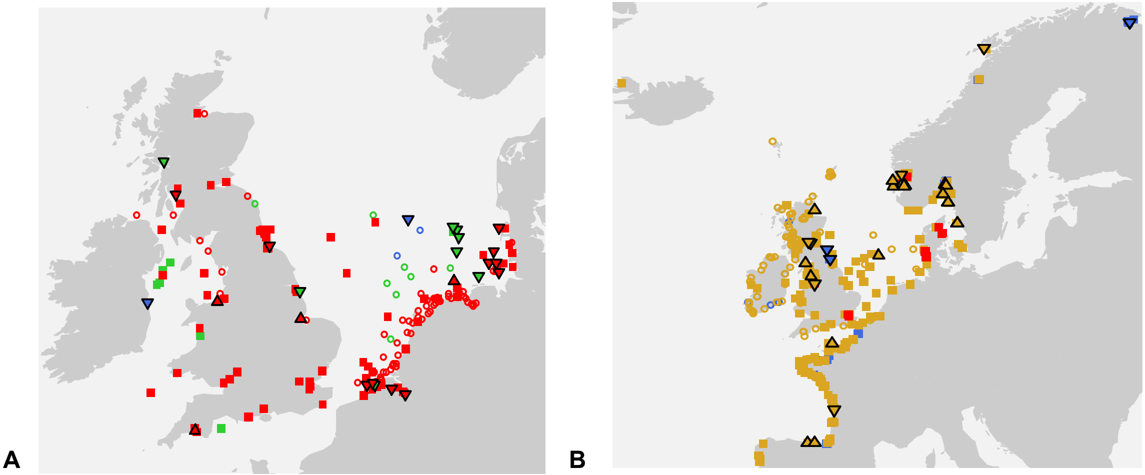
According to data reported to EMEP there has been an overall reduction in total air emissions of around 20% in the period 1998 – 2006. The picture of reductions achieved across OSPAR countries is very varied. Total emissions from industrial processes, including manufacturing industries, remained fairly stable over this period with there being an increase in emissions from the metal production sector. The most consistent development since 1998 has been for mercury emissions from the chlor-alkali industry which halved, as have the total losses of mercury from this industry through product, waste water and air. Recent estimates suggest that despite significant emission reduction in Europe and North America, global mercury emissions have not changed significantly over the past 15 years due to emissions growth in other parts of the world (*e.g.* Asia). Data on discharges of mercury to water reported to EPER give indication that discharges from heavily regulated point sources continue, but do not allow conclusions on trends. Direct and riverine inputs of mercury are the major input in Regions II, III and IV. Riverine inputs of mercury decreased significantly by 75% in the Greater North Sea (Region II). Direct discharges were much smaller and showed a similar scale of decrease. Major reductions in riverine inputs (~85%) and direct discharges of mercury were also observed for the Celtic Seas. Data are not sufficient to allow conclusions on changes in either riverine or total waterborne mercury inputs in Region I or IV. In Region I atmospheric deposition accounts for 99% of inputs.

How does this affect the marine environment?

Almost all temporal trends in mercury concentrations in sediments are downwards. Both upward and downward temporal trends occur in biota. A number of upward trends of mercury in biota were detected in southern Norway. Concentrations of mercury in sediments indicate a risk of pollution effects in the southern North Sea, at many of the other locations monitored on coast of the UK, west coast of Norway and some locations in near urban industrialized areas in northern and southern Spain. Concentrations around the Dogger Bank are also high, but elsewhere in offshore areas of the North Sea are lower, and at background in some locations. Background concentrations also occur in parts of northern Scotland and in northern Norway. Mercury concentrations in fish and shellfish are at background at a large proportion of stations on the Channel coast of France, and the French and Spanish coasts of the Bay of Biscay. Background concentrations are also found at some stations in Ireland, Scotland, and western Norway. Concentrations above EU dietary limits occur mainly around Denmark and in certain industrialized estuaries in Norway and the UK. Elevated concentrations close to Iceland may be a consequence of geological conditions.



Status of mercury concentrations in (A) sediments and (B) biota: background (blue), acceptable (green) or below EU dietary limits (amber), and unacceptable (red)



Temporal trends of mercury concentrations in (A) sediment and (B) biota: downward ▽, upward △, insufficient data for trend assessment ○

2. Organic tin compounds

Organic tin compounds known to be environmental pollutants comprise mono-, di-, tri-, and tetrabutyl and triphenyltin compounds. Tributyltin (TBT) was used from the 1960s onwards in the marine environment as a biocide in antifouling coatings on underwater structures, ships and other craft. TBT has also been used for wood coatings and as an antiseptic agent in carpets and canvas. Disubstituted organotins, such as dibutyltin and dioctyltin, are used in high volumes in consumer products and as stabilisers in plastic. Triphenyltin (TPT) has been used as an agricultural pesticide.

What is the problem?

Tributyltin compounds are considered the most hazardous of all tin compounds and several studies in various parts of the world oceans have shown their effects: shell malformations of oysters, imposex in marine snails, reduced resistance to infection (*e.g.* in flounder), and effects on the human immune system. The effect of triphenyltin seems to be the same. Other organic tin compounds (*e.g.* mono- and dibutyltins) are considered less harmful for the marine environment. The main source of tributyltin is leaching from coatings of sea vessel hulls and from underwater structures. Shipyards, docking activities and disposal of dredge spoil are additional sources. The main source of TPT is from agriculture.

What has been done?

Marketing of TBT for use on small vessels was banned in the mid-1980s, as unwanted effects on marine snails and bivalves emerged. Use of TBT as a marine antifouling agent is currently being phased out through the 2001 International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS Convention), which banned the application of TBT-based antifouling paints for use on ship hulls. The Convention entered into force in 2008 but has previously been implemented through EU Regulation (EC) No 782/2003. Use of TBT for wood treatment has also been phased out. The remaining commercial uses of organic tin compounds and the use as pesticide have ceased to a large extent in the OSPAR area. Earlier, OSPAR measures have targeted the retail sale of organotin paints and their use on pleasure boats, fish net cages and sea going vessels, and the losses of TBT from docking activities to the aquatic environment.

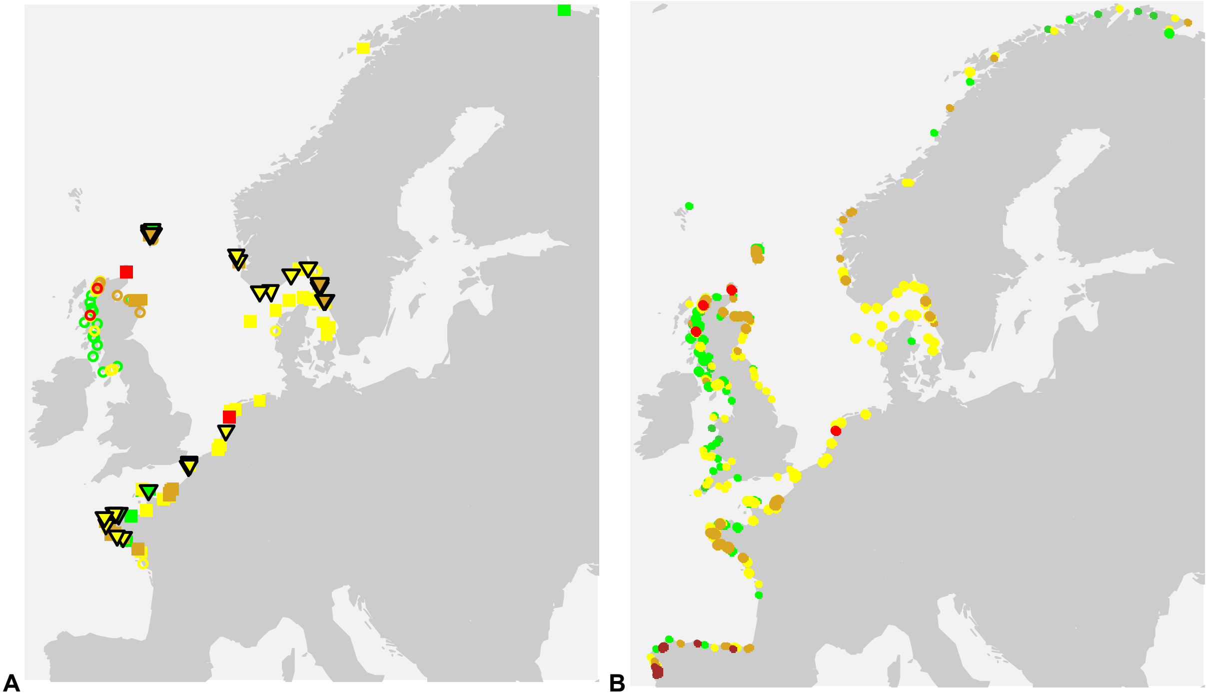
Did it work?

Releases of TBT and other organic tin compounds to water still continue. In the absence of sufficient data, quantification of releases is difficult and no statements on trends can be made. Yet, it is expected that the ban on uses of TBT as antifoulant and biocide in the EU and on ships worldwide has resulted in reduced releases. It is expected that, locally, ship docks removing ship coatings containing TBT still continue to be a source of TBT pollution. Redistribution and re-suspension of TBT and dibutyltin (DBT) through dumping of contaminated sediments, especially from harbours, can add to the pollution in other areas and the availability of those substances to living organisms in the marine environment. Releases of organic tin compounds, such as disubstituted compounds, from industrial processes and products also continue.

How does this affect the marine environment?

Since 2003, monitoring of imposex and related effects of TBT in marine snails in OSPAR Regions I, II, III and IV has been monitored regularly. Monitoring data for 1998 – 2007 show that the effect of the measures taken has been initially positive. A reduction in imposex has been evident at the vast majority of location monitored; none of these locations showed a significant upward trend in the level of imposex.

Although the overall status is improving, marine snails still show pollution effects from TBT over the large parts of the OSPAR area, especially Regions II, III and IV. There is a clear relationship between shipping and imposex with levels high in the vicinity of busy shipping lanes and some larger harbours (*e.g.* Rotterdam, Clydeport, Vigo). The situation is markedly better where there is less large vessel traffic *e.g.* the west coast of Scotland and in the northern part of Norway. However, even in these areas, harbours can have a detectable impact, highlighting the importance of local factors.



(A) Significant downward trends (triangle) of imposex in the period 1998 – 2007; circles indicate insufficient data for trend analysis. (B) Status of imposex measurements; Large symbols = 3 or more years of data; smaller symbols = 1 or 2 years of data. The colour coding refers to the six assessment classes for TBT: dark and light green = good status; light and dark yellow = moderate status; light and dark red = bad status.

3. Organohalogens

3.1 Short-chain chlorinated paraffins (SCCPs)

SCCPs are the most hazardous of chlorinated paraffins. In 1998, their main use was still as metal working fluids with volumes more than 4000 tonnes being used annually in Europe. This was down from 13 000 tonnes in 1994. Today, the total consumption of SCCPs in Europe is less than 1000 tonnes a year. Remaining uses are as rubber flame retardant (more than 50%) and as plasticiser or additive in sealants, adhesives, and in paints and textile waterproofing.

What is the problem?

SCCPs are a concern for the marine environment and human health on account of high toxicity to aquatic organisms, high persistence and non biodegradability (OSPAR, 2009j). Up to 2006, the main sources of SCCPs were releases from metal and leather working facilities. The main remaining sources of SCCP releases are emissions to air, water and soil from rubber working plants, emissions from surfaces treated with SCCP-containing paints and releases from products in waste streams. The main releases occur to sediments and surface waters in rivers, emissions to air and through soil spread with sewage sludge. SCCPs are effectively transported by air over long distances.

What has been done?

OSPAR Decision 95/1 and subsequent EU measures regulate the main uses of SCCPs and sources. Total consumption volumes have dropped by more than 75% since 1998. The phase-out of SCCPs in metal and leather working fluids has been broadly achieved by 2006. Efforts to phase out the remaining main uses of SCCPs under OSPAR Decision 95/1, envisaged by end of 1999, still continue (OSPAR, 2006). This is supported by a voluntary phase-out agreement of the SCCPs producers in the OSPAR area and proposals for global actions under the UNEP Stockholm POP Convention and the POP Protocol of the UNECE Convention on Lang-range Transboundary of Air Pollution (LRTAP). SCCPs have been substituted with medium and long chained chlorinated paraffins (MCCPs and LCCPs). Recent environmental risk assessments suggest that restrictions of those and other uses of MCCPs may be required.

Did it work?

Information reported by Contracting Parties in the EU and UNECE LRTAP regulatory frameworks indicate that measures have resulted in a decrease of discharges and emissions of SCCPs from production in metal and leather working fluids and that only a few point sources with low discharge and emission levels remain. Based on quantities of SCCPs still used in 2001, total releases from waste to the environment were estimated to amount to 9.8 – 19.4 tonnes per year to surface water and 0.0039 – 0.078 tonnes to air. It is expected that currently existing and planned efforts are likely to lead to a cessation of SCCP releases to the environment by 2020. Measurements to indicate the loads of SCCPs reaching the sea via rivers and atmospheric deposition are not available.

How does this affect the marine environment?

Data from the period 2000 – 2005 show widespread contamination of the marine environment with SCCPs. Around the North Sea, SCCPs have been found in sediments, fish and mussels at reference sites. Highest concentrations measured on the Southern coast of Norway were in cod liver (750 ng/g ww) and in sediments (1800 ng/g dw). Concentrations of the sum of SCCPs and MCCPs in mixed fish livers reached levels up to 3900 ng/g lw. Two water measurements were below detection limits (EQS for water: 0.4 µg/l). SCCPs have also been found in Arctic biota (fish, seabirds and marine mammals, including polar bears). Some measurements in remote areas (Arctic char from Bear Island, Norway) reached levels comparable to concentrations in cod reported for the North Sea and the Baltic Sea. SCCPs have also been detected in human milk fat in the UK (49 – 820 ng/g fat) and in cow's milk in Denmark, France, Ireland and the UK. The ubiquitous presence of SCCPs and observed levels in mammals confirm concerns that SCCPs are of be of significance at a regional and potentially global scale. Available data do not allow conclusions on trends of SCCP pollution since 1998.

3.2 Perfluorooctane sulphonates (PFOS)

PFOS and PFOS-related substances (a group of 96 chemicals which can degrade to PFOS) are part of the larger family of perfluoroalkyl sulphonate substances (PFAS). They are used as surface-active agents to repell water and oil in a wide range of industrial applications and consumer products. Remaining uses in Europe include PFOS-containing fire fighting foam held in stocks (estimated 122 tonnes), metal plating (8 – 10 tonnes per year) and to a much lesser extent the photographic industry, photolithography, semiconductor industry and hydraulic fluids for aviation (together ~2 tonnes per year).

What is the problem?

PFOS and PFOS related substances are toxic to aquatic organisms and through the food chain. They are extremely persistent and accumulate in animals and humans in concentrations with effects on physiology and environmental and human health. The persistency, bioaccumulation and toxicity of PFOS are considered to meet the POP (Persistent Organic Pollutant) criteria for long-range transport. PFOS are mainly released to the environment via waste water treatment effluents, sewage sludge and leachates from landfills. Other sources include atmospheric losses during combustion and from certain domestic and commercial uses, wash-off from various applications such as in fire fighting foams, or emissions from wearing PFOS-treated materials.

What has been done?

OSPAR action promoted recent EU measures which restrict the use of the commercially important PFOS compounds in most applications and products with effect from 2008 (OSPAR, 2008a). Derogations apply for the currently remaining uses; stocks of PFOS-containing fire fighting foams previously placed on the market must cease by summer 2011. The main producer worldwide ceased the manufacture of PFOS and PFOS-related substances over the period 2001 – 2003 and uses such as in cleansing products, textile-, leather- and carpet protection, flame retardants, and pesticides are suggested to have ceased since 2001. Recently PFOS and PFOS-related substances have been included for elimination under the UNEP Stockholm POP Convention.

Did it work?

Quantitative information on emissions, discharges and losses and on loads transported by rivers and atmosphere to the sea are scarce. With the sharp drop in production and consumption since 2001, releases to the environment may have decreased. With existing and currently planed measures, releases to the environment will continue beyond 2010, especially from waste streams, it is expected that good progress can be made towards the cessation target by 2020.

How does this affect the marine environment?

The PFOS accumulating through the environmental food chain is perfluroalkylated acid (PFA), which is extremely persistent and has been found toxic mainly to birds and mammals. PFA bioaccumulates in proteins (blood plasma) and liver (fatty acids) of animals and humans in concentrations with effects on physiology and environmental and human health. In 2000 – 2006, PFOS (PFA) have been reported to be found in all environmental compartments in the Arctic and Greater North Sea Regions at reference and polluted sites. Concentrations in sediments ranged from 0.5 µg/kg d.w. at reference sites to 3.7 µg/kg d.w. at contaminated sites. Concentrations of PFOS in biota (shrimp, shellfish, fish, mammals and seabird eggs) were found at levels up to 26 µg/g w.w. (guillemot egg) at reference sites and up to 2420 µg/g ww (porpoise liver) at contaminated sites. The pattern of PFAS contamination in wildlife varies greatly among species and geographical locations. Contaminant levels in mammals in the OSPAR area show a decreasing trend from south to north. Data from seabird eggs from northern Norway suggest that increasing PFOS concentrations levelled off in 1993 – 2003 and have since decreased. Swedish time series for guillemot eggs for 1968 – 2003 suggest a continuous increase at an average of 7 – 11% per year. Concentrations in ringed seal liver (1985 – 2003) and polar bears

(1984 – 2006) from Greenland suggest high annual increases. The widespread presence of PFOS in the environment and the observed levels at higher trophic levels are of concern. Due to the substance's extreme persistence PFOS legacies in the environment are expected to contribute to exposure and bioaccumulation in future. Biological and ecosystem effects of measured PFOS levels are not fully understood although there is some evidence of endorine disruption and liver disease. Chronic exposure of seabird species to PFOS indicate adverse effects on reproductivity, hatchability and pathological changes.

3.3 Polychlorinated dibenzodioxins and dibenzofurans

Polychlorinated dibenzodioxins and dibenzofurans are two groups of chlorinated organic compounds generally referred to as “dioxins”. They are not manufactured intentionally, but are formed as unintended by-products of natural and human-induced combustion of organic materials and in the production of certain chlorinated chemicals and pulp bleaching.

What is the problem?

Dioxins are very persistent in the environment, bioaccumulate in the food chain and are toxic to aquatic organisms, birds and mammals. Waste is considered the dominant source of releases of dioxins to water. Other releases via waste water include industries using chlorine (*e.g.* pulp and paper, textiles) and chloroorganic industries (*e.g.* manufacture of vinyl chloride monomer). Emissions to air result from industrial combustion processes (*e.g.* metal industry, power plants), incineration of wastes and ship engines. Natural events such as forest fires and volcanoes contribute to dioxin releases to air.

What has been done?

OSPAR measures and subsequent EU measures regulate releases of dioxins from the main industrial sources, mainly through the use of best available techniques and emission and discharge limits. EU waste legislation addresses losses of dioxins from wastes. Dioxin releases are regulated worldwide through the UNEP Stockholm POP Convention and the UNECE POP Protocol.

Did it work?

Data on emissions, discharges and losses of dioxins are scarce. Estimates suggest that roughly 20 kg dioxins are still released to the environment each year (OSPAR, 2008a). One quarter is directly emitted to air, the rest is released via wastes to soil and water. Available data suggest that emissions to air from industrial sources have almost halved in 1998 – 2007. Data on loads of dioxins transported to the sea by rivers and air are not available. Further effort is needed to reduce releases from point sources and diffuse sources, especially wastes, to move towards the cessation target in 2020.

How does this affect the marine environment?

Dioxins and dioxin-like congeners (*i.e.* planar PCBs) may induce biological and toxic effects (endocrine disruption, immune system, reproduction). The binding capacity to, and induction potency of, AhR (a protein of the family of cytosolic transcriptor factors with critical function in organisms) by individual dioxin and furan congeners (as well as PCBs and PAHs) differs considerably. A toxic equivalency factor (TEF) is used to express the induction potency of individual dioxins, PCBs and PAHs relative to 2,3,7,8-tetrachlorodibenzodioxin (TCDD) being the most potent inducer (TEF of 1). In 2000 – 2006, dioxins have been reported to be found widespread in the OSPAR maritime area. In the Arctic Region, concentrations of dioxins in sediments reach 2.22 ng/kg TEQ at reference and contaminant sites and are considered to be at background concentrations and not of concern. In contrast to the dioxin levels found in herring in the Baltic Sea, fish in the Greater North Sea and the Celtic Seas show contamination levels well below EU dietary limits (up to 0.61 pg/g TEQ at reference sites and 0.87 pg/g TEQ at contaminated sites). Concentrations of dioxins those Regions range in fatty fish between 0.61 pg/g TEQ at reference sites and 0.87 pg/g TEQ at contaminated sites and in shellfish between 0.43 pg/g TEQ at reference sites and 7.95 pg/g TEQ at contaminated sites. Concentrations in northern fulmar eggs range between 3972 and 7793 pg/g l.w. TEQ and exceed several thresholds for biological effects set for different seabird species. Total TEQ levels of dioxins, non-ortho and mono-ortho CBs measured in polar bears are below TEQ thresholds for immune suppression of captive harbour seals. It is unclear whether the comparative TEQ thresholds are relevant for determining possible serious adverse effects for northern fulmar and polar bears, but the fact that elevated concentrations are found at high trophic levels gives rise to concern. Data is not sufficient to allow indication of trends for the OSPAR maritime area. Without environmental assessment criteria, it is not possible to confirm or exclude that the observed levels have potential for significant adverse effects on marine ecosystems.

3.4 Polychlorinated biphenyls

Polychlorinated biphenyls (PCBs) are synthetic substances produced commercially in Europe from 1929 until the mid-1980s and used both in ‘closed’ applications, such as insulators and cooling fluids in transformers, dielectric fluid in capacitors and as hydraulic fluids, and for ‘open’ uses, such as grouting, and sealants and as plasticisers in paints. Production in Europe was stopped in the mid-1980s, but may still be continuing in other parts of the world.

What is the problem?

PCBs are toxic and, since they are hydrophobic, bioconcentrate particularly in fatty tissues. They can adversely affect reproduction, and may affect immune systems so as to make disease epidemics worse. The higher levels of the food web, especially fish-eating birds and marine mammals can be particularly affected. It is estimated that some 700 000 tonnes of PCBs have been produced, of which 30% (at least 200 000 tonnes) may have been released to the environment. The main remaining sources of PCB releases are PCB-containing units, waste disposal, re-mobilisation of PCB-containing sediments and, to an unknown extent, formation as by-products in various thermal and chemical processes. The most toxic PCBs are those with a planar structure which have similar chemical properties to dioxins and furans.

What has been done?

OSPAR specifically targeted pollution from PCBs requiring that all PCBs and hazardous PCB substitutes are phased out and destroyed in an environmentally safe manner. Within the EU the main uses of PCBs in products have been banned since 1986 and disposal has been targeted. An EU strategy addresses ‘uncontrolled PCB applications’ which are not covered by the ban, *i.e.* large volumes with very low concentrations of PCBs, or products with a small volume of PCBs, non-industrial wastes, and ‘historic pollutions’. EU waste legislation addressing PCBs includes the restriction of use of hazardous substances in electrical and electronic equipment and the mandatory segregation of PCB-containing components in waste electrical and electronic equipment to ensure their adequate disposal. Requirements on the phase-out and destruction of PCBs, similar to those in place under OSPAR, are set out under the UNECE POP Protocol and the UNEP Stockholm POP Convention with targets for phase-out of use of equipment containing PCBs by 2025 and treatment and elimination by 2028.

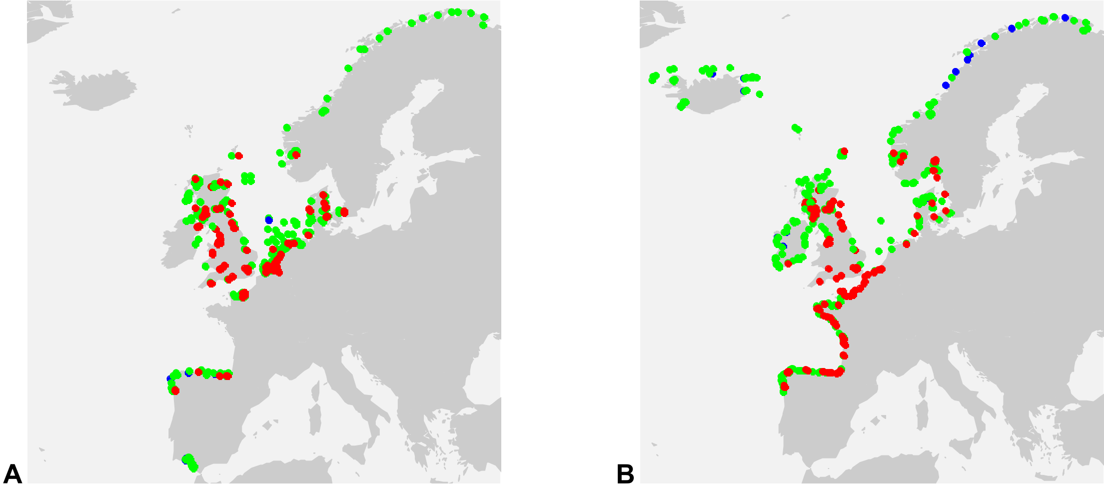
Did it work?

Substantial reductions in releases and good progress on the phase-out of remaining stocks have been achieved in the period 1998 – 2005 supporting a movement towards the cessation target for PCBs. Releases of PCBs to air and water continue. Emissions to air from large point sources show a substantial downward trend. No trend information is available for discharges to water. Yet, the treatment and elimination of remaining stocks and so-called uncontrolled applications will provide a continued source for releases to the environment in the next years before their phase-out has been completed. More efforts are needed to address remaining releases of PCBs within the EU framework, especially concerning unintended production.

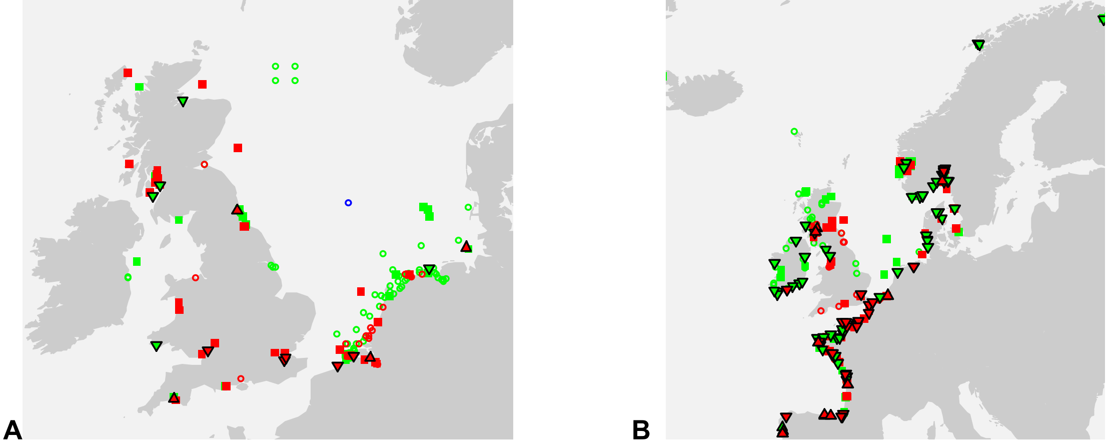
According to data reported to EMEP the total emissions of PCBs to air reduced by 75% over the period 1998 – 2006. EMEP model results suggests an overall decrease of CB-153 deposition of around 60 – 75% in the five OSPAR Regions. Data reported by Contracting Parties on riverine inputs and direct discharges under the OSPAR RID Study are too patchy for assessment. The few reported data however indicate that releases to water still continue. Data on dredged material dumped suggest that loads of PCBs continue within dredged sediments.

How does this affect the marine environment?

OSPAR environmental monitoring has concentrated on a set of 7 PCB congeners, which cover the range of toxicological properties of the group. In the maps below the assessment results for the target group of congeners of PCBs *i.e.* the ICES 7 CBs (CB congeners 28, 52, 101, 118, 138, 153, 180) have been aggregated to simplify their presentation. There are few locations where the concentrations of the target CB congeners in biota are close to zero. These are mainly in northern Norway. However at many stations remote from industrial activity concentrations are not yet at levels close to zero, including parts of northern Norway in Region I, northern Scotland and offshore locations in the North Sea (Region II) and some sites on the north coast of Spain (Region IV). In the Arctic, PCBs are among contaminants detected in highest concentration. Furthermore, in Regions II, III (Celtic Seas) and IV there are widespread locations where the concentrations of at least one CB congeners in fish and shellfish pose a risk of pollution effects, particularly around the coasts of the Bay of Biscay and the English Channel, in more populated and industrialised UK estuaries, and in scattered locations in Denmark, Germany and southern Norway. The pattern of contamination in sediments is very similar to that for biota. Thus PCBs may still be causing adverse biological effects over large parts of the Convention area. Observed concentrations of PCBs in blubber of stranded porpoises around the UK suggest a link between contamination of animals and their susceptibility to infectious diseases and associated death. PCB concentrations are decreasing at a high proportion of the fish/shellfish stations, particularly along the continental coast of the North Sea, the west of the UK, and Ireland. A small number of stations showed increasing trends.



Status of PCB concentrations in (A) sediments and (B) biota: zero (blue), acceptable (green), and unacceptable (red)



Temporal trends of PCB concentrations in sediment (A) and in biota (B): downward ▽, upward △, insufficient data for trend assessment ○

3.5 Brominated flame retardants

Brominated flame retardants (BFR) are a group of bromine-containing chemical flame retardants, which have been very effective in plastics and textile applications. BFR are widely used in consumer products including computers, electronics and electrical equipment, televisions, textiles, foam furniture, insulating foams, and other building materials. The five major BFR in use in Europe in 2001 were tetrabromobisphenol-A (TBBP-A), hexabromocyclododecane (HBCD), and the following poly-brominated diphenyl ethers (PBDEs): decaBDE, octaBDE and pentaBDE. OctaBDE and pentaBDE were used in much smaller quantities than decaBDE. Polybrominated biphenyls (PBB) have also been used, but production was stopped in September 2000.

What is the problem?

The different BFR pose a range of risks to both the marine environment and human consumption of fish and shellfish. TBBP-A is persistent and toxic and may degrade in sediments to the endocrine disrupting substance bisphenol-A. Those PBDEs with smaller molecules (*e.g.* pentaBDE) are more toxic and bioaccumulative. Environmental degradation of decaBDE to these forms has been considered as a possibility. PentaBDE may also disrupt the oestrogenic system. HBCD is toxic to aquatic organisms and degrades slowly. Some of these chemicals are liable to bioaccumulate. The main sources of BFR to the environment are products and associated waste streams and treatment (*e.g.* incineration, waste dumps, dismantling and recycling activities), but also production and manufacture processes. Since the products containing these chemicals are widely dispersed, their possible release from waste disposal routes is also of concern.

What has been done?

OSPAR has promoted actions in the EU on use restrictions for PBDEs, risk-reduction strategies for octaBDE, decaBDE and HBCD, and waste legislation. OctaBDE and pentaBDE were banned in the EU in 2004 and the use of PBB and polyBDEs in electrical and electronic appliances has been restricted since 2006. DecaBDE was exempted from this restriction until 2008 and is still widely used in Europe. DecaBDE will now go through the REACH registration. An EU risk reduction strategy for decaBDE encouraged product stewardships and voluntary emissions control by the BFR industry. Uses of HBCD are not yet sufficiently regulated, although voluntary action has significantly reduced emissions from point sources. Current measures on releases from products are not adequate. No specific OSPAR or EU measures have been agreed for TBBP-A, although the IPPC Directive has been considered as the most appropriate measure to manage this chemical. EU waste legislation on electrical and electronic equipment supports the reduction of emissions, discharges and losses from end-of-life waste containing BFR. PentaBDE has recently been included for elimination under the UNEP Stockholm POP Convention.

Did it work?

There are insufficient data to quantify trends of releases of brominated flame retardants in the OSPAR area. Environmental monitoring data indicate that discharges/releases of pentaBDE and octaBDE are decreasing. However, some diffuse releases may remain due to illegal occurrence in imported products (plastics *etc.*). Emissions of HBCD in Europe have been heavily dominated by one point source production site, which has now been closed down. Total emissions have therefore probably gone down but emissions from products and materials (*e.g.* polystyrene) still exist. There are no data available on loads of TBBP-A entering the OSPAR maritime area and on atmospheric inputs, although the atmospheric pathway is considered to be less significant for TBBP-A. Although some BFR production sites in Europe have recently closed, world consumption and production of BFR may have seen a steady annual increase since 1998 due to growing demands, especially in Asia.

How does this affect the marine environment?

Data from the period 2000 – 2005 show widespread contamination of the marine environment with PBDEs and HBCD in all components of marine ecosystems. Regular monitoring of these substances[2] in the marine environment, which commenced at an OSPAR scale in 2008, needs to be continued to evaluate whether any of the actions that have been taken so far are effective in terms of reducing this burden on the marine environment. In the Arctic Region (Region I), PBDEs have been measured in fish, seabirds, predatory birds and polar bears indicating widespread contamination. In seabirds, PBDEs have been detected in such diverse locations in Region I as northern Norway, Svalbard and southern Greenland. An increasing trend of certain PDBEs in seabird eggs in Norway has been reported up to 2003. In the Greater North Sea area congeners found in the toxic lower brominated PBDEs can be detected in sediment, fish and mussels from the coastal zone and the open sea at reference locations distant from known sources and in apparently high concentrations in the blubber of harbour porpoise and the harbour seal (*e.g.* >1000 µg kg^{-1} l.w.). PBDEs have also been detected in stranded dolphins and whales in the Greater North Sea (Region II) and Celtic Seas (Region III) and in mussels in Bay of Biscay/Iberian Coast (Region IV). DecaBDE has also been measured in the coastal zone and open sea of the North Sea and also has been detected in birds eggs in Region I. Monitoring in northern France has indicated more recent downward trends in the occurrence of pentaBDE and octaBDE in mussels but a more broadscale picture needs to be established. HBCD has also been measured in shellfish, fish, seabirds and mammals at locations distant from major sources. When detected in the marine environment, TBBP-A has mainly been measured in the vicinity of polluted locations occurring in sediment, shellfish, fish, seabirds and mammals.

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[2] For the purposes of OSPAR, the polybrominated diphenyl ethers to be monitored covers the congeners PBDEs 28, 47, 66, 85, 99, 100, 153, 154 and 183 for sediment and biota. BDE 209 is covered for sediment but should not be included in any totals but reported separately.

3.6 Trichlorobenzenes

Trichlorobenzenes (TCBs) are aromatic chlorinated compounds comprising the three isomers 1,2,3 TCB, 1,2,4 TCB and 1,3,5 TCB. Commercial TCB consists mainly of 1,2,4 TCB and is used as intermediate in the production of herbicides, pigments and dyes.

What is the problem?

TCBs do not readily biodegrade and have a high potential to bioaccumulate and adhere to the organic matter of sediments. They are very toxic to aquatic organisms and may cause long term adverse effects in the marine environment, including reproductive and endocrine disrupting effects. The main source for TCB releases to water and air are production and use as intermediate in manufacturing processes. Other sources include releases as by-product from the production of hexachlorbenzol (HCB), lindane and other hexachlorcyclohexan (HCH) isomers, waste streams, including from imported products containing TCBs, and combustion of plastics and degradation of higher chlorinated benzenes.

What has been done?

Production and use of TCBs have declined in the OSPAR area since 1998; only one production site remains and the German producer no longer sells TCB for dispersive uses. EU measures regulate the releases from main industrial sources. The main uses of TCB as intermediate have been restricted in the EU framework with effect from summer 2007. Existing and planned international and EU control measures on HCB and HCH isomers contribute to reduction of releases of TCBs. Losses of TCB from diffuse sources, especially from products via waste streams, have not been regulated.

Did it work?

There is a clear indication of reduction in TCB releases from point sources over the period 1985 – 1998. This is consistent with a reduction in production volumes from 17 000 to 4 000 tonnes per year over the period 1983 – 2003. However, data on discharges, emissions and losses since 1998 are scarce. Discharges to water from remaining production of TCBs in the OSPAR area are estimated to be 30 kg per year. With regulation of main point sources, it is expected that wastes, including waste water treatment effluents, are the main source for releases to water but no data are available for quantification. Limited information on emission to air suggests reduction from industrial sources; data reported in 2004 suggest total emissions of 0.19 tonnes in the OSPAR area. With recent use restrictions there is indication that a downward trend in releases may be expected. Further efforts are needed to move towards the cessation target in 2020.

How does this affect the marine environment?

Marine environmental data are limited, often below detection limits and mostly restricted to sites close to pollution sources. In the Greater North Sea, levels measured in coastal and inshore waters (including rivers) at reference and contaminated sites are below EU environmental quality standards for TCB (0.4 µg/l) except for concentrations in the Scheldt estuary (0.64 µg/l). Contamination in sediments and biota at the Norwegian North Sea coast at sites close to sources reach 0.05 ng/g. Concentrations in mussels in the southern North Sea were observed at levels up to 5 ng/g dw. In Arctic Waters, sediment concentrations at contaminated sites reach 1.20 ng/g d.w. The observed concentrations of TCB in water and sediment in the OSPAR area are below threshold levels proposed in literature for ‘no-effect’ for the marine aquatic environment and suggest that they give no cause for concern. The possibility of reproductive and endocrine disrupting effects has not been excluded. More monitoring information is necessary to conclude on the distribution and levels of TCBs in the OSPAR maritime area and their concern for the marine environment.

4. Polycyclic aromatic hydrocarbons

The large group of polycyclic aromatic hydrocarbons (PAHs) are natural components of coal and oil. PAHs are primarily formed as by-products of incomplete combustion of carbon-containing fuels (wood, coal, diesel, fat, tobacco or incense), including forest fires and volcanoes. As a result they are one of the most widespread organic pollutants and can be used as markers for combustion processes in a region. Different types of combustion yield different distributions of PAHs in both relative amounts of individual PAHs and in which isomers are produced. Some PAHs occur in crude oil arising from chemical conversion of natural molecules. PAHs have few intended uses. These are mainly as intermediates or in final products. For example, naphthalene serves as a chemical intermediate in the production of insecticides, stabilisers, pharmaceuticals, cosmetic additives, and PAHs are contained in the plastic or rubber handles of tools and in tar widely used in the past in asphalt works, floorings and floor coatings.

What is the problem?

PAHs are toxic, persistent and bioaccumulate, especially in invertebrates. Some PAH compounds are carcinogenic. PAHs are released to the environment from a variety of diffuse sources. The dominant diffuse sources are wood preservatives (*e.g.* creosote), incomplete combustion of fossil fuel and biomass in fixed installations (particularly in small or older installations, including domestic stoves) and road traffic, and industrial processes, especially the primary aluminium industry. Other sources include dredged materials, discharges from offshore installations, shipping and oil spills. The main pathways to the sea are through long-range atmospheric transport or waterborne inputs. Long-range air transport of PAHs from other parts of the world may contribute to atmospheric inputs to the OSPAR maritime area. Given expected growth of industrial activities for example in Asia, the relative share of long-range PAH air transport to atmospheric inputs in the OSPAR area is likely to increase in future.

What has been done?

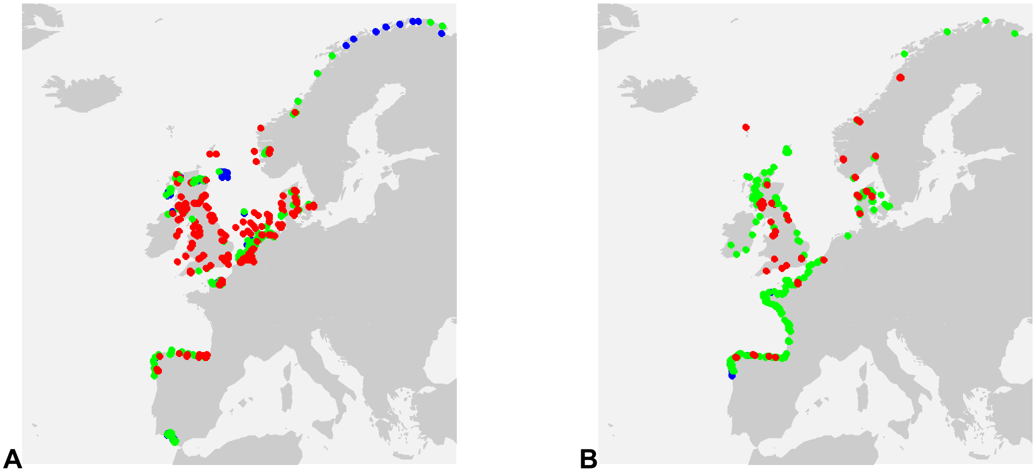
Specific OSPAR measures targeting emissions, discharges and losses of PAHs have focussed on the main industrial PAH sources including aluminium plants, the iron and steel industry, and refineries. OSPAR has also recommended the phase-out of the use of one-component coating systems on inland ships containing considerable quantities of PAHs. Less specific OSPAR measures on Best Available Techniques for large combustion plants and the organic chemical industry have also addressed PAH emissions. Both the UNECE POP Protocol to the Convention on Long-Range Transboundary Air Pollution and the UNEP Stockholm POP Convention addressing mobile sources of PAHs have been implemented through EU legislation. Other measures in the EU framework address PAHs in tyres, use of creosote treated timber in a number of products and content of PAHs in diesel fuels. It is expected that new and stricter emission limits for cars and trucks in the EU will reduce PAH emissions from this diffuse source. The full and effective implementation of the requirements of the Water Framework Directive for PAHs will also support further reduction in releases. As complementary approach standards have been developed for residual solid fuel burning appliances.

Did it work?

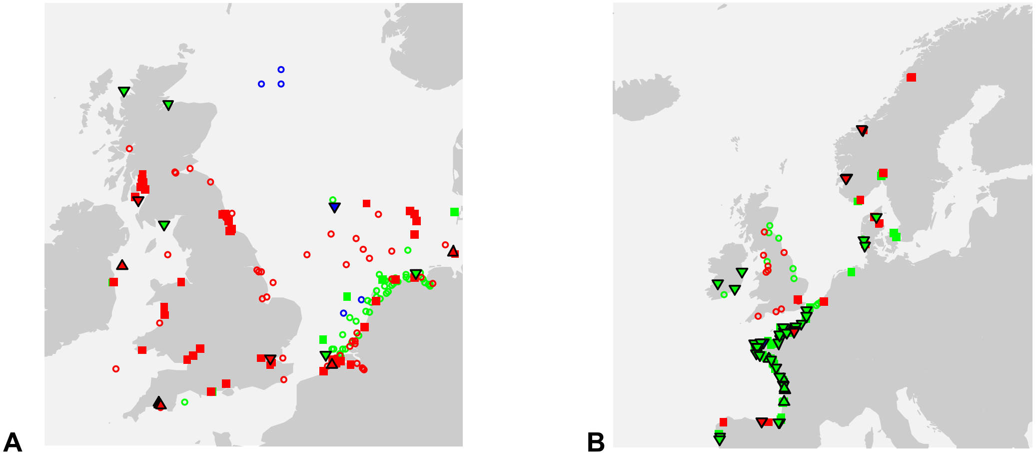
Point sources have been regulated, but total elimination of PAH releases is impossible. There are still substantial releases of PAHs to air and water. Data on discharges, emissions and losses of PAH are of poor quality for various reasons and it is not possible to give an overall trend in releases. For some sources *e.g.* in the aluminium production, reductions have been achieved due to technical improvements, but there is indication that in some sectors and for some Contracting Parties emissions to air might even be increasing. Additional efforts are needed to address emissions to air, in particular from combustion processes, but it will not be possible to eliminate all emissions. With increasing emissions outside the Convention area, the contribution of atmospheric deposition to inputs of PAHs to the OSPAR maritime area is likely to increase and it is therefore doubtful that the cessation of releases can be achieved. Atmospheric deposition of PAHs from combustion processes is an important pathway to the North-East Atlantic. Data reported to EPER indicate that discharges from heavily regulated point sources continue, but do not allow conclusions on trend. Data on riverine inputs of PAHs are scarce although this is an important pathway. PAHs are also discharged by the offshore oil and gas industry with produced water. From data reported to OSPAR no reduction in these discharges is evident.

How does this affect the marine environment?

OSPAR environmental monitoring has concentrated on a set of 6 PAH compounds (benz[a]anthracene; benzo[ghi]perylene; benzo[a]pyrene; fluoranthene; pyrene; phenanthrene). In the maps below the assessment results for the target group have been aggregated to simplify their presentation. Overall there is a dominance of downward trends in PAH concentrations in coastal shellfish (mussels) between 1998 and 2007. In contrast, there are relatively fewer temporal trends in sediment concentraions, suggesting that concentrations in sedimenets respond less rapidly to changes in inputs to teh sea than concentrations in biota. This refelcted in widespread concentrations of PAHs in sediments at levels which give rise to risk of pollution effects. The implied decrease in exposure of marine life to PAHs is supported by decreases in some observations of EROD activity in fish (dab) liever in the Greater North Sea and the Celtic Seas. However, the failure to achieve background concentrations of PAHs in mussels is evidence of continuing widespread contamination, possibly mediated through atmospheric transport. The scattered occurrence of concentrations which give rise to risk of pollution effects are often in harbours, estuaries and close to industrial installations.



Status of PAH concentrations in (A) sediments and (B) biota: background (blue), acceptable (green), and unacceptable (red)



Temporal trends of PAH concentrations in (A) sediment and (B) biota: downward ▽, upward △, insufficient data for trend assessment ○

5. Pesticides and biocides

Pesticides and biocides are used on plants to repel, kill or control pests, or otherwise in medicine, agriculture, forestry or other applications to kill, and protect against, for example germs, bacteria, viruses, parasites, fungi *etc.* For purposes of EU legislation, the distinction between pesticides and biocides may be described in general terms as agricultural uses (pesticides) and non-agricultural uses (biocides). OSPAR has prioritised six pesticidal and biocidal substances for priority action: dicofol, endosulfan, hexachlorocyclohexane (namely lindane), methoxychlor, pentachlorophenol (PCP) and trifluralin.

What is the problem?

Except trifluralin, a dinitroaniline herbicide, the priority pesticides/biocides are chlorinated organic pollutants. They have distinct chemical properties but all are toxic to aquatic organisms, highly bioaccumulative and very persistent. Dicofol, endosulfan and methoxychlor are suspected endocrine disruptors. Some of the substances can travel with air over long distances; in contrast, trifluralin used in agriculture is not expected to reach the marine environment due to its properties. None of the chemicals are any longer produced in Europe except for the formulation of trifluralin in France and Spain. The main concern are the uses of the pesticides/biocides outside Europe and their introduction via imported products and atmospheric deposition to the Convention area. Main sources are releases from reservoirs in sediment, soil and sludge as legacy of past uses, landfills with disposed products treated with those substances, and imported goods *e.g.* textiles and wood treated with PCP and lindane.

What has been done?

Almost all uses of the pesticides substances have been phase out under the EU Pesticides Directive (91/414/EEC) and Biocides Directive (98/8/EC) by 2009. A period of grace for dicofol expires in 2010. Lindane has recently been included for elimination under the UNEP Stockholm POP Convention, endosulfan is still under review for inclusion.

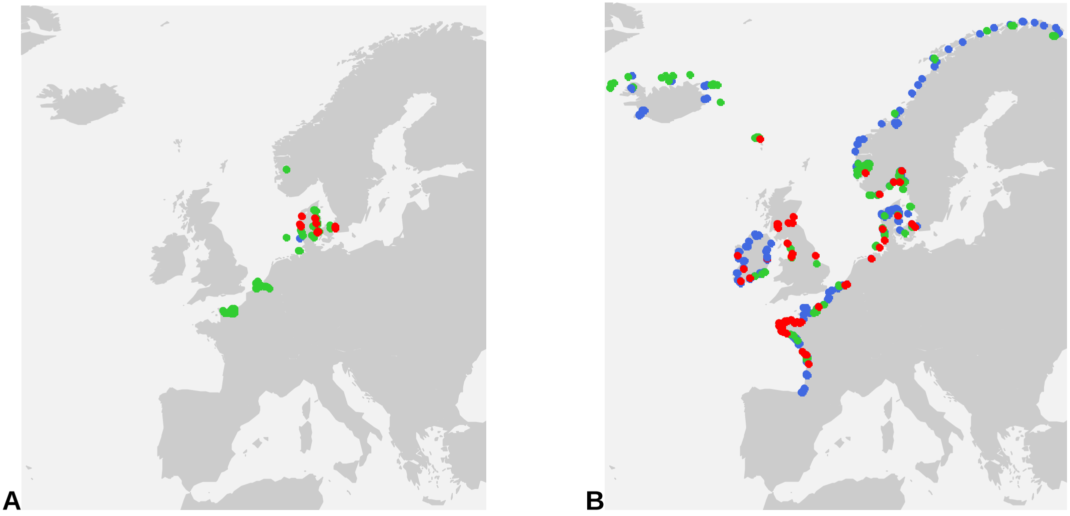
Did it work?

Source related data are scare for the OSPAR priority pesticides and biocides. There is some evidence that releases are falling. For lindane consistent data collected under the OSPAR Comprehensive Atmospheric Monitoring Programme suggest that while emissions continue, atmospheric deposition has dropped by more than one third across OSPAR in the period 2004 – 2007. The downward trend is confirmed by model calculations indicating a reduction between 70 and 80% since 1998 in all OSPAR Regions. There is evidence that lindane is still released to water partly from historic uses, partly from the organic chemical industry (20 kg reported for 2004 to the European Pollution Register). Measurements for estimating riverine inputs of lindane are patchy and often below detection limit.

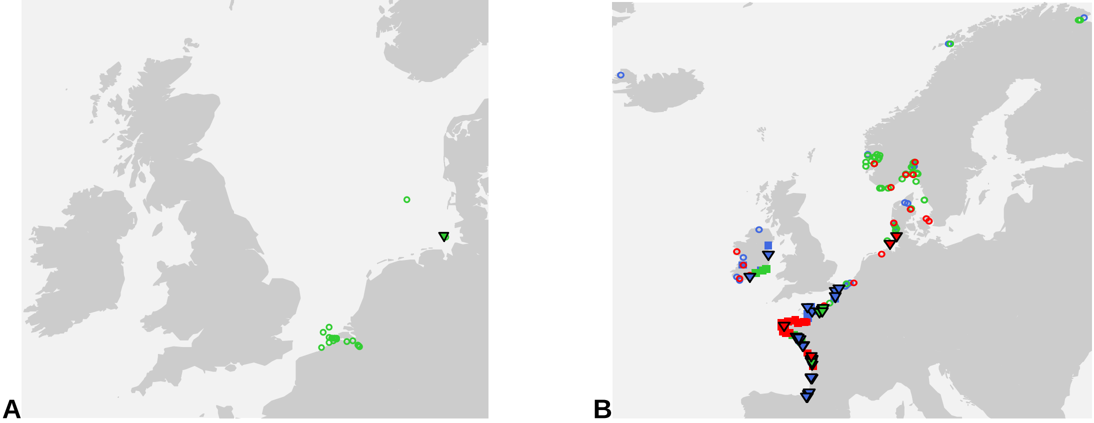
How does this affect the marine environment?

Marine monitoring data is scarce for most pesticides and biocides. The best coverage is for lindane although these data are relatively sparse compared to the data for metals, PCBs, or PAHs. Where data exist, concentrations in sediments are generally not close to zero. Some concentrations around Denmark are at levels which pose a risk of pollution effects. Concentrations measured in northern France and the Netherlands pose no risk. There are insufficient time series of data to make any statements on temporal trends on lindane in sediments in the OSPAR area.

Monitoring data for lindane in biota show a wide range of concentrations. In some areas, for example western and northern Norway, parts of Ireland, France and Iceland, concentrations are close to zero. However, concentrations remain at levels where there is a risk of pollution effects in a number of other areas in particular the coast of Brittany, the German Bight, and certain northern UK estuaries (Humber, Clyde, Forth, Tay). The localised nature of these hotspots, which may persist for years to come, may reflect historical use in adjacent areas.



Status of lindane concentrations in (A) sediments and (B) biota: close to zero (blue), acceptable (green), and unacceptable (red)



Temporal trends of lindane concentrations in (A) sediment and (B) biota : downward ▽, upward △, insufficient data for trend assessment ○

6. Phthalates

Dibutylphthalate (DBP), diethylhexylphthalate (DEHP) and butylbenzyl (BBP) are part of the group of 'certain phthalates' which have been prioritised by OSPAR for action. They are mainly used in the polymer industry as plasticisers in PVC. Phthalates are not chemically bound to the plastics and can be released from them during their life cycle. A variety of industries use phthalates also as softeners, adhesives or solvents in consumer products, including sealants, paints, printing inks, cosmetics, coatings of different products such as cars, coils, cables or fabrics. The widely used phthalates (plasticisers) di(isononyl)phthalate (DINP) and di(isodecyl)phthalate (DIDP) were removed from the OSPAR list of chemicals for priority action in 2006 on the basis of new information.

What is the problem?

The three priority phthalates are suspected to cause endocrine disruption and have been classified in the EU as carcinogenic, mutagenic and reprotoxic (CMR) substances and thus are of concern for environmental and human health. None meet all three PBT criteria but phthalates can be persistent and do not degrade easily under anaerobic conditions in sediments and at low temperatures. DBP and BBP are considered highly toxic to aquatic organisms. Phthalates are used in large volumes of which DEHP was the major fraction in 1998. Diffuse losses of DBP and DEHP from their use as plasticisers in consumer products are the main source of concern. DEHP enters the environment mainly via direct releases to air and waste water, from sewage sludge and from solid waste. In air, DEHP may occur both in vapour phase and as solid particles. Particles formed by weathering of polymers probably represents an important route of DEHP distribution. Phthalates may also be released to the environment from production and manufacturing sites causing elevated local exposure.

What has been done?

EU measures regulate industrial sources of phthalates. EU use restrictions for DEHP, DBP and BBP target only selected consumer products, such as toys and childcare products and focus on health protection. Further use and marketing restrictions are still under consideration.

Did it work?

Since classification as CMR substances (carcinogens, mutagens and reproductive toxicants), the market for DEHP and DBP has declined and they now form only a smaller part of the phthalate consumption in Europe. However, due to the large quantities consumed annually (285 000 t estimated for 2007) and the use in many articles with long service life, diffuse releases of DEHP to the environment are expected to continue for some years through waste streams. Quantitative information on releases and transport to the sea is scarce. Recent estimates suggest that 11 600 t of DEHP were released to the environment in 2007, with two thirds to soil, 3400 t to waste water and 600 t to air (EU, 2009). Measurements of effluent water from various sources, including sewage treatment plants, in the late 1990s suggest a total release of 800 tonnes per year, corresponding to 4.5% of the annual consumption in the EU at that time. Further efforts are necessary to control and reduce releases to the environment in order to achieve the cessation target by 2020.

How does this affect the marine environment?

Since 2000, DEHP has been reported to be widespread in mussels, fish and sediments in Arctic Waters (Region I), Greater North Sea (Region II) and Celtic Seas (Region III) at both reference and polluted sites. The highest concentrations in mussels found at a reference site are 1.523 mg/kg w.w. in Norwegian waters. The highest concentrations in fish liver were found at remote Nordic sites, maximum at 55.7 mg/kg w.w. (DEHP). There are indications that DEHP is transported by air in particulate form towards the colder regions, where it is trapped during the winter and released again during the summer (SPFO, 2007). This is consistent with the increasing concentrations observed in marine sediments and fish liver from southern to northern Norway. DEHP could therefore be subject to 'global distillation', a process recognised for POPs with capability for long-range transport.

No concentrations of DEHP have been reported above the PNEC value in sediments. The PNECs for DEHP in food for mammals, birds and fish have been calculated to be 3.3, 17 and 16 mg/kg w.w. food respectively. Based on these values, only in remote areas of Region I DEHP concentrations have been found in fish liver which can pose a risk for mammals and to a lesser extent to birds through the food chain. There is no information available to compare observed concentrations in seawater with PNECs. There is a need to further investigate the environmental risks of phthalates in the northern parts of the OSPAR area.

7. Alkylphenols

Alkylphenols are natural constituents of petroleum oil and may be found in produced water discharged from offshore oil and gas installations. The three alkylphenols listed for priority action – nonylphenol (NP), octylphenol (OP) and 2,4,6-tri-tert-butylphenol (2,4,6-TTBP) – are used as intermediates in the production of other chemicals. NPs are used to produce NP derivates, especially ethoxylates, with end uses as emulsifiers, dispersive agents, surfactants and/or wetting agents in various industrial and domestic products. OP is mainly used to produce phenol/formaldehyde resins with various end uses (tackifier in rubber for tyres, water-based paints, pesticide formulations, and recovery of oil in offshore processes). 2,4,6-TTBP may be used in the production of antioxidants for rubber and plastic and as an additive to fuel or lubricants.

What is the problem?

All three alkylphenols on the OSPAR list of chemicals for priority action are toxic to marine organisms and fulfil the OSPAR criteria for persistency and bioaccumulation. Nonylphenol, octylphenol and their derivates (NP ethoxylates (NPE) and phenol/formaldehyde resins) are suspected endocrine disruptors which induce sex change in male fish. The main releases to the environment occur through discharge of waste water from land-based industrial activities where the substances are used as intermediates and from uses of derivates in products.

What has been done?

Releases of alkylphenols from industrial point sources are regulated in the EU framework. OSPAR Recommendation 92/8 and subsequent EU measures restrict the use of NP/NPEs in a number of products such as industrial and domestic cleaning, textiles and leather processing, metal working, manufacturing of pulp and paper, cosmetic products and pesticides. Measures to reduce production and use of NP/NPEs will also reduce releases of octylphenol compounds which may be present as impurities in NPEs. No specific measures exist for 2,4,6-TTBP which is considered to be used only in small quantities in Europe.

Did it work?

Quantitative data on emissions, discharges and losses of the three alkylphenols to the environment are poor. The observed presence of alkylphenols in waste water effluents, sewage sludge and rivers suggest that discharges of NP and OP continue from diffuse sources such as from the washing of imported textiles. Given their chemical properties, the main pathway is direct discharges and losses to water and sediments. It is expected that atmospheric concentrations are low and transport by air is unlikely. With existing measures it is expected that the cessation target will be met in 2020 for NP/NPE but not for octylphenol; available information is too limited to draw a firm conclusion for 2,4,6-TTBP.

How does this affect the marine environment?

Limited monitoring data is available from which to draw conclusions on environmental status in relation to alkylphenols. There is evidence that alkylphenols can be present in all marine environmental compartments. For example, in the Greater North Sea, NP, OP and 2,4,6-TTBP have been detected in sediment samples from a highly industrialised UK estuary at levels of 5.88 mg/kg d.w., 0.53 mg/kg d.w. and 0.09 mg/kg d.w. Surveys carried out by Sweden in estuaries in the Kattegat region have detected levels of NP and OP in seawater exceeding EU environmental quality standards at reference and contaminated sites. In the Irish Sea, measurements of NP in water, mussels and sediment reach levels of up to 0.17 mg/kg d.w. in sediments. In Arctic Waters, the presence of NP and OP has been reported in sediments at reference sites (NP: up to 60 ng/kg d.w.; OP: up to <2.1 µg/kg d.w.). However, the measurements of alkylphenols in the marine environment suggest that they may not pose a significant concern to the open sea, but may be of concern in areas close to sites of production or use.

8. Pharmaceuticals, personal care and other substances

8.1 Clotrimazole

Clotrimazole is a pharmaceutical which has many ecotoxicological properties in common with a range of fungicides used in agriculture. It is mainly used for treatment of dermatological and gynaecological fungal infections in humans.

What is the problem?

Clotrimazole is a persistent substance with toxic and bioaccumulative properties which are considered a borderline case under OSPAR PBT criteria. Clotrimazole is used as active ingredient in creams, tablets, solutions, spray and powder and is washed into waste water through normal body hygiene procedures. The main entry route of clotrimazole to the environment is via waste water treatment effluents as a result of waste water from households and hospitals. Releases to different environmental compartments from production and formulation processes are considered negligible.

What has been done?

OSPAR actions and subsequent EU measures require consumer information through package leaflets of clotrimazole products to enhance controlled disposal of the products and environmental protection. EU measures regulate releases from production and formulation processes and the use of clotrimazole as pharmaceutical.

Did it work?

Monitoring data on emissions, discharges and losses of clotrimazole and its transport to the sea is poor and not conclusive. There is indication that clotrimazole may be detected in waste water treatment effluents (<100 ng/l) and transported by rivers to the sea. Available information suggests that further efforts are needed to move towards the cessation target by 2020, but conclusions need to be reviewed in light of additional monitoring data.

How does this affect the marine environment?

Marine environmental information is scarce. In the Greater North Sea, few studies of water samples from contaminated sites in Elbe (Germany) and Tyne (UK) rivers and estuaries are available with contradictory results for the Tyne. One set of studies suggests that clotrimazole can hardly be detected due to the high adsorption potential to particulate matter, another set shows that clotrimazole can be detected in rivers and estuaries and may reach the marine environment even after passage through a tertiary waste water treatment plant. OSPAR has not given priority to marine environmental monitoring, but focused on keep discharges at source under review. Recent research results along the Swedish West coast suggest that the low observed concentrations of clotrimazole were sufficient to give rise to concern for risks of disturbance of growth and reproduction of single cell algae, the basis of the ocean’s food chain.

8.2 Musks

Musks are substances with a musky scent used in a variety of consumer products including cosmetics, detergents, fabric softeners, cleaning and household products. From the three groups of substances referred to as musks, musk xylene (a nitro musk) is prioritised by OSPAR.

What is the problem?

Musk xylene is a very persistent substance which accumulates in biota and is toxic to marine organisms. Nitro musks are not produced in Europe, but are imported and exported both as pure substance and in finished products. Consumption volumes of musk xylene have remained stable since 1998. Musk xylene are diffusely released to the marine environment from the widespread dispersive use of consumer products. The main sources for releases to the environment are domestic waste water and effluents from the sewerage systems and sewage treatment plants.

What has been done?

EU restrictions apply to the contents of nitro musks, including musk xylene, in cosmetic products. Musk xylene has been proposed for authorization under the REACH Regulation ((EC) No. 1907/2006) as very persistent and very bioaccumulative substance. An EU risk assessment has recently been concluded and the need for risk reduction measures is still under consideration.

Did it work?

National studies in 1995 – 2000 suggested that musks are found at low concentrations in effluents from sewage treatment plants and in sewage sludge and that discharge levels were steadily decreasing. Studies in 2004 indicate that levels measured in southern Europe are lower than those observed in the northern countries. There are limited observations of very low concentrations in rivers.

How does this affect the marine environment?

There is no monitoring data available on concentrations of musk xylenes in the marine environment. OSPAR has not given priority to environmental monitoring of musk xylenes, but promotes exposure and risk assessments to clarify the concern of the substance for the marine environment.

8.3 6PPD

4-(dimethylbutylamino) diphenylamine (6PPD) is an aromatic amine and is used in high volumes as a protective agent (anti-ozonant and anti-oxidant) in the rubber industry, mainly for production of tyres.

What is the problem?

6PPD is acutely toxic to marine organisms but does not have adverse carcinogenic, mutagenic and reprotoxic (CMR) properties. It rapidly degrades in air and by biotic and abiotic processes and is unstable in water, but both 6PPD and its metabolites have potential to adsorb persistently to sediment. Its potential to bioaccumulate is below the OSPAR threshold. There are gaps in knowledge concerning the degradation of 6PPD in soil and the environmental fate and behaviour of the metabolites. 6PPD is not a PBT substance but its properties indicate a hazard for the environment. As a high volume production chemical it may be widely released to the environment, thus warranting continuous attention. 6PPD is released during the use of rubber products and mainly from abrasion and disposal of tyres. 6PPD can be leached by rainwater from the tyre debris deposited on roadsides.

What has been done?

There are no specific measures in place to regulate or reduce releases and uses of 6PPD. Discharges from production and manufacture via air and waste water are regulated by EU legislation. Production emissions are considered negligible. 6PPD is part of the OECD existing chemicals programme under which its exposure and possibly its risks are recommended for further investigation, including the identities and properties of degradation products.

Did it work?

In a worst case scenario, it was estimated that rubber particles containing up to 800 tonnes of 6PPD were released in Germany in 2000. There is no monitoring information on emissions, discharges and losses of 6PPD to confirm the magnitude or indicate trends of releases to the environment and the transport of the substance and its metabolites to the sea. Available information does not allow conclusions on progress towards the cessation target in 2020.

How does this affect the marine environment?

There is no monitoring data available on concentrations of 6PPD in the marine environment. OSPAR has not given priority to environmental monitoring of 6PPD, but promotes exposure and risk assessments to clarify the potential risks arising from 6PPD for the marine environment.

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Annex 2

Complementary national monitoring information

To complete the picture for those OSPAR priority chemicals which are not included in the Coordinated Environmental Monitoring Programme (CEMP) or have been included in the CEMP too recently to result in data series for assessment, national monitoring information has been collected. This includes observation results from routine and periodic monitoring, one-off surveys and research programmes.

This information has not been collected in a coordinated way and is not comparable to the standard and quality of monitoring results under the CEMP. The information still provides evidence about the occurrence of those priority chemicals in the marine environment. Most of them are man-made substances (except dioxins, nonylphenols and octylphenols which are naturally occurring) and OSPAR's ultimate objective is that their concentrations in the marine environment is zero. In many cases, there are no assessment criteria available within or outside OSPAR to conclude on the severity of the problem and whether there is risk of pollution effects for marine organisms.

Lead countries for OSPAR priority chemicals have undertaken to examine national information and compiled the appended tables with information for the following priority chemicals for each OSPAR Region and matrix for reference (background) sites and polluted sites. References to information sources are included with each substance.

Short Chain Chlorinated Paraffins (SCCP)

s+mPCA	*short and medium chain chlorinated paraffins*
PCA	*short, medium and long chain chlorinated paraffins*

OSPAR Sub-region	**Location**	**Compound**	**Matrix**	**Reference sites Concentration range (unit)**	**Contaminated sites Concentration range (unit)**	**Range of observed concentrations is of concern:**	**Reference**
Biota							
Region I	Bear Island Svalbard	s+mPCA	Arctic char	200-2500 ng/g lw			Oehme *et al.* , 2005
Region I	Lofot Islands/Iceland	s+mPCA	Cod liver	46-265 ng/g lw			Oehme *et al.* , 2005
Region I	Svalbard	SCCP	polar bears	0.004-2.6 pg/g ww			SFT, 2004b
Region II	Norway coast	SCCP	Blue mussel	0.9-4.8 ng/g ww (140-360 ng/g lw)			SFT, 2004a
Region II	Norway coast	SCCP	Cod liver	30-110 ng/g ww (69-270 ng/g lw)			SFT, 2004a
Region II	Southern Norway	SCCP	Cod liver	80- 130 ng/g ww			SFT, 2002
Region II	Southern Norway	SCCP	Cod liver	23 - 750 ng/g ww			SFT, 2002
Region II	Southern Norway Drammens Fjord	SCCP	Eel, trout, orfe, perch	1.7-41 ng/g ww			SFT, 2004a
Region II	Southern Norway Lake Mjøsa	SCCP	Perch, pike, trout and burbot	4.8-29 ng/g ww			SFT, 2004a
Region II	North sea	s+mPCA	Fish liver	54-3900 ng/g lw			Oehme *et al.* , 2005
	Baltic Sea	*s+mPCA*	*Fish liver*	*90-3170 ng/g lw*			*Oehme et al., 2005*
Sediments							
Region I	Barents sea	SCCP	Sediment	8-92 ng/g dw		No*	SFT, 2008
Region II	Kattegat - Göta Älv estuary	SCCP	Sediment		8.1-13 ng/g dw		SEPA, 2008
Region II	Kattegat	SCCP	Sediment	<DL			SEPA, 2008
Region II	Norway coast	SCCP	Sediment	5.8-1300 ng/g dw			SFT, 2004a
Region II	Southern Norway Lake Mjøsa	SCCP	Sediment	130-510 ng/g dw			SFT, 2004a
Region II	Southern Norway Drammens River	SCCP	Sediment	12-1 800 ng/g dw			SFT, 2004a
Region II	Southern Norway Inner Drammens Fjord	SCCP	Sediment	94-1300 ng/g dw			SFT, 2004a
Region II	North Sea	PCA	Sediment	5-355 ng/g dw			Oehme *et al.* , 2005

	Baltic Sea	*PCA*	*Sediment*	*45-377 ng/g dw*			Oehme *et al.* , 2005
Region II	North sea/Baltic Sea	s+mPCA	Water	<DL			Oehme *et al.* , 2005

No* - According to the author of the document

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PFOS

OSPAR Region	Area	Matrix	Reference sites Concentration range (unit)	Contaminated sites Concentration range (unit)	Range of observed concentrations is of concern:	Reference
Region I	Faroe Islands	Fulmar eggs		31 & 38 µg/kg ww	YES	Kallenborn *et al., 2004*
Region I	Norway (Bear Island)	Fulmar liver	0.8 to 8.3 µg/kg ww		YES	SFT, 2005
Region I	Norway (Svalbard)	Glaucous gull liver	21 – 629 µg/kg ww		YES	SFT, 2007a
Region I	Norway (Svalbard)	Guillemot eggs	8.5 – 26 µg/kg ww		YES	SFT, 2008
Region I	North Norway (1983)	Herring gull eggs		~ 22 ± 4.9 µg/kg ww	YES	SFT, 2006
Region I	North Norway (1993)	Herring gull eggs		~ 41 ± 4.2 µg/kg ww	YES	SFT, 2006
Region I	North Norway (2003)	Herring gull eggs		~ 40 ± 4.2 µg/kg ww	YES	SFT, 2006
Region I	Barents Sea	Marine fish whole	2.0 – 8.0 µg/kg ww		NO	SFT, 2008
Region I	Faroe Islands	Marine fish		0.9 – 2.1 µg/kg ww	YES	Kallenborn *et al.*, 2004
Region I	Iceland	Marine fish		12 – 28 µg/kg ww	YES	Kallenborn *et al.*, 2004
Region I	Iceland	Minke whale		19 – 71 µg/kg ww	YES	Kallenborn *et al.*, 2004
Region I	Faroe Islands	Pilot whale		88 – 336 µg/kg ww	YES	Kallenborn *et al.*, 2004
Region I	Norway Svalbard	Polar bear plasma		57 – 150 µg/kg ww	YES	SFT, 2004
Region I	Barents Sea	Shrimp	2.5 – 10 µg/kg ww		YES	SFT, 2008
Region II	Sweden	Grey seal		331 - 537 µg/kg ww	YES	Kallenborn *et al.*, 2004
Region II	Sweden	Guillemot eggs		up to ~ 1,300 µg/kg ww	YES	NRM, 2007
Region II	Denmark	Harbour seal		565 – 977 µg/kg ww	YES	Kallenborn *et al.*, 2004
Region II	Sweden	Herring liver		up to 7.9 µg/kg ww	YES	NRM, 2007
Region II	Denmark	Marine fish		18 – 21 µg/kg ww	YES	Kallenborn *et al.*, 2004
Region II	Sweden	Marine fish		8.1 – 62 µg/kg ww	YES	Kallenborn *et al.*, 2004
Region II	Baltic Sea and North Sea	Marine fish liver		2.4 – 26 µg/kg ww	YES	Oehme M. *et al.* , 2005.
Region II	Denmark	Marine fish liver		9.5 – 156 µg/kg ww	YES	Strand *et al.* , 2007
Region II	Norway	Marine fish liver		0.3 – 57 µg/kg ww	YES	SFT, 2007b
Region II	Norway Oslofjord	Marine fish liver		20 – 62 µg/kg ww	YES	SFT, 2008

Region II	Baltic Sea and North Sea	Marine fish muscle		0.7 – 4.2 µg/kg ww	YES	Oehme M. *et al* ., 2005.
Region II	Norway	Mussels		0.2 – 2.2 µg/kg ww	YES	SFT, 2007b
Region II	Netherlands	Porpoise liver (2006)		270 – 3,000 µg/kg ww	YES	ICES, 2008
Region II	UK waters	Porpoise liver		< 16 – 2,390 µg/kg ww	YES	Law et al., 2008.
Region III	UK waters	Porpoise liver		78 - 2,420 µg/kg ww	YES	Law et al., 2008.
Sediment						
Region I	Barents Sea	Sediment	< 0.08 – 0.44 µg/kg		NO	SFT, 2008
Region I	Faroe Islands	Sediment		< LOQ - 0.11 µg/kg ww	NO	Kallenborn *et al.,* 2004
Region I	Iceland	Sediment	< LOQ		NO	Kallenborn *et al.,* 2004
Region II	Baltic Sea and North Sea	Sediment		0.02 - 2.4 µg/kg dw	NO	Oehme M. *et al.* , 2005.
Region II	Finland	Sediment		0.22 – 1.0 µg/kg ww	NO	Kallenborn *et al.,* 2004
Region II	Norway (coast)	Sediment	0.2 – 0.5 µg/kg dw		NO	SFT, 2008
Region II	Norway Haltenbanken	Sediment		0.2 – 1.8 µg/kg dw	NO	SFT, 2008
Region II	Norway	Sediment		0.11 & 0.39 µg/kg ww	NO	Kallenborn *et al.,* 2004
Region II	Norway	Sediment		0.1 – 3.7 µg/kg dw	NO (PNEC 220 µg/kg	SFT, 2007b
Region II	Sweden	Sediment		< LOQ – 0.07 µg/kg ww	YES	Kallenborn *et al.,* 2004
Water						
Region I	Faroe Islands	Seawater		0.08 – 0.24 ng/L	YES	Kallenborn *et al.,* 2004
Region I	Greenland Sea	Seawater	0.01 – 0.08 ng/L		YES	ICES, 2007
Region I	Iceland	Seawater	< LOQ – 0.08 ng/L		YES	Kallenborn *et al.,* 2004
Region II	Baltic Sea and North Sea	Seawater		0.3 - 30 ng/L	YES	Oehme *et al* ., 2005.
Region II	Denmark	Seawater		0.17 – 0.53 ng/L	YES	Kallenborn *et al.,* 2004
Region II	Finland	Seawater		0.9 – 22 ng/L	YES	Kallenborn *et al.,* 2004

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Dioxins

OSPAR Region	Area	Matrix	Reference sites Concentration range (pg/g TEQ)	Contaminated sites Concentration range (TEQ)	Range of observed concentrations is of concern:	Reference
Biota						
Region I	Barents sea	Bird - glaucous gull - plasma and egg	1.38 ± 0.17 (0.79 − 2.25) male plasma 1.84 ± 0.32 (0.65 − 4.21) female plasma	4.62 ± 0.67 (1.31 − 8.14) (egg) n=10 -32	Σcoplanar PCB represented only 0.2–0.4% of ΣPCB in glaucous gull plasma. Levels in eggs consistent with Swallbard/Bear island levels	SFT, 2004
Region II	Kattegat +(HELCOM)	Bird - Guillemot egg	0.86 pg/g (0.74-1.01, n=10) lipid		Contaminated site in Baltic sea (HELCOM area)	NRM, 2007
Region II	Kattegat (+HELCOM)	Bird - Guillemot egg	0.84 pg/g (0.73-0.98) lipid		Contaminated site in Baltic sea (HELCOM area)	NRM, 2008
Region II	Swedish waters	Fish - Harbour porpoise	221-285 ng/kg wet blubber 27 ng/kg liver 11 ng/kg muscle			Ishaq, 2000
Region II	Kattegat + (HELCOM)	Fish - Herring	0.38 (0.32 - 0.47) *9.1 (7.7-11) lipid*	0.71 (0.58 - 0.86) *28 (24-33) lipid*	Contaminated site in Baltic sea (HELCOM area) Level in baltic above EU 4 pg/g fr. limit in fatty fish	NRM, 2007

Region II	Kattegat + (HELCOM)	Fish - Herring	0.39 (0.32 - 0.47) fr *9.1 (7.7-11) lipid*	0.72 (0.59 - 0.87) fr *28 (24-33) lipid*	Contaminated site in Baltic sea (HELCOM area)	NRM, 2008
Region II	Kattegat	Fish - Strömning	0.44 pg/g fresh		Obs: Not dioxins	Naturvårdsverket, 2007
Region II	Belt Sea	*Mytilus edulis*	0.03 pg/g TEQ (0.03 – 0.06)			Larsen, M., 2007
Region II	Denmark	*Mytilus edulis*	range: <0.01 – 0.3 pg/g wet (n=53)	3.6 – 7.95 pg/g wet (n=3)	Smålandsfarvandet south of sealand outlier	Larsen, M., 2007
Region II	Kattegat	*Mytilus edulis*	1.1 pg/g		Obs: Not dioxins	Naturvårdsverket, 2007
Region II	Kattegat	*Mytilus edulis*	0.045 pg/g (0.04 – 0.06)	0.14 - 0.17 - 0.22		Larsen, M., 2007
Region III	Irish Waters	Fish - Mackerel	0.3 (0.21-0.32 n=4) excl PCB 1,2 (0,97 – 1.58) incl. PCB			Tlustos, C *et al* ., 2007
Region III	Irish Waters	Fish - Salmon	0.32 (0.13-0.61, n=10) excl PCB 0.76 (0.41-1.3) incl. PCB		Well below food safety limits. 27-45% lower in 2004 than 2001 farmed	Tlustos, C *et al* ., 2007
Region III	Irish Waters	Fish - Wild Herring	0.42 (0.38-0.44 n=10) excl PCB 1.03 (0.93-1.09) incl. PCB		Well below food safety limits.	Tlustos, C *et al* ., 2007
Region III	Irish Waters	Mussels	0,16 pg/g wet (<0,25 – 0.35, n=7)	1.1 pg/g		McGovern, 2007
Region III	Irish Waters	Oysters	0.21 (0.09-0.43, n=5) excl PCB 0.37 (0.22-0.63) incl. PCB		Well below food safety limits	Tlustos, C et al., 2007
Sediments						

Region I	Barents Sea	Sediment	0.22 (<DL-0.44) PCDF-WHO eqv 0.25 (0.01-0.47) PCDD/PCDF eqv.	0.68 (0.1-1.01) PCDF-WHO eqv 1.12 (0.19-2.2) PCDD/PCDF eqv.		SFT, 2008
Region II	Baltic Area	Sediment	3.2-7.0	17 PCDDF TEQ		Naturvårdsverket, 2007
Region II	Kattegat	Sediment	3.76 pg/g (15-30cm, n=1) 5.53 pg/g wet, n=1	14.2 (0-15 cm, n=1)		Larsen, M., 2007
	Arkona (HELCOM)	*Sediment*	*10 pg/g wet, n=4*	*97 pg/g wet, n=1*		Larsen, M., 2007

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Polybrominated Diphenylethers (PBDE)

OSPAR Region	Area	Compound	Matrix	Reference sites Concentration range (unit)	Contaminated sites Concentration range (unit)	Range of observed concentrations is of concern:	Reference
Region II	Sweden, Fladen	BDE-47	Cod liver	7.7-24 ng/g lw			NRM, 2008
Region II	Sweden, Utlängan	BDE-47	Herring muscle	4.5-21 ng/g lw			NRM, 2008
Region II	Sweden, Fladen	BDE-47	Herring muscle	1.8-3 ng/g lw			NRM, 2008
Region II	Sweden, Väderöarna	BDE-47	Herring muscle	1.7-4.3 ng/g lw			NRM, 2008
Region I	Northern Norway-Röst	Deca BDE	A. puffin eggs	<DL-0.2 ng/g ww		No*	SFT, 2005
Region I	Northern Norway-Hornöy	Deca BDE	Herring gull eggs	<DL-11 ng/g ww		No*	SFT, 2005
Region I	Northern Norway-Röst	Deca BDE	Herring gull eggs	0.1-14 ng/g ww		No*	SFT, 2005
Region I	Northern Norway-Hornöy	Deca BDE	Kittikawe eggs	<DL-0.2 ng/g ww		No*	SFT, 2005
Region II	Baltic Sea	Deca BDE	Dab (*Limanda limanda L .*) liver	<DL		No*	Lepom *et al* ., 2006
Region II	North Sea	Deca BDE	Dab (*Limanda limanda L .*) liver	<DL		No*	Lepom *et al* ., 2006
Region II	Norway - coast	Deca BDE	Cod liver	<DL-1.5 ng/g ww			SFT, 2004b
Region II	Southern Norway	Deca BDE	Blue mussel	<0.5- 0.16 ng/g ww			SFT, 2002
Region II	Southern Norway	Deca BDE	Cod liver	<0.5 - 0.16 ng/g ww			SFT, 2002
Region III	English Channel (Villervi	Deca BDE	Blue mussel		<DL-0.96 ng/g dw		Johansson *et al* ., 2006
Region III	UK coast	Deca BDE	Bottlenose dolphin	<DL		No*	Law *et al.* , 2005
Region III	UK coast	Deca BDE	Sowerby´s beaked whale	<DL		No*	Law *et al.* , 2005
Region III	UK coast	Deca BDE	Killer whale	<DL		No*	Law *et al.* , 2005
Region III	UK coast	Deca BDE	Pugmy sperm whale	<DL		No*	Law *et al.* , 2005
Region III	UK coast	Deca BDE	Hooded seal	<DL		No*	Law *et al.* , 2005
Region III	UK coast	Deca BDE	Other whales and dolphin (7 st)	<DL		No*	Law *et al.* , 2005
	Mediterranean Sea (Tha	*Deca BDE*	*Blue mussel*	*<DL*		*No**	*Johansson et al., 2006*
Region IV	the Atlantic (Pen Be´)	Deca BDE	Blue mussel	<DL		No*	Johansson *et al* ., 2006
Region I	Barents sea	Penta BDE	Blue mussel	<DL-1.2 ng/g dw		No*	SFT, 2008
Region I	Barents sea	Penta BDE	Capelin	0.047-0.18 ng/g ww			SFT, 2008
Region I	Barents sea	Penta BDE	Cod liver	4.3-29 ng/g ww		No*	SFT, 2008
Region I	Barents sea	Penta BDE	Shrimp	0.001-0.017 ng/g ww		No*	SFT, 2008
Region II	Norway - coast	Penta BDE	Blue mussel	0.03-0.73 ng/g ww			SFT, 2004b
Region II	Southern Norway	Sum 4 BDE (28, 47, 99, 100)	Blue mussel	0.16- 0.59 ng/g ww			SFT, 2002
Region II	Southern Norway	Sum 4 BDE (28, 47, 99, 100)	Cod liver	13 - 140 ng/g ww			SFT, 2002
Region II	Southern Norway	Sum 4 BDE (138, 153, 154, 183)	Blue mussel	<0.01- 0.02 ng/g ww			SFT, 2002

Region II	Southern Norway	Sum 4 BDE (138, 153, 154, 183)	Cod liver	0.49 - 8.01 ng/g ww			SFT, 2002
Region I	Northern Norway-Hornöy	Sum 8 BDE (28, 47, 100, 99, 154, 153, 183, 209)	A. puffin eggs	9.0-21 ng/g ww		No*	SFT, 2005
Region I	Northern Norway-Röst	Sum 8 BDE (28, 47, 100, 99, 154, 153, 183, 209)	A. puffin eggs	7.0-25 ng/g ww		No*	SFT, 2005
Region I	Northern Norway-Hornöy	Sum 8 BDE (28, 47, 100, 99, 154, 153, 183, 209)	Herring gull eggs	39-91 ng/g ww		No*	SFT, 2005
Region I	Northern Norway-Röst	Sum 8 BDE (28, 47, 100, 99, 154, 153, 183, 209)	Herring gull eggs	45-83 ng/g ww		No*	SFT, 2005
Region I	Northern Norway-Hornöy	Sum 8 BDE (28, 47, 100, 99, 154, 153, 183, 209)	Kittikawe eggs	7.3-24 ng/g ww		No*	SFT, 2005
Region I	Northern Norway-Röst	Sum 8 BDE (28, 47, 100, 99, 154, 153, 183, 209)	Kittikawe eggs	18-32 ng/g ww		No*	SFT, 2005
Region I	Northern Norway-Bear Is	Sum 9 BDE (28, 47, 100, 99, 154, 153, 138, 183 and 209)	Glaucous gulls plasma (male)	7.4-76 ng/g ww			SFT, 2004c
Region I	Northern Norway-Bear Is	Sum 9 BDE (28, 47, 100, 99, 154, 153, 138, 183 and 209)	Glaucous gulls plasma (female)	27-53 ng/g ww			SFT, 2004c
Region I	Northern Norway-Bear Is	Sum 9 BDE (28, 47, 100, 99, 154, 153, 138, 183 and 209)	Glaucous gulls eggs	24-104 ng/g ww			SFT, 2004c
Region I	Northern Norway-Bear Is	Sum 9 BDE (28, 47, 100, 99, 154, 153, 138, 183 and 209)	Glaucous gulls (brain)	220-11000 ng/g lw			SFT, 2007
Region I	Northern Norway-Bear Is	Sum 9 BDE (28, 47, 100, 99, 154, 153, 138, 183 and 209)	Glaucous gulls (liver)	1800-103000 ng/g lw			SFT, 2007
Region III	UK coast	Sum 10 BDE (28, 47, 66, 85, 100, 99, 138, 154, 153 and 183)	Bottlenose dolphin	0.85-11 ng/g ww			Law *et al.* , 2005
Region III	UK coast	Sum 10 BDE (28, 47, 66, 85, 100, 99, 138, 154, 153 and 183)	Hooded seal	0.005-0.005 ng/g ww			Law *et al.* , 2005
Region III	UK coast	Sum 10 BDE (28, 47, 66, 85, 100, 99, 138, 154, 153 and 183)	Killer whale	0.61-16 ng/g ww			Law *et al.* , 2005
Region III	UK coast	Sum 10 BDE (28, 47, 66, 85, 100, 99, 138, 154, 153 and 183)	Other whales and dolphin (7 st)	<DL-0.41 ng/g ww			Law *et al.* , 2005
Region III	UK coast	Sum 10 BDE (28, 47, 66, 85, 100, 99, 138, 154, 153 and 183)	Pugmy sperm whale	0.3-0.37 ng/g ww			Law *et al.* , 2005

Region III	UK coast	Sum 10 BDE (28, 47, 66, 85, 100, 99, 138, 154, 153 and 183)	Sowerby´s beaked whale	0.11-0.85 ng/g ww			Law *et al.* , 2005
Region II	English Channel (Villerville)	Sum 10 BDE (28, 49, 47, 66, 85, 100, 99, 154, 153 and 183)	Blue mussel		4.8-25 ng/g dw		Johansson *et al* ., 2006
Region IV	the Atlantic (Pen Be´)	Sum 10 BDE (28, 49, 47, 66, 85, 100, 99, 154, 153 and 183)	Blue mussel	0.19-1.4 ng/g dw			Johansson *et al* ., 2006
	Mediterranean Sea (Thau lagoon)	*Sum 10 BDE (28, 49, 47, 66, 85, 100, 99, 154, 153 and 183)*	*Blue mussel*	*0.6-1.6 ng/g dw*			*Johansson et al., 2006*
Region II	Norway - coast	Sum 12 BDE (28, 47, 49, 71, 77, 100, 99, 119, 138, 153, 154, 183)	Cod liver	7.2-25 ng/g ww			SFT, 2004b
Region II	Norway Drammens Fjord	Sum 12 BDE (28, 47, 49, 71, 77, 100, 99, 119, 138, 153, 154, 183)	Eel, trout, orfe, perch		1.1-18 ng/g ww (12-170 ng/g lw)		SFT, 2004b
Region II	North Sea	Sum 13 BDE (28, 47, 66, 71, 75, 85, 100, 99, 138, 154, 153, 183, 190)	Dab (*Limanda limanda L* .) liver	2.8 ng/g ww		No*	Lepom *et al* ., 2006
	Baltic Sea	*Sum 13 BDE (28, 47, 66, 71, 75, 85, 100, 99, 138, 154, 153, 183, 190)*	*Dab (Limanda limanda L.) liver*	*3.6 -10 ng/g ww*		*No**	*Lepom et al., 2006*
Region II	Norway Lake Mjösa/Lake Losna	Sum 13 BDE (28, 47, 49, 71, 77, 100, 99, 119, 138, 153, 154, 183, 209)	Perch, pike, trout and burbot		2.4-980 ng/g ww (49-22000 ng/g lw)		SFT, 2004b
Region III	England	Sum 14 BDE (28, 47, 66, 71, 75, 77, 85, 99, 100, 119, 138, 153, 154 and 190)	Cormorant livers		1.8 - 140 µg/kg ww		Law *et al.* , 2002
Region III	England	Sum 14 BDE (28, 47, 66, 71, 75, 77, 85, 99, 100, 119, 138, 153, 154 and 190)	Porpoise blubber		<DL - 6900 µg/kg ww		Law *et al.* , 2002
Region I	Svalbard	Sum 40 BDE (7-209)	Polar bears	0.015-0.048 ng/g ww			SFT, 2004d
Sediments							
Region I	Barents sea	Deca BDE	Sediments	<DL-1.1 ng/g dw		Yes*	SFT, 2008
Region I	Norway Drammens River	Deca BDE	Sediments		3.6-79 ng/g dw		SFT, 2004b
Region I	Norway Lake Mjösa/Lake Losna	Deca BDE	Sediments		0.23-11 ng/g dw		SFT, 2004b
Region I	Norway Lillehammar	Deca BDE	Sediments		6-10 ng/g dw		SFT, 2004b
Region II	Dutch Marine and Coastal waters	Deca BDE	Sediments		0.92-130 ng/g dw		Langenberg, 2005
Region II	Dutch Marine and Coastal waters	Deca BDE	Suspended matter		12-2700 ng/g dw		Langenberg, 2005

Region I	Barents sea	Penta BDE	Sediments	0.0015-0.3 ng/g dw		Yes*	SFT, 2008
Region I	Kattegat	Penta BDE	Sediments	<DL		No*	Cato & Kjellin, 2008
Region I	Norway - coast	Penta BDE	Sediments	0.04-1.5 ng/g dw			SFT, 2004b
Region I	Skagerrak, Bothnian Bay	Penta BDE	Sediments	<0.02-1.1 ng/g dw		No*	Cato & Kjellin, 2008
Region II	Sweden	Penta BDE	Water (surface)	0.68-57 pg/l			SEPA, 2007
Region I	Northern Norway, Ellasjøen	Sum 10 BDE (28, 47, 71, 77, 99, 100, 138, 153, 154, 183)	Sediments	0.73 ng/g dw		No*	SFT, 2004a
Region I	Norway Drammens River	Sum 12 BDE (28, 47, 49, 71, 77, 100, 99, 119, 138, 153, 154, 183)	Sediments		0.5-1.0 ng/g dw		SFT, 2004b
Region I	Norway Lake Mjösa/Lake Losna,	Sum 12 BDE (28, 47, 49, 71, 77, 100, 99, 119, 138, 153, 154, 183)	Sediments		0.17-16 ng/g dw		SFT, 2004b
Region I	Norway Lillehammar	Sum 12 BDE (28, 47, 49, 71, 77, 100, 99, 119, 138, 153, 154, 183)	Sediments		18-17 ng/g dw		SFT, 2004b
Region II	Dutch Marine and Coastal waters	Sum 14 BDE (28, 47, 49, 66, 71, 75, 77, 85, 100, 99, 119, 138, 154, 183)	Sediments		0.61-2.2 ng/g dw		Langenberg, 2005

No/Yes* - According to the author of the document

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Polybrominated Biphenyls (PBB)

OSPAR Region	Location	Matrix	Reference sites Concentration range (unit)	Contaminated sites Concentration range (unit)	Range of observed concentrations is of concern:	Reference
Region I	Northern Norway, Björnöya	Northern fulmars liver	0.21- 0.44 ng/g ww			SFT, 2005
Region I	Northern Norway-Bear Island	Glaucous gulls plasma (	0.09-0.76 ng/g ww			SFT, 2004
Region I	Northern Norway-Bear Island	Glaucous gulls plasma (	0.09-0.56 ng/g ww			SFT, 2004
Region I	Northern Norway-Bear Island	Glaucous gulls eggs	0.06-0.54 ng/g ww			SFT, 2004
Region II	Southern Norway	Blue mussel	<0.01- 0.13 ng/g ww			SFT, 2002
Region II	Southern Norway	Cod liver	<0.2 - 0.45 ng/g ww			SFT, 2002

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Hexabromocyclododecane

OSPAR Region	Location	Matrix	Reference sites Concentration range (unit)	Contaminated sites Concentration range (unit)	Range of observed concentrations is of concern:	Reference
Biota						
Region I	Northern Norway - Björnöya	Northern fulmars liver	0.2 - 2.22 ng/g ww			SFT, 2005
Region I	Barents sea	Capelin	<DL		No*	SFT, 2008
Region I	Svalbard	Polar bears	0.001-0.045 ng/g ww			SFT, 2004d
Region I	Barents sea	Shrimp	<DL		No*	SFT, 2008
Region I	Northern Norway-Bear Island	Glaucous gulls plasma (male	0.1-1.5 ng/g ww			SFT, 2004c
Region I	Northern Norway-Bear Island	Glaucous gulls plasma (fema	0.2-2 ng/g ww			SFT, 2004c
Region I	Northern Norway-Bear Island	Glaucous gulls eggs	2-70 ng/g ww			SFT, 2004c
Region I	Northern Norway-Bear Island	Glaucous gulls (brain)	5.1-475 ng/g lw			SFT, 2007
Region I	Northern Norway-Bear Island	Glaucous gulls (liver)	195-15000 ng/g lw			SFT, 2007
Region II	North Sea	Cod (liver)	<DL			CEFAS, 2006
Region II	Norway - coast	Cod liver	0.7-4.9 ng/g ww			SFT, 2004b
Region II	Sweden, Fladen	Cod liver	0.031 - 58 ng/g lw			NRM, 2008
Region II/III	England	Cormorant (liver)	140-1300 ng/g lw			CEFAS, 2006
Region II	Scheldt basin Belgium	Eel	<DL-33000 ng/g lw			CEFAS, 2006
Region II	Netherlands - Rivers	Eel	12-850 ng/g lw			CEFAS, 2006
Region II	North Sea	Harbour porpoise (blubber)	440-6800 ng/g lw			CEFAS, 2006
Region II	North Sea - E. England	Harbour porpoise (blubber)	<DL-1020 ng/g lw			CEFAS, 2006
Region II	W. Wadden Sea	Harbour seal (blubber)	63-2055 ng/g lw			CEFAS, 2006
Region II	Sweden, Väderöarna	Herring muscle	12 - 25 ng/g lw			NRM, 2008
Region II	North Sea	Hermit crab (abdomen)	<DL			CEFAS, 2006
Region II	Norway, Southern, Lake Mjøsa	Perch, pike, trout and Turbot	2-15 ng/g ww (100-880 ng/g lw)			SFT, 2004b
Region II	Western Scheldt	Sea star (digestive system)	<DL-84 ng/g lw			CEFAS, 2006

Region II	Western Scheldt	Common Tern (eggs)	330-7100 ng/g lw			CEFAS, 2006
Region II	North Sea	Common whelk (whole)	29-47 ng/g lw			CEFAS, 2006
Region II	North Sea	Whiting (muscle)	<DL			CEFAS, 2006
Region II/III	UK coast	Harbour porpoise	10-19200 ng/g ww (11-21300 ng/g lw)			Law *et al* ., 2006
Region III	Atlantic - S. Ireland	Hake (liver)	<DL			CEFAS, 2006
Sediments						
Region I	Barents sea	Sediment	<DL-190 ng/g dw		No*	SFT, 2008
Region I	Northern Norway, Ellasjøen	Sediment	<DL - 4.3 ng/g dw			SFT, 2004a
Region II	Dutch Marine and Coastal waters	Sediment		0.04-30 ng/g dw		Langerberg, 2005
Region II	Norway - coast	Sediment	<DL-14 ng/g dw			SFT, 2004b
Region II	Southern Norway - Drammens River	Sediment	<DL - 4.1 ng/g dw			SFT, 2004b
Region II	Dutch Marine and Coastal waters	Suspended matter		6-313 ng/g dw		Langenburg, 2005

No* - According to the author of the document

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Tetrabromobisphenol-A

OSPAR Region	Area	Matrix	Reference sites Concentration range (unit)	Contaminated sites Concentration range (unit)	Range of observed concentrations is of concern:	Reference
Biota						
Region II	Netherlands	Eel		< 0.1 – 1.3 µg/kg lw	YES	Morris *et al*., 2004
Region II	North Sea	Fish liver		< 0.3 – 1.8 µg/kg lw	YES	Morris *et al*., 2004
Region II	Norway	Fish liver		0.1 – 0.16 µg/kg ww	YES	SFT, 2002
Region II	North Sea	Fish muscle		< 97 – 245 µg/kg lw	YES	Morris *et al*., 2004
Region II	Wadden Sea	Harbour seal blubber		< 14 µg/kg lw	NO	Morris *et al*., 2004
Region II	Norway	Moss		0.04 – 0.89 µg/kg ww	YES	SFT, 2002
Region II	Norway	Mussels		0.01 – 0.03 µg/kg ww	YES	SFT, 2002
Region II	North Sea	Porpoise blubber		< 11 – 418 µg/kg lw	YES	Morris *et al*., 2004
Region II	UK waters	Porpoise blubber (1994-2003)		< LOQ – 35 µg/kg ww *	??	Law *et al.*, 2006a
Region II	UK waters	Porpoise blubber (2003-2006)	< LOQ		NO	Law *et al., 2006b*
Region II	Norway	Predatory birds' eggs		< LOQ – 0.013 µg/kg ww	YES	Herzke *et al.*, 2005
Region II	Scheldt estuary	Shrimp		0.8 – 7.7 µg/kg lw	YES	Verslycke *et al*., 2005
Region II	Scheldt estuary	Tern eggs		< 2.9 µg/kg lw	NO	Morris *et al*., 2004
Region II	North Sea	Whelk		5.0 – 96 µg/kg lw	YES	Morris *et al*., 2004

Region III	Atlantic Ocean	Fish liver	< 0.2 µg/kg lw		NO	Morris *et al*., 2004
Region III	Ireland	Mussels	< LOQ		NO	McGovern, 2007
Region III	UK waters	Porpoise blubber (1994-2003)		< LOQ – 13 µg/kg ww *	??	Law *et al.*, 2006a
Region III	UK waters	Porpoise blubber (2003-2006)	< LOQ		NO	Law *et al.*, 2006b
Sediments						
Region I	Barents Sea	Sediment	< LOQ		NO	SFT, 2008
Region II	North Sea (NL)	Sediment		0.1 – 6.9 µg/kg dw	YES	Morris *et al*., 2004
Region II	North Sea (UK)	Sediment		< 2.4 – 9,750 µg/kg dw	YES	Morris *et al*., 2004
Region II	Norway	Sediment		1.9 – 44 µg/kg dw	YES	Hansen *et al*., 2008
Region II	Norway	Sediment		0.01 – 39 µg/kg dw	YES	Iversen, 2007
Region II	Norway	Sediment		1.9 – 44 µg/kg ww	YES	SFT, 2002
Region II	Scheldt estuary	Sediment		< 0.1 – 67 µg/kg dw	YES	Morris *et al*., 2004
Region II	UK (R. Tees)	Sediment		mean value 25 µg/kg dw	YES	Morris *et al*., 2004
Region II	UK (Tees Bay)	Sediment		< LOQ	NO	Morris *et al*., 2004

* positive values in some doubt following use of later confirmatory method

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Trichlorobenzenes

OSPAR Region	Area	Matrix	Reference sites Concentration range (unit)	Contaminated sites Concentration range (unit)	Range of observed concentrations is of concern:	Reference
Biota						
WFD waters	European study	Biota		<16 ng/g dw/lipid		EC, 2006
Region II	North sea coast	Biota	?	0.02 – 0.05 ng/g fw		SFT, 2007
Region III	Irish study	Biota	?	<1-5 ng/g dw		McGovern
Sediments						
Region I	Barents Sea	Sediment	?	0.27 – 1.20 ng/g dw		SFT, 2008
WFD waters	European study	Sediment	?	< 6 ng/g dw	No	EC, 2006
Region II	Norwegian sediments North sea coast	Sediment	?	0.03 – 0.05 ng/g dw		SFT, 2007
Water						
Region II	Dutch rivers	Water	?	<0.1 ng/l (below LOD)	No	Miermans *et al.,* 2000
WFD waters	European waters	Water	?	n.d.	No	EC, 2006
Region II	North Sea	Water	?	<0.1 ng/l (below LOD)	No	Van Wijk *et al.,* 2006
Region II	Scheldt Estuary	Water	<0.2 ng/l	86 - 640 ng/l	No	Huybrechts *et al.,* 2004
Region II	Southern North Sea	Water	Median concentrations 0.4 - 1.3	86 - 640 ng/l	No	Huybrechts *et al.,* 2005
Region II	Swedish waters	Water	?	<0.1 ng/l (below LOD)	No	SEPA, 2007

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Pesticides

OSPAR Subregion	Area	Matrix	Substance / group	Concentration	Reference
Air					
Region I	Norwegian CAMP Station, Birker	Air	alpha-Endosulfan	3.4 - 25 pg x m^{-3}	SFT, 2007
Region I	Norwegian CAMP Station, Ny-Al	Air	alpha-Endosulfan	5.2 - 13.2 pg x m^{-3}	SFT, 2007
Biota					
Region II	Germany	Fish liver	alpha-Endosulfan	0.11 - 1.44 ng x g^{-1} w.w.	Oehme M., *et al*., 2005
Region III	Corh Harbour	Mussels (*Mytilus edulis*)	alpha-Endosulfan	<1 µg x kg-1 d.w. (LOD)	SEPA, 2007
Region III	Dublin Bay	Mussels (*Mytilus edulis*)	alpha-Endosulfan	<1 µg x kg-1 d.w. (LOD)	McGovern, 2007
Region III	River Boyne_Drogheda Port	Mussels (*Mytilus edulis*)	alpha-Endosulfan	<1 µg x kg-1 d.w. (LOD)	SEPA, 2007
Region III	River Corrib_D/S Galway	Mussels (*Mytilus edulis*)	alpha-Endosulfan	<1 µg x kg-1 d.w. (LOD)	SEPA, 2007
Region III	River Liffey_Eastlink Bridge	Mussels (*Mytilus edulis*)	alpha-Endosulfan	<1 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Shannon_Shannon Estuar	Mussels (*Mytilus edulis*)	alpha-Endosulfan	<1 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Suir_Bellview	Mussels (*Mytilus edulis*)	alpha-Endosulfan	<1 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Suir_Waterford Estuary	Mussels (*Mytilus edulis*)	alpha-Endosulfan	<1 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Sediment					
Region I	Norwegian CAMP Station, Ny-Al	Sediment	alpha-Endosulfan	<0.01 - <0.08 ng x g^{-1} (LOD)	SFT, 2007
Region II	Baltic Sea, Germany	Sediment	alpha-Endosulfan	<0,004/0.011 - 0.198 µg x kg-	Oehme M., *et al*., 2005
Region II	North Sea, Germany	Sediment	alpha-Endosulfan	<0,004/0.011 - 0.21 µg x kg-1	Oehme M., *et al*., 2005
Region II	Sweden	Sediment (Sea)	α-HCH	≤0,13 µg x kg^{-1}	Cato & Kjellin, 2008.
Water					
Region II	Baltic Sea, Denmark	Water	alpha-Endosulfan	<20 - 62 pg x l^{-1}	ICES, 2005
Region II	Baltic Sea, Germany	Water	alpha-Endosulfan	0.013 - 0.062 ng x l^{-1}	Oehme M., *et al*., 2005
Region II	North Sea, Denmark	Water	alpha-Endosulfan	<20 - 43 pg x l^{-1}	ICES, 2005
Region II	North Sea, Germany	Water	alpha-Endosulfan	0.007/0.020 - 0.51 ng x l^{-1}	Oehme M., *et al*., 2005
Region II	Baltic Sea, Germany	Water (surface 5m)	alpha-Endosulfan	13 - 62 pg x l^{-1}	Oehme M., *et al*., 2005
Region II	North Sea, Germany	Water (surface 5m)	alpha-Endosulfan	12 - 51 pg x l^{-1}	Oehme M., *et al*., 2005
Region II	North Sea, German Bight	Water (surface 5m)	alpha-Endosulfan	<10 - 47 pg x l^{-1}	Oehme M., *et al*., 2005
Air					
Region I	Norwegian CAMP Station, Birker	Air	beta-Endosulfan	<0.02 pg x m^{-3} (LOD)	SFT, 2007
Region I	Norwegian CAMP Station, Ny-Al	Air	beta-Endosulfan	<0.01 pg x m^{-3} (LOD)	SFT, 2007

OSPAR Subregion	Area	Matrix	Substance / group	Concentration	Reference
Biota					
Region II	Germany	Fish liver	beta-Endosulfan	0.07 - 0.7 ng x g^{-1} w.w.	Oehme M., *et al*., 2005
Region III	Corh Harbour	Mussels (*Mytilus edulis*)	beta-Endosulfan	<1 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	Dublin Bay	Mussels (*Mytilus edulis*)	beta-Endosulfan	<1 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Boyne_Drogheda Port	Mussels (*Mytilus edulis*)	beta-Endosulfan	<1 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Corrib_D/S Galway	Mussels (*Mytilus edulis*)	beta-Endosulfan	<1 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Liffey_Eastlink Bridge	Mussels (*Mytilus edulis*)	beta-Endosulfan	<1 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Shannon_Shannon Estuar	Mussels (*Mytilus edulis*)	beta-Endosulfan	<1 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Suir_Bellview	Mussels (*Mytilus edulis*)	beta-Endosulfan	<1 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Suir_Waterford Estuary	Mussels (*Mytilus edulis*)	beta-Endosulfan	<1 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Sediment					
Region I	Norwegian CAMP Station, Ny-Al	Sediment	beta-Endosulfan	<0.01 - <0.19 ng x g^{-1} (LOD)	SFT, 2007
Region II	Baltic Sea, Germany	Sediment	beta-Endosulfan	0.004 / 0.014 - 0.086 µg x kg^{-1}	Oehme M., *et al*., 2005
Region II	North Sea, Germany	Sediment	beta-Endosulfan	0.004 / 0.014 µg x kg^{-1} d.w.	Oehme M., *et al*., 2005
Region II	Sweden	Sediment (Sea)	β-HCH	≤0,57 µg x kg^{-1}	Cato & Kjellin, 2008.
Water					
Region II	Baltic Sea, Denmark	Water	beta-Endosulfan	<20 - 49 pg x l^{-2}	ICES, 2005
Region II	North Sea, Denmark	Water	beta-Endosulfan	<20 - 37 pg x l^{-1}	ICES, 2005
Region II	Baltic Sea, Germany	Water	beta-Endosulfan	<0.007 - 0.49 ng x l^{-1}	Oehme M., *et al*., 2005
Region II	North Sea, Germany	Water	beta-Endosulfan	<0.007 - 0.15 ng x l^{-1}	Oehme M., *et al*., 2005
Region II	Baltic Sea, Germany	Water (surface 5m)	beta-Endosulfan	<10 - 49 pg x l^{-1}	Oehme M., *et al*., 2005
Region II	North Sea, Germany	Water (surface 5m)	beta-Endosulfan	<10 pg x l^{-1} (LOD)	Oehme M., *et al*., 2005
Sediment					
Region II	Baltic Sea, Denmark	Sediment	Endosulfan	<0.03 - 0.067 µg x kg^{-1}	ICES, 2005
Region II	Denmark	Sediment	Endosulfan	<0.03 µg x kg^{-1} (LOD)	ICES, 2005
Region II	North Sea	Sediment	Endosulfan	<0.03 µg x kg^{-1} (LOD)	ICES, 2005
Region II	Sweden	Sediment (Sea)	Endosulfan	≤0,3 µg x kg^{-1} (LOD)	Cato & Kjellin, 2008.
Water					
Region II	Belgium	Rain water	Endosulfan	1 - 224 ng x l^{-1}	Oehme M. *et al*., 2005
Region II	Sweden	Surface water	Endosulfan (sum)	148 - 2825 pg x l^{-1}	SEPA, 2007

OSPAR Subregion	Area	Matrix	Substance / group	Concentration	Reference
Air					
Region I	Norwegian CAMP Station, Birker	Air	Endosulfan sulfat	<0,01 pg x m^{-3} (LOD)	SFT, 2007
Region I	Norwegian CAMP Station, Ny-Ale	Air	Endosulfan sulfat	<0,01 pg x m^{-3} (LOD)	SFT, 2007
Sediment					
Region I	Norwegian CAMP Station, Ny-Ale	Sediment	Endosulfan sulfat	<0,01 - <0,02 ng x g^{-1} (LOD)	SFT, 2007
Biota					
Region III	Corh Harbour	Mussels (*Mytilus edulis*)	Lindane (γ-HCH)	<0,5 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	Dublin Bay	Mussels (*Mytilus edulis*)	Lindane (γ-HCH)	0,5 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Boyne_Drogheda Port	Mussels (*Mytilus edulis*)	Lindane (γ-HCH)	<0,5 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Corrib_D/S Galway	Mussels (*Mytilus edulis*)	Lindane (γ-HCH)	<0,5 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Liffey_Eastlink Bridge	Mussels (*Mytilus edulis*)	Lindane (γ-HCH)	<0,5 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Shannon_Shannon Estuary	Mussels (*Mytilus edulis*)	Lindane (γ-HCH)	<0,5 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Suir_Bellview	Mussels (*Mytilus edulis*)	Lindane (γ-HCH)	<0,5 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Suir_Waterford Estuary	Mussels (*Mytilus edulis*)	Lindane (γ-HCH)	<0,5 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Sediment					
Region I	Barent sea / Arctic	Sediment	Lindane (γ-HCH)	100 ng x kg^{-1} d.w.	SFT, 2008
Region II	Sweden	Sediment (Sea)	Lindane (γ-HCH)	0.19 - 3.4 µg x kg-1	Cato & Kjellin, 2008.
Biota					
Region I	Barent sea / Bear island	Seabirds / Egg homogenates	Total HCH	1.16 - 20.1 ng x g^{-1} w.w.	SFT, 2004
Region I	Barent sea / Bear island	Seabirds / Gull plasma	Total HCH	0.3 - 6.63 ng x g^{-1} w.w.	SFT, 2004
Region II	North Sea, German Bight	Biota	Total HCH	0.2 - 0.6 µg x kg^{-1} w.w.	Oehme M., *et al* ., 2005
Sediment					
Region I	Barent sea / Arctic	Sediment	Total HCH	0.02 - 0.05 µg x kg^{-1} d.w.	SFT, 2008
Region II	Tees estuary	Sediment	Total HCH	0.31 - 0.94 µg x kg-1	Cefas, 2006
Biota					
Region II	Germany	Fish liver	Trifluralin	0.04 - 1.74 ng x g^{-1} w.w.	Oehme M., *et al* ., 2005
Region III	Corh Harbour	Mussels (*Mytilus edulis*)	Trifluralin	<0,5 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	Dublin Bay	Mussels (*Mytilus edulis*)	Trifluralin	0.540819433	SEPA, 2007
Region III	River Boyne_Drogheda Port	Mussels (*Mytilus edulis*)	Trifluralin	<0,5 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Corrib_D/S Galway	Mussels (*Mytilus edulis*)	Trifluralin	<0,5 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Liffey_Eastlink Bridge	Mussels (*Mytilus edulis*)	Trifluralin	<0,5 µg x kg^{-1} d.w. (LOD)	SEPA, 2007

OSPAR Subregion	Area	Matrix	Substance / group	Concentration	Reference
Region III	River Shannon_Shannon Estuary	Mussels (*Mytilus edulis*)	Trifluralin	<0,5 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Suir_Bellview	Mussels (*Mytilus edulis*)	Trifluralin	<0,5 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Region III	River Suir_Waterford Estuary	Mussels (*Mytilus edulis*)	Trifluralin	<0,5 µg x kg^{-1} d.w. (LOD)	SEPA, 2007
Sediment					
Region II	Baltic Sea, Germany	Sediment	Trifluralin	0.001 - 0.018 µg x kg-1 d.w.	Oehme M., *et al* ., 2005
Region II	North Sea, Germany	Sediment	Trifluralin	0.003 - 0.21 µg x kg-1 d.w.	Oehme M., *et al* ., 2005
Region II	Sweden	Sediment (Sea)	Trifluralin	<0,0002 mg x kg^{-1} (LOD)	Cato & Kjellin, 2008.
Water					
Region II	Baltic Sea, Germany	Water	Trifluralin	0.006 - 0.46 ng x l^{-1}	Oehme M., *et al* ., 2005
Region II	North Sea, Germany	Water	Trifluralin	0.002/0.007 - 0.58 ng x l^{-1}	Oehme M., *et al* ., 2005
Region II	Baltic Sea, Germany	Water (surface 5m)	Trifluralin	7 - 46 pg x l^{-1}	Oehme M., *et al* ., 2005
Region II	North Sea	Water (surface 5m)	Trifluralin	11 - 26 pg x l^{-1}	Oehme M., *et al* ., 2005
Region II	North Sea, German Bight	Water (surface 5m)	Trifluralin	<10 - 110 pg x l^{-1}	Oehme M., *et al* ., 2005
Region II	Sweden	Surface water	Trifluralin	0.86 - 36 pg x l^{-1}	SEPA, 2007

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OSPAR Subregion	Area	Matrix	Substance / group	Concentration	Reference

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2,4,6 Tri-tert-butylphenol

OSPAR Region	Area	Matrix	Reference sites Concentration range (unit)	Contaminated sites Concentration range (unit)	Range of observed concentrations is of concern:	Reference
Region II	Western North Sea	Sediment		< 0.01 – 0.09 mg/kg dw	NO	Cefas, 2006
Region II	Western Sweden	Sediment	< 0.0001 mg/kg dw	< 0.0001 – 0.021 mg/kg dw	NO	SEPA, 2008
Region III	Irish Sea	Sediment		< 0.01 – 0.08 mg/kg dw	NO	Cefas, 2006

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Nonylphenols

OSPAR region	Area	Compound	Matrix	Reference sites Concentration range (unit)	Contaminated sites Concentration range (unit)	Range of observed concentrations is of concern:	Reference
Sediments							
Region I	Barents sea	Nonylphenol	Sediment (1-2 cm)	<DL		No*	SFT, 2008
Region I	Barents sea	Nonylphenol ethoxylates	Sediment	<DL-60 ng/g dw		No*	SFT, 2008
Region II	Kattegat, Skagerrak	4-n-nonylphenol	Sediment	<DL -0.0085 mg/g dw			Cato & Kjellin, 2008
Region II	Kattegat, Skagerrak	4-iso-nonylphenol	Sediment (1-2 cm)	<DL - 0.021 mg/g dw			Cato & Kjellin, 2008
Water							
Region II	Sweden coast and river estuaries	Nonylphenol	Filtrated surface water	0.15-0.7 µg/l			SEPA, 2007
Region II	Sweden coast and river estuaries	Nonylphenol	Unfiltrated surface water	0.01-1.1 µg/l			SEPA, 2007

No* - According to the author of the document

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Octylphenol

OSPAR Region	Area	Matrix	Reference sites Concentration range (unit)	Contaminated sites Concentration range (unit)	Range of observed concentrations is of concern:	Reference
Biota						
Region II	Denmark	Fish	< 0.0015 mg/kg dw		NO	Hansen *et al*., 2008
Region II	Denmark	Mussels	< 0.0015 mg/kg dw		NO	Hansen *et al*., 2008
Region III	Ireland	Mussels	ND		NO	McGovern, 2007
Sediments						
Region I	Barents Sea	Sediment	< 0.6 - < 2.1 µg/kg dw		NO	SFT, 2008
Region II	Baltic Sea	Sediment		< 3 – 81 µg/kg dw	?? (No standards in sediments)	Cato and Kjellin, 2008
Region II	UK estuaries	Sediment		< 0.01 – 0.53 mg/kg dw	NO	Cefas, 2006
Region III	Irish Sea	Sediment		< 0.01 – 0.17 mg/kg dw	NO	Cefas, 2006
Water						
Region II	Sweden	Water		< 0.02 to 0.2 µg/L *	YES (AA-EQS 0.1 µg/L)	SEPA, 2007
Region II	UK estuaries	Water		13 µg/L	YES (EQS MAC 2.5 µg/L)	Blackburn and Waldock, 1995
Region III	UK estuaries	Water	< 1 µg/L		NO	Blackburn and Waldock, 1995

* could not distinguish marine from freshwater samples

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Phthalates

(Units are as mg/kg dry weight. if data are followed by ±x, then average is reported, otherwise medians and range are indicated. The phthalates with results are di-(2-ethyl)hexyl phthalate (DEHP), di-isononylphthalate (DINP), di-isodecyl phthalate (DIDP) and di-(2-ethyl)hexyl adipate (DEHA).

OSPAR Region	**Area**	**Matrix**	**Reference sites Concentration range (pg/g TEQ)**	**Contaminated sites Concentration range (TEQ)**	**Range of observed concentrations is of concern:**	**Reference**
Biota						
Region I+II	Norwegian waters	Fish - Gardu morha liver	7.684 (0.276-55.7, n=10) µg/kg DEHP			SFT, 2007
Region I+II	Norwegian waters	*Mytilus edulis*	0.111 µg/kg ww (0.061-1.523, n=13) DEHP [outlier 16.9]			SFT, 2007
Region II	Swedish waters	Fish	<10-15 DEHP <50 DINP <50 DIDP <5-5 DEHA	<10-26 µg DEHP/kgW <50 µg DINP/kgW <50 µg DIDP/kgW	(n=12)	IVL, 2007
Region II	Swedish waters	*Mytilus edulis*	<0.5 – 0.81 mg/kg DINP <0.2 – 1.24 mg/kg DIDP			IVL, 2007
Region III	Ireland	Mussel	<500 µg/kg DW DEHP <2 µg/kg DW DBP. BBP. DINP (n=8)			McGovern, 2007
Sediments						
Region I	Barents Sea	Sediments	1.16-57.7 mg/kg DW DEHP		(n=11)	SFT, 2008
Region I	Barents Sea (harbours)	Sediments		0.07 to 0.3 .mg/kg DW	(n=11)	SFT, 2008

Region I+II	Norwegian waters	Sediments	0.156 mg/kg DW (0.074-0.353, n=22) DEHP			SFT, 2007
Region II	Baltic Sea	Sediments		1.7 mg/kg DW (0.5 – 2.8)		Cato & Kjellin, 2008
Region II	North Sea	Sediments	<0.1-0.51 mg/kg TS/ 4.9 – 17.8 mg/kg TOC (n=11)			Langenburg, 2005
Region II	North Sea	Sediments	0.12-0.83 mg/kg TS/ 2.7 – 11.3 mg/kg TOC (n=18)			Langenburg, 2005
Region II	Swedish waters	Sediments	<0.04 mg/kg DWDEHP <0.1 mg/kg DWDINP <0.1 mg/kg DWDIDP	0.2 mg/kg DW (0.082-2.8) DEHP 0.34 mg/kg DW (0.13-3.2) DINP		IVL, 2007
Region II	Swedish waters	Sediments	<0.1 – 0.25 DINP <0.025 -6.2 DINP <0.1 – 0.19 DIDP <0.015 -1.1 DIDP			IVL, 2007
Region II	Swedish waters	Sediments	0.13 mg/kg DW (0.01-1.1)			Cato & Kjellin, 2008

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Clotrimazole

OSPAR Region	Area	Matrix	Reference sites Concentration range (unit)	Contaminated sites Concentration range (unit)	Range of observed concentrations is of concern:	Reference
Region II	Lough 3	Water		22 (ng/l)		Thomas & Hilton, 2004
Region II	Tees 1	Water		<1 (ng/l)		Thomas & Hilton, 2004
Region II	Tees 2	Water		7.5 (ng/l)		Thomas & Hilton, 2004
Region II	Tees 3	Water		3.8 (ng/l)		Thomas & Hilton, 2004
Region II	Tees 4	Water		<1 (ng/l)		Thomas & Hilton, 2004
Region II	Tees 5	Water		7.2 (ng/l)		Thomas & Hilton, 2004
Region II	Thames 1	Water		<1 (ng/l)		Thomas & Hilton, 2004
Region II	Thames 2	Water		11 (ng/l)		Thomas & Hilton, 2004
Region II	Tyne 1	Water		14 (ng/l)		Thomas & Hilton, 2004
Region II	Tyne 2	Water		8.5 (ng/l)		Thomas & Hilton, 2004
Region II	Tyne 3	Water		18 (ng/l)		Thomas & Hilton, 2004
Region II	Tyne 4	Water		<1 (ng/l)		Thomas & Hilton, 2004
Region II	Tyne 5	Water		7.6 (ng/l)		Thomas & Hilton, 2004
Region II	Tyne 6	Water		6.8 (ng/l)		Thomas & Hilton, 2004
Region III	Mersey 1	Water	***< LOQ ?***	6.2 (ng/l)	***NO or YES ?***	Thomas & Hilton, 2004
Region III	Mersey 2	Water		<1 (ng/l)		Thomas & Hilton, 2004

Region III	Mersey 3	Water		<1 (ng/l)		Thomas & Hilton, 2004
Region III	Mersey 4	Water		<1 (ng/l)		Thomas & Hilton, 2004
Region III	Mersey 5	Water		<1 (ng/l)		Thomas & Hilton, 2004
Region III	Mersey 6	Water		<1 (ng/l)		Thomas & Hilton, 2004
Region III	Belfast 1	Water		19 (ng/l)		Thomas & Hilton, 2004
Region III	Lough 2	Water		20 (ng/l)		Thomas & Hilton, 2004

For clotrimazole compound, % recoveries (RSD) = 90 (20), and LOD (ng/l) = 1

OSPAR Region	Area	Matrix	Reference sites Concentration range (unit)	Contaminated sites Concentration range (unit)	Range of observed concentrations is of concern:	Reference
Region II	Site 1A ; Lemington Point, River Tyne	surface water		20 (ng/l)		Roberts and Thomas, 2005
Region II	Site 1B ; Lemington Point, River Tyne	surface water		27 (ng/l)		Roberts and Thomas, 2005
Region II	Site 1C ; Lemington Point, River Tyne	surface water		19 (ng/l)		Roberts and Thomas, 2005
Region II	Site 2A ; Derwenthaugh Marina, River Tyne	surface water		26 (ng/l)		Roberts and Thomas, 2005
Region II	Site 2B ; Derwenthaugh Marina, River Tyne	surface water		22 (ng/l)		Roberts and Thomas, 2005
Region II	Site 2C ; Derwenthaugh Marina, River Tyne	surface water		21 (ng/l)		Roberts and Thomas, 2005

Region II	Site 3A ; Elswick Riverside, River Tyne	surface water		23 (ng/l)		Roberts and Thomas, 2005
Region II	Site 3B ; Elswick Riverside, River Tyne	surface water		25 (ng/l)		Roberts and Thomas, 2005
Region II	Site 3C ; Elswick Riverside, River Tyne	surface water		34(ng/l)		Roberts and Thomas, 2005
Region II	Site 4A ; River Team Tributary, River Tyne	surface water		31 (ng/l)		Roberts and Thomas, 2005
Region II	Site 4B ; River Team Tributary, River Tyne	surface water		27 (ng/l)		Roberts and Thomas, 2005
Region II	Site 4C ; River Team Tributary, River Tyne	surface water		23 (ng/l)		Roberts and Thomas, 2005
Region II	Site 5A ; Mariners Wharf, River Tyne	surface water		6 (ng/l)		Roberts and Thomas, 2005
Region II	Site 5B ; Mariners Wharf, River Tyne	surface water		11 (ng/l)		Roberts and Thomas, 2005
Region II	Site 5C ; Mariners Wharf, River Tyne	surface water		10 (ng/l)		Roberts and Thomas, 2005
Region II	Site 6A ; Downstream WTW, River Tyne	surface water		18 (ng/l)		Roberts and Thomas, 2005
Region II	Site 6B ; Downstream WTW, River Tyne	surface water		17 (ng/l)		Roberts and Thomas, 2005
Region II	Site 6C ; Downstream WTW, River Tyne	surface water		17 (ng/l)		Roberts and Thomas, 2005
Region III	River Clyde, Scotland	surface water and effluent samples		3 and 54 ng/L		Peschka *et al* ., 2007

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Annex 3

Compilation of complementary case study material

This Annex compiles case study material prepared by experts from OSPAR countries who work within the OSPAR framework. The material expands the evidence base for some of the text box studies included in this report and in the Quality Status Report (QSR) 2010 summary report.

Lead in the Nervíon estuary

An integrated case study at catchment basis

Joana Larreta, Javier Franco and Victoriano Valencia

AZTI-Tecnalia

February 2009

1. Introduction

1.1 Lead

Lead and its compounds are some of the priority substances covered by the Directive 91/414/EEC and remain still present in all the Directives amending the WFD Directive 2000/60/EC.

Lead is an abundant, widespread, but not major element of the earth crust. This metal is an extremely reactive element, quickly removed from the water column via its association with particulates and a subsequent sedimentation. Lead is widely used in the human activities. In consequence, lead has been extracted from minerals, concentrated and re-distributed, under different chemical forms, in almost all environments and ecosystems, becoming a characteristic case of contamination (undesirable excess of concentration) and pollution (adverse effects and environmental concerns). It is classed as a 'scavenged element', with dissolved concentration profiles in the marine environment exhibiting a continuous decrease between the surface and the bottom. On the other hand, because of environmental and health problems, lead has been widely studied for years. So, the biogeochemistry of lead (natural and anthropogenic sources and pathways) is well known and it is one of the typical elements studied/measured in environmental monitoring programs in coastal and estuarine environments; it is also the case in the Nervión estuary (Borja *et al*., 2008a; Franco *et al.* 2008).

1.2 The Nervión estuary

The Nervión estuary is located in the Cantabrian Sea, in the Southeastern corner of the Bay of Biscay. It is located in the province of Bizkaia, in the Basque Country (N. Spain). The Nervión estuary and its surroundings is the most populated urban area in the north of Spain. The total population in the area is of one million inhabitants.

The Basque Country is a coastal mountainous region, dominated by rocky shores and estuaries. In general terms, all the estuaries of the Basque County due to the proximity of the Cantabrian mountain range to sea have a short length and high slope characteristics systems. Besides, the high rainfall (that presents an increasing gradient towards the east, with 2,500 mm per year in the easternmost area) and the high runoff coefficient make the hydrological systems classified as torrential systems (Lopez, 1986; García de Bikuña and Docampo, 1990). This pattern, in addition to tidal dynamics, determines the circulation and dynamics of the estuaries. Tidal amplitudes vary between around 1 m on neap tides and more than 4.5 m on spring tides; as such, they can be considered as generally mesotidal systems (Valencia *et al.*, 2004a).

The lithology of this region is characterised by materials ranging from the Palaeozoic to the quaternary, with and absence of Oligocene materials. The area is characterised by sedimentary rocks, with a higher proportion of sandstones and lutites in the eastern part of the region and more marls and limestones towards the west (Pascual *et al.*, 2004; Rodriguez *et al*, 2006). Taking into account the geochemical composition of the underlying geological strata of the region, with a blenda-galena-pyrite-calcopyrite paragenesis being dominant over the area, the sediments are naturally enriched in some elements, particularly Fe, Zn and Pb (Belzunce *et al*., 2004a, b).

The Nervion estuary is the largest estuarine system of the Basque Country. It is located in the western part of the Basque coast (Figure 1). It is the longest (22 km long from the outer limit, situated between Punta Lucero and Punta Galea, and the inner tidal limit, situated in the city of Bilbao), the most extensive (29.2 km^2) and the deepest (down to 30 m in the outermost area) of the estuarine systems of the Basque Coast (Valencia *et al*., 2004a).

Overall, the tributaries of this estuary drain a surface of around 1,800 km^2 and the river flow has a mean value of around 36 m^3 s^{-1} (Garcia de Bikuña and Docampo, 1990). This represents, in the context of the Basque Country, the 34% of the surface of the Atlantic river basins and the 24% or the river runoff across the estuaries to the Cantabrian Sea (Eraso *et al*., 2001; Valencia *et al*., 2004b; Borja *et al*., 2006).

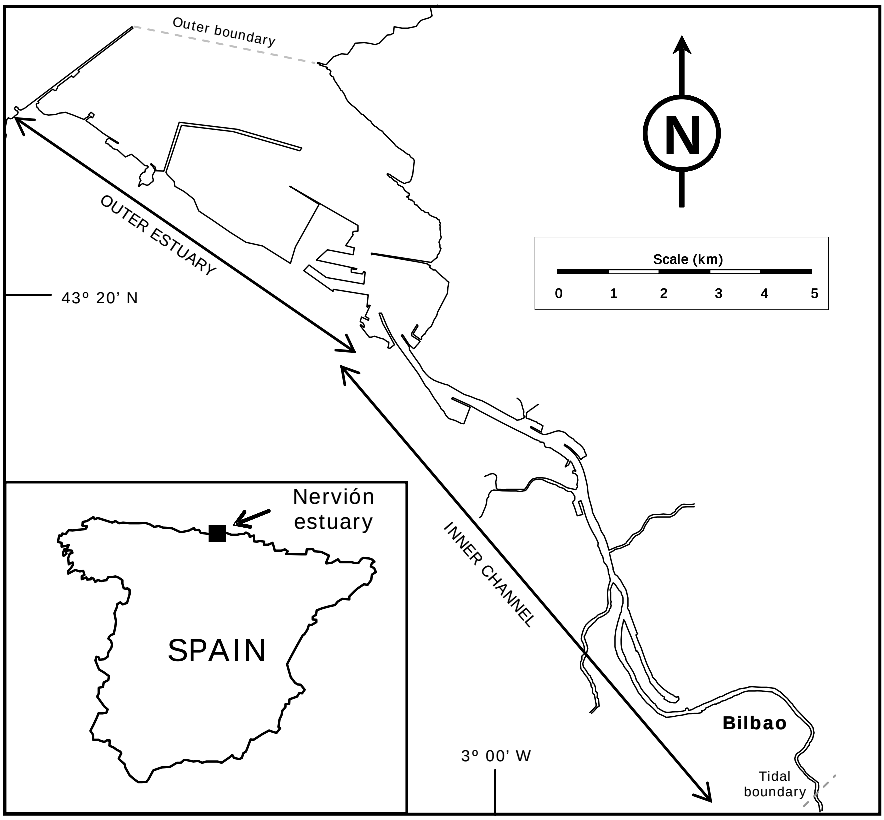

***Figure 1**. Map of the Nervión estuary. General location and main boundaries.*

From the morphological and hydrographical points of view, two main parts can be distinguished (Figure 1): an inner artificial channel, heavily stratified, with maximum depths of around 10 m and surface average salinities between 0 and 25 PSU, that was created for navigation purposes; and an outer area, slightly stratified, with depths ranging between 10 and 30 m and surface average salinities higher than 25 PSU, where most of the port facilities are located. Both areas but especially the inner one has been intensively dredged. A permanent salt wedge is found within the bottom layer, with salinities normally higher than 30 PSU. Salinity differences between the surface and bottom waters increase upstream. In this way, in the innermost reach of the Nervión estuary, oligohaline water is found usually at the surface, whilst polyhaline water is present normally at the bottom.

From the original estuary surface, it was calculated that more than 30% was lost (Rivas and Cendrero, 1992) mainly by anthropogenic causes, motivated for the need of areas for industrial development and housing. Most of the original estuarine habitats disappeared. The current estuary surface is mainly subtidal, and intertidal areas are scarce (Rivas and Cendrero, 1992; Valencia *et al*., 2004b).

The mean volume of the Nervion estuary is 400 10^6 m^3 (Valencia *et al*., 2004b), much higher than the rest of the estuaries of the Basque Country. Most of this (> 90 %) corresponds to the outer part. Taking into account the high volume, the mean river flow and the tidal influence, the water residence time was calculated to be in the order of several weeks.

1.3 The pollution history and the partial recovery story of the Nervión estuary: industrialization, urbanization and the sewerage scheme

As it has been abovementioned, the entire Basque region is naturally enriched in some elements, mainly iron. Since ancient times this was exploited in rural, hand-made small steel factories. During the second part of the XIX century the exploitation drastically changed, incorporating modern industrial processes and technologies. Bilbao became a very important site of iron production and this was the first driver for the great industrialization and transformation of the area in the 19th century. At first, most of the iron was exported to England for its processing, but afterwards steel factories were built in several locations of the Basque Country, some of them in the Nervión estuary margins. At the same time, and facilitated by the strategic geographical position of the area for the Atlantic maritime commerce, many different industries (mainly mining, steel factories, chemical factories and shipyards) were established in the surrounding areas and all this generated a great attractiveness for people; in this way, population rapidly increased. At the same time the Bilbao harbour experienced a large growth, becoming the most important commercial port of the Spanish Cantabrian Coast.

During many decades the estuary directly received, without any kind of treatment, domestic and industrial wastes from numerous and diverse sources. Some of the most contaminant industries were mining and steel factories (industrial wastes, mineral sluicing, mineral slags, *etc.*). In addition to the wastes directly discharged into the estuary, mineral slags and highly polluted dredged sediments were disposed in the adjacent coastal area. These inputs were discharged and accumulated in different compartments as air, water, sediments and biota.

All this produced a very strong deterioration of the estuary, with sharp oxygen depletion, very high concentration of contaminants in the water and the sediments, loss of animal life, bacteriological pollution, *etc.* (Saiz-Salinas and González-Oreja, 2000; Belzunce *et al*., 2004b). Due to the large loads of toxic pollutants such as trace metals, some sediment could be deemed as toxic for animal life, providing a potential source of diffuse pollution (González-Oreja and Saiz-Salinas, 2003).

In order to reverse the situation of poor environmental quality, in 1979 a sewerage scheme for the area was approved. The aim of this scheme was the overall recovery of the system. A water quality standard based on dissolved oxygen in the water was established. Water cleaning started in 1990 with a physico-chemical primary treatment and, in 2001 a biological treatment came into operation. To survey in a comprehensive way the estuarine quality over time, a monitoring programme (including the biotic and the abiotic component) has been carried out since 1989. The results from this monitoring programme show a clear improvement regarding both, the abiotic and biotic components (García-Barcina *et al*., 2006; Borja *et al*., 2006; Borja *et al*., 2008b; Uriarte and Borja, in press). In addition to the progressive implementation of the sewerage scheme, some of this improvement should be attributed to the transformation of the surrounding areas of the estuary and the whole river basin and, especially, to the decline/transformation of some of the most pollutant industries, especially mining, steel factories and shipyards.

2. Main lead sources into the Nervión estuary

Overall, historically the main sources of lead to the Nervión estuary system were the big steel companies and mining activities. Although no quantitative information regarding these inputs are available, large amount of lead were directly discharged into the estuary.

Regarding lead inputs to the atmosphere, for many years the main source has been, by far, the emissions from vehicles using leaded gasoline (Bryan, 1985). These mean a great deposition of atmospheric particles by rain and direct discharges into the river. Although the data on lead in the atmosphere in the study area is scarce and it is not measured in routine air quality monitoring, the existing information indicates a clear reduction of lead concentrations during the last decade, after leaded gasoline went out of use in the late 20th century and many industries associated to lead emissions closed, were restructured or improved waste management processes, reducing lead emissions to the atmosphere.

The main sources of lead to the water are point sources to the estuary (sewage and industrial discharges), diffuse sources entering the estuary via the main tributaries and diffuse inputs by dry and wet fallout. Estimations of the total dissolved Pb annual loads to the Nervión estuary in the years 2001 to 2006 show a large inter-annual variability, with maximum estimations ranging from 3100 kg in 2001 to 27 589 kg in 2004. Although there is no a direct relationship between annual loads and annual river flow, the maximum load coincided with the highest annual river flow (Data Reports on the Comprehensive Study of Riverine Inputs and Direct Discharges (RID) from Spain, years 2001 to 2006).

Because of its extreme reactivity, lead is quickly removed from the water column via its association with particulates and subsequent sedimentation. This high reactivity can explain the lack of conservative behaviour of dissolved lead in the estuarine water column, favoured by the high water residence time in this system (Tueros *et al*., 2008).

3. Lead concentrations in the different compartments of the Nervión estuary

The metal behaviour in transitional estuarine waters is very complex and related to factors that affect biogeochemistry processes, and those factors present a high variability throughout the mixing estuarine processes (Michel *et al*., 2000). For some of the metals and for specific estuaries or costal river plumes, the distribution of trace metals is related to salinity (Elbaz-Poulichet *et al*., 1996; Owens and Balls, 1997; Nolting *et al*. 1999), reflecting the importance of mixing processes. However, in the Nervion estuarine water, as it has been observed in other estuarine systems, dissolved Pb concentrations appear to be regulated more by river flow and river inputs than by water masses distribution within the estuary, as reflected in salinity (Monbet, 2006; Tueros *et al*., 2008). In this way, no conservative behaviour of dissolved Pb is normally observed within the estuary (Borja *et al*., 2008a). Total metal concentrations in water can be affected by estuarine sedimentation, then eventual re-suspension, changing the metal concentrations related to suspended particulate matter (SPM). For the dissolved phase, precipitation and co-precipitation decrease the metal concentration (Morris, 1986). Conversely, desorption from SPM, formation and stabilization of complexes with organic or inorganic ligands, re-dissolution from sediments and diffusion from pre water, can increase the dissolved metal content within the water column. These processes vary also along the estuarine mixing and might change the metal balance between the dissolved and particulate phases for different salinity intervals (Owens *et al*., 1997; Gerringa *et al.*, 2001; Monbent, 2006; Audry *et al.*, 2007).

In the study area the main source of data on dissolved Pb comes from the Littoral Water Quality Monitoring and Control Network (hereafter LWQM), in operation since 1994 by the Department of

Environment and Land Action of the Basque Government. Five sampling stations are located in the Nervión estuary and two additional stations in the adjacent coastal area (Figure 2). Surveys are performed two times during the year and samples are taken at surface waters. No clear temporal trends were detected (Figure 3). A very high variability is observed. Nevertheless, as shown in Table 1, except in five cases, the concentrations of Pb in water did not exceed neither the quality objective established by the Directive 2000/60/EC (7.2 microg/l) nor the maximum threshold of the ecotoxicological assessment criteria established by OSPAR in 1997 (5 microg/l). Most of the concentrations are between the quality objective and the detection limit (Borja *et al.*, 2008b).

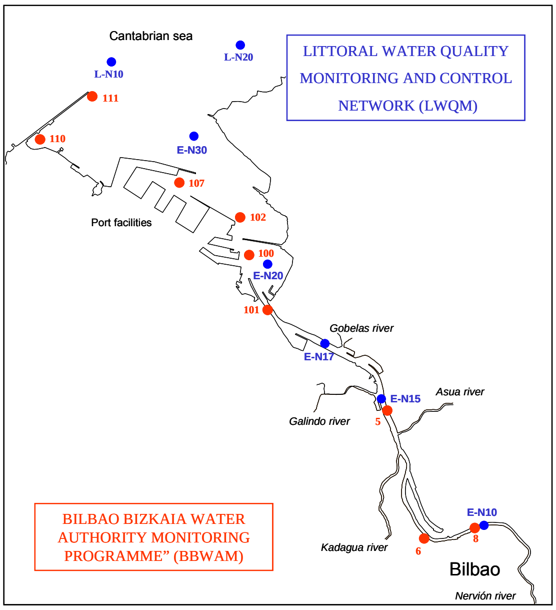

***Figure 2**. Sampling stations corresponding to the Littoral Water Quality Monitoring and Control Network (LWQM) in the Nervión estuary and the adjacent coastal area, and to the Bilbao Bizkaia Water Authority Monitoring Programme (BBWAM) in the estuary.*

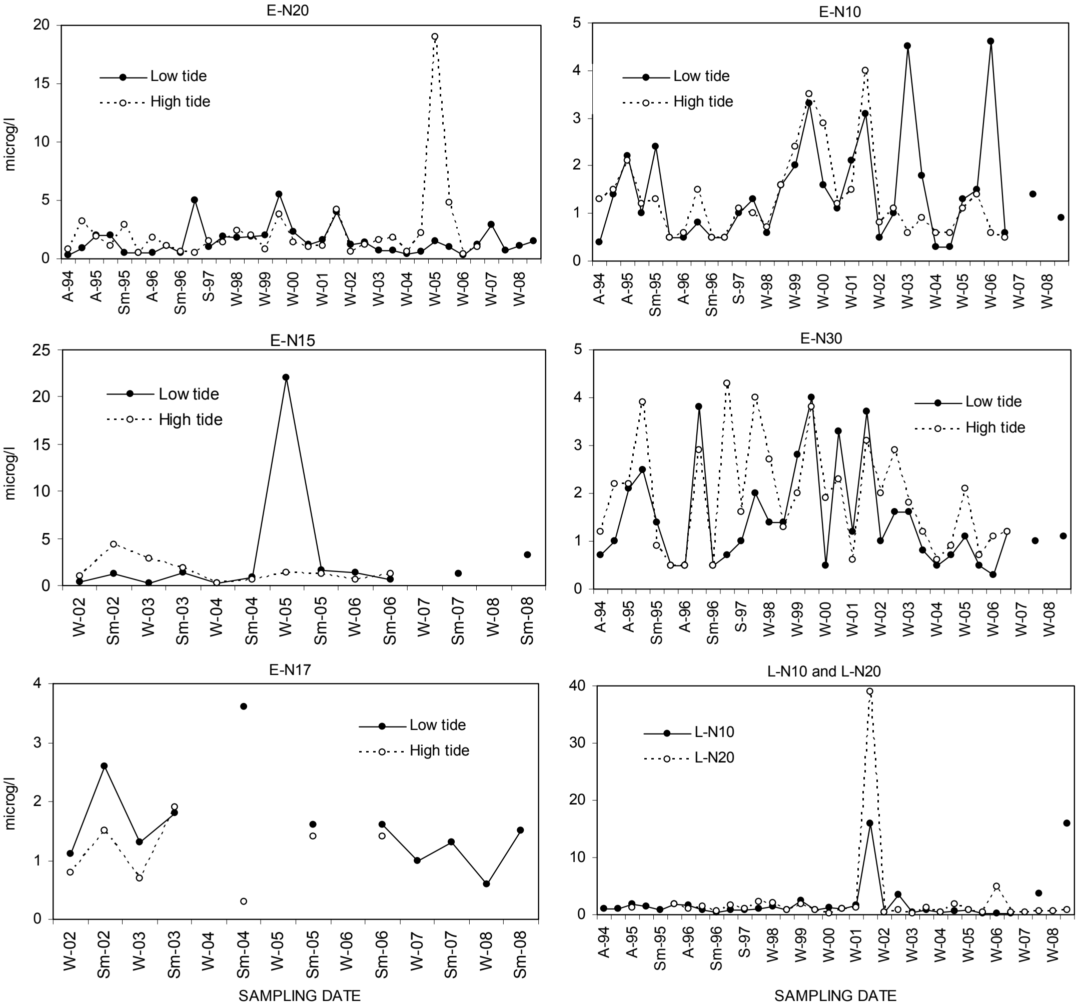

Figure 3*. Temporal series of concentrations of Pb (microg/l) in different sampling stations within the Nervión estuary at low and high tide and in the adjacent coastal area. Data from LWQM. A. Autumn; W: Winter; S: Spring; Sm: summer.*

Table 1*. Percentage (%) of samples with dissolved Pb concentration in surface water above the quality objective established by the Directive 2000/60/EC (7.2 microg/l), between this value and the detection limit (0.3 microg/l) and below the detection limit, in the sampling stations of the LWQM within the estuary and in the adjacent coastal area (see Figure 2 for location of sampling stations). Percentages calculated from all the campaigns at each sampling station. L. low tide; H: high tide.*

	E-N10		E-N15		E-N17		E-N20		E-N30		L-N10	L-N20
	L	H	L	H	L	H	L	H	L	H		
>7.2	0	0	8	0	0	0	0	3	0	0	6	3
0.3-7.2	94	100	75	90	100	86	94	97	97	100	84	90
<0.3	6	0	17	10	0	14	6	0	3	0	9	7

In order to assess the possible relationship between Pb concentrations in the estuarine water and in the main tributaries, Pb concentrations along time have been plotted for the main tributaries and the nearest estuarine sampling stations (Figure 4). No temporal trends are observed in the main tributaries; a common feature is the low concentration in all the tributaries in 2000 and 2001. Except in very few cases, Pb concentrations in the tributaries are significantly higher than in the estuary.

Sediment is an essential, integral and dynamic part of the water cycle. This is especially true in estuaries, where physico-chemical as well as biogeochemical processes cause complex interactions between sediments and the water column. In the Nervión estuary sediments were rapidly degraded from the industrialisation period; the quality of the sediments was drastically reduced (Cearreta *et al*., 2002; Belzunce *et al*. 2004a) and sediments became an important reservoir of lead in the study area.

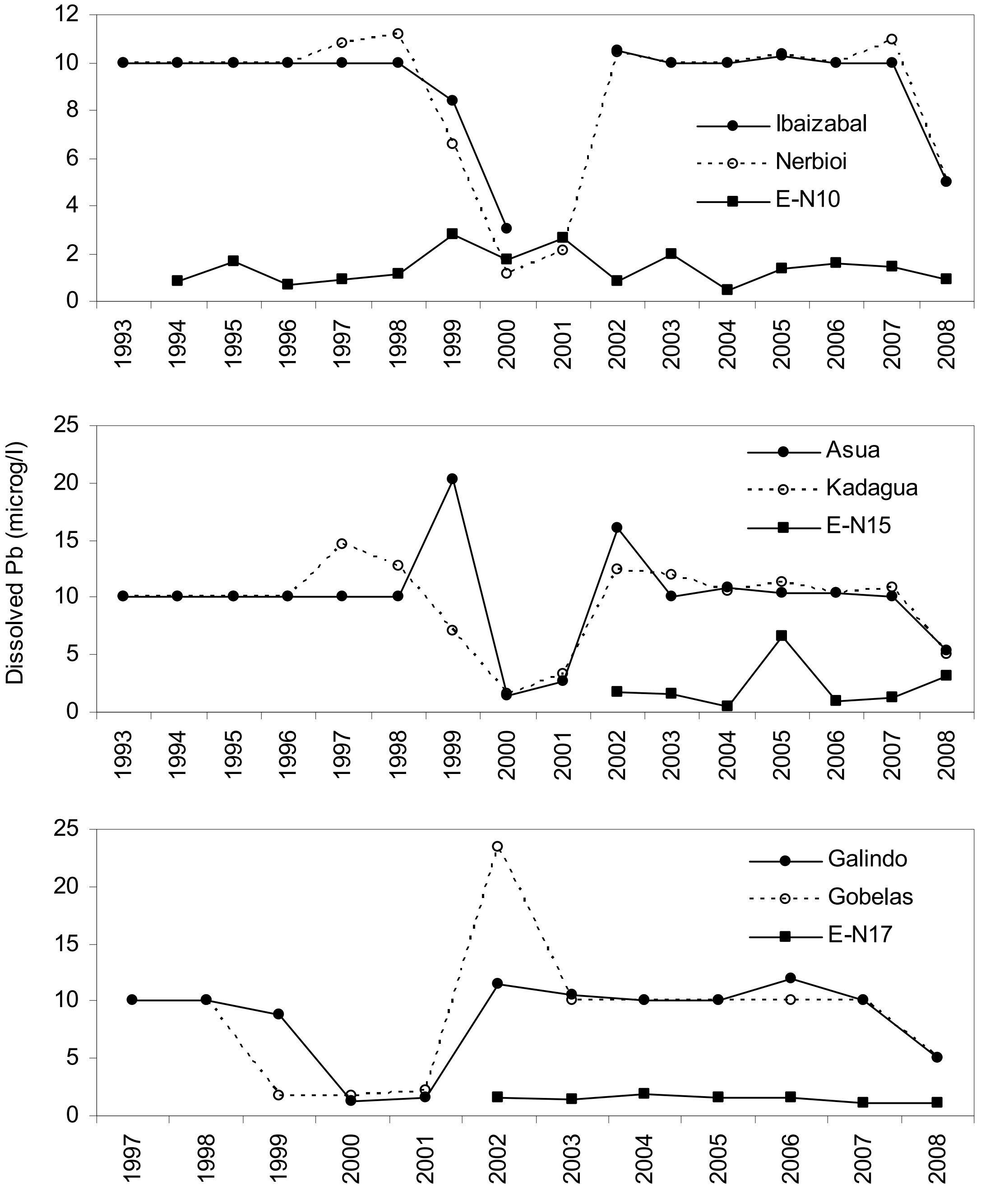

Figure 4. *Temporal series of dissolved Pb concentrations in the main tributaries (Asua, Kadagua, Ibaizabal, Nerbioi, Galindo and Gobelas) and in the nearest estuarine sampling stations (see Figure 2 for location of sampling stations). Data correspond to mean annual values. Data from the tributaries provided by the Basque Water Agency.*

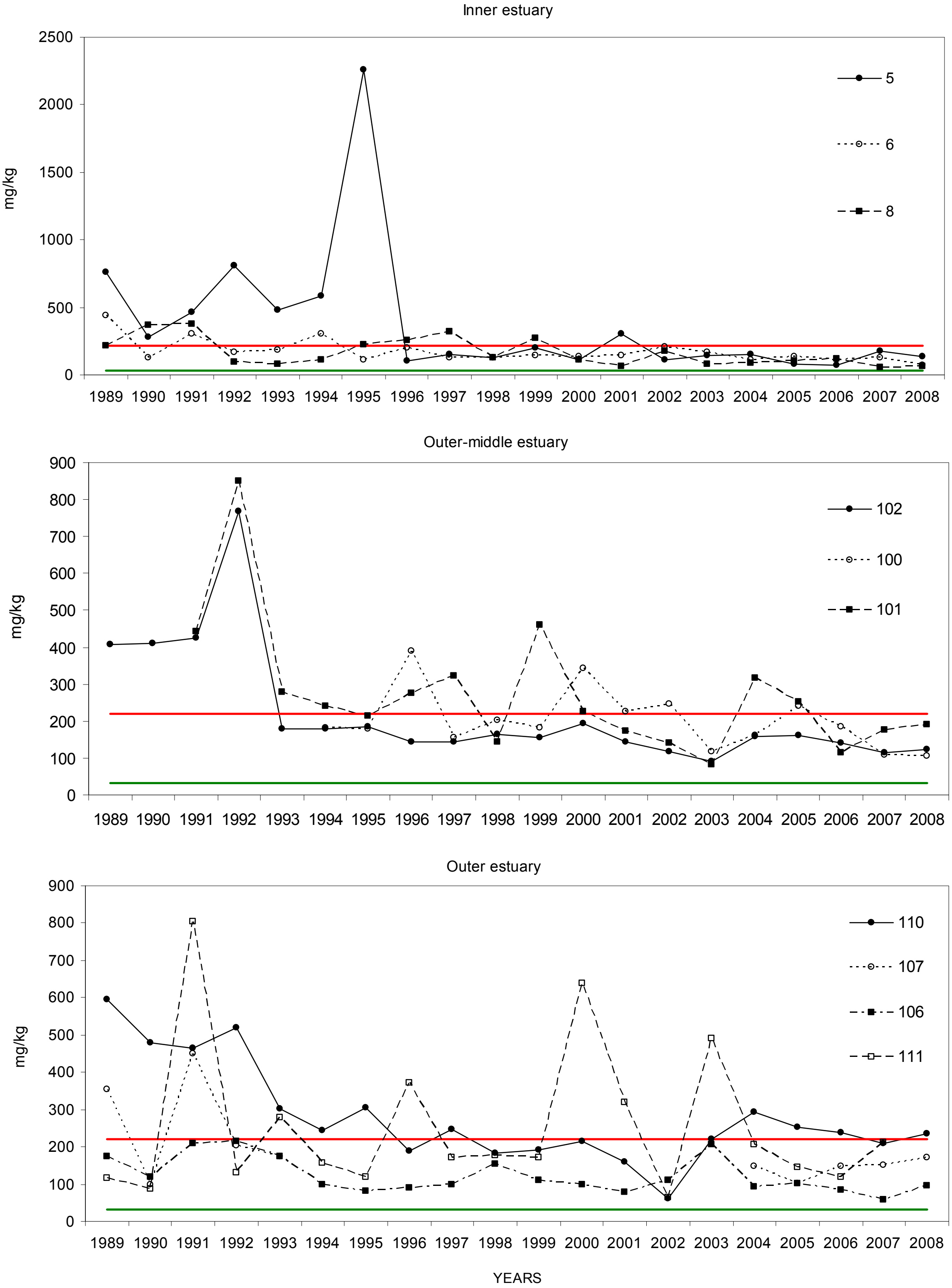

***Figure 5**. Temporal series of Pb concentration (mg/kg) in the sediments (< 63 microns fraction) of the Nervión estuary. See Figure 2 for location of sampling stations. The red line corresponds to the Effects Range Low (218 mg/kg; Long et al., 1995) and the red one to the background value (31 mg/kg; Rodríguez et al., 2006). Data from BBWAM.*

Different studies based on sequential extraction of metals in the sediments have shown that a high proportion of Pb was associated with the three most mobile forms, which can be easily transformed liberating cations into the water column. However, the residual phase is present in significant proportions and dominant in some stations, which demonstrates its origin associated with iron and steel making and the mineralogy of the basins (Figure 6) (Belzunce *et al.*, 2004b; Borja *et al.*, 2008b).

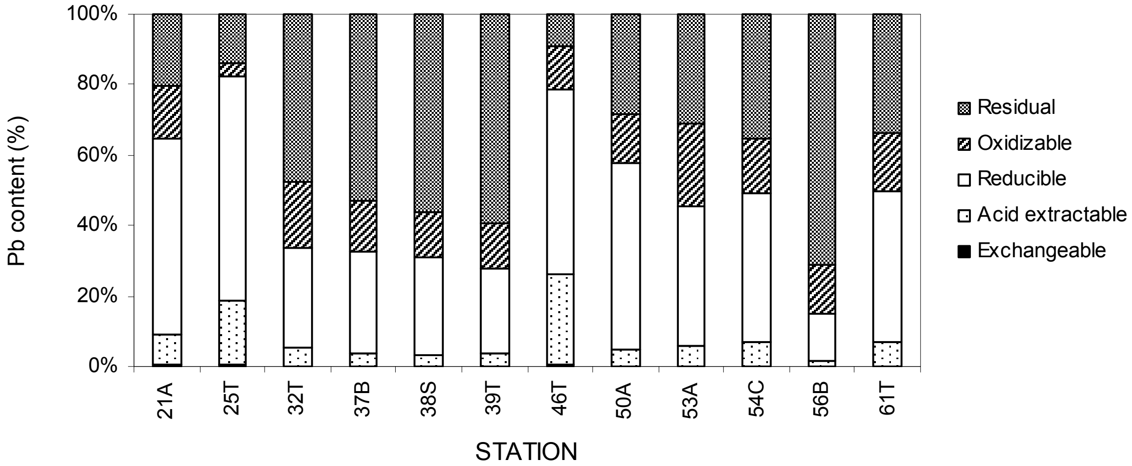

***Figure 6**. Fractions of Pb concentrations (%) in different stations of the Nervión estuary (all the stations located in the inner estuary) (Unpublished report for the Bilbao Port Authority).*

Regarding potential adverse effects on biota, all the measured Pb concentrations in the surficial sediments along the monitoring programme (BBWAM) have been above the Effects Range Low (ERL, 47 mg/kg) and around one third of them above the Effects Range Median (ERM, 218 mg/kg) (Long *et al.*, 1995). This suggests that lead could have been adversely affecting benthic organisms. However, it must be taken into account that ERL and ERM values refer to concentrations in the whole sediment, whereas Pb concentrations in the Nervión estuary are measured in the fine fraction; this implies an overestimation of potential adverse effects when using ERL and ERM references. Table 2 presents, for the entire sampling period and at each sampling station, the percentage of Pb concentrations exceeding the ERM, between ERL and ERM and below ERL. Stations 110 and 101 present the highest proportions of Pb values above ERM. Most of the ERM exceedences corresponded to the first years of the sampling period and in the recent years very few values above ERM have been measured (Figure 5). This indicates a reduction of the Pb contamination of the surficial sediments and a consequent improvement of the estuarine bottom for benthic recovery, as has been observed in several studies (*e.g.* Borja *et al*., 2006).

***Table 2**. Percentage of samples with Pb concentration in surficial sediments exceeding the ERM, between ERL and ERM and below ERL (Long et al., 1995), at each sampling stations of the BBWAM (see Figure 2 for location of sampling stations).*

	STATIONS									
	111	110	107	106	102	100	101	5	6	8
>ERM	30	65	20	0	20	33	56	40	15	30
ERL-ERM	70	35	80	100	80	67	44	60	85	70
<ERL	0	0	0	0	0	0	0	0	0	0

Lead concentrations in biomonitors (mussels) sampled twice a year since 1994 in the LWQM did not show any statistically significant temporal trend (Figure 7). The quality objective proposed for this region (1.5 mg/kg FW; Borja *et al.*, 1996) by the commission regulation CE/1881/2006 was fulfilled in all the campaigns except in 1995 at both sampling sites (I-N10 and I-N20), in 1996 (at I-N20) and in the last 2 years of study (2007 and 2008) at I-N10.Most of the values are between the proposed upper background value by OSPAR and the quality objective value.

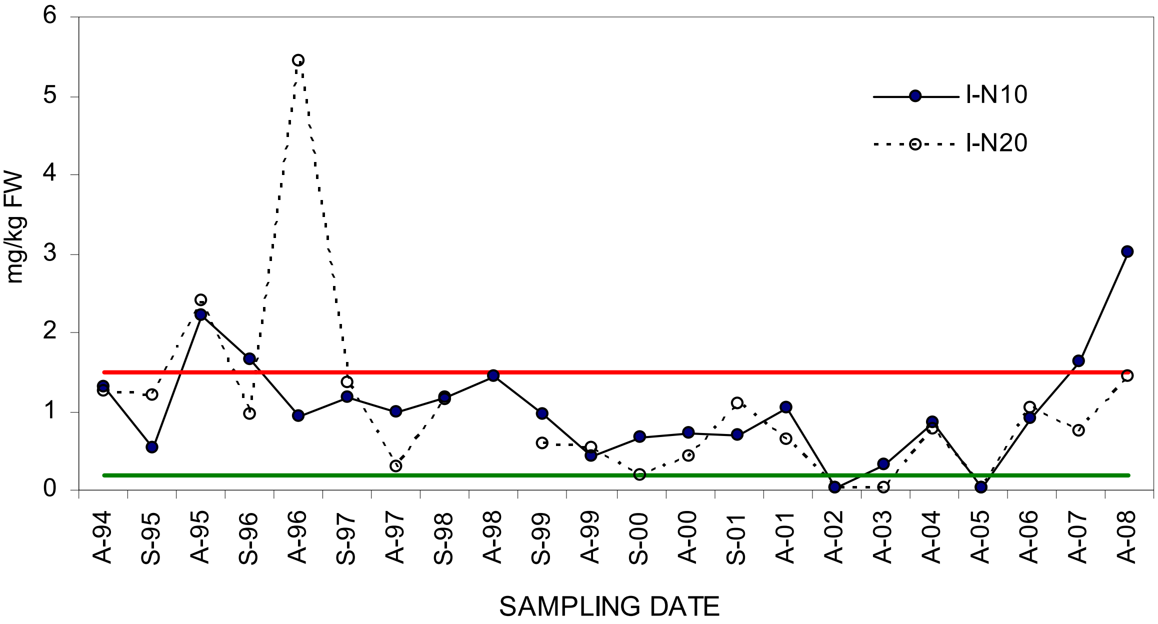

Figure 7. *Lead concentrations in mussels in two sampling stations located in the outer part of the Nervion estuary. The red line indicates de quality objective value (1.5 mg/kg) and the green one the upper background value (0.19 mg/kg) proposed by OSPAR 2000. Data from LWQM.*

4. Other indicators of ecosystem health

Sediment toxicity tests performed in the last for years with marine invertebrates indicate low toxicity of sediments from the Nervión estuary (Franco *et al.*, 2005, 2006, 2007 and 2008), with very few cases of significant differences with respect to control stations. This indicates that, in spite of a significant contamination (defined as concentrations above natural values caused by human activities) and risk of potential adverse effects, toxicity is probably limited by low availability of contaminants; in this regard, a significant portion of metal content in the sediments correspond to residual, low reactive fractions, associated with iron and steel making and the mineralogy of the basin.

All this is in accordance with the results from the monitoring of biological communities, especially benthic invertebrates, which reflect the overall improvement of the environmental quality of the system since the beginning of the monitoring programme (Borja *et al*., 2006; Borja *et al*., 2008a).

In the following years additional management actions could be implemented in order to a further improvement of the environmental quality of the system: new sewerage actions in the estuary, completion of sewerage schemes in the river basins, sediment remediation and environmental dredging.

5. Summary and conclusions

The Nervión estuary received for many years an intense input of lead from various sources in relation to different human activities (mining, steel industries, atmospheric emissions from vehicles, *etc.*). This produced lead accumulation in some compartments of the estuarine system, as it is mainly reflected in the sediments. In the last years, the closure and/or transformation of some contaminant industries, in addition to the implementation of the sewerage scheme, have considerably reduced the lead inputs to the system. The concentration of lead in this compartment presents a general decreasing trend from 1995. Although this trend is neither progressive nor statistically significant in all the studied stations, Pb concentrations in surficial sediment are much lower in the recent years than at the beginning of the studied period (around 20 years ago). Regarding potential adverse effects on biota, although one third of the measured values along the studied period are above concentrations associated to toxicity, in the recent years very few values exceed those references. Temporal series of lead concentrations in biomonitors (mussels) do not present statistically significant temporal trends; most of the values fulfil the quality objective proposed for this region. Sediment toxicity tests performed in the last years with marine invertebrates indicate low toxicity of sediments from the Nervión estuary, with very few cases of significant differences with respect to control stations. All this is in accordance with the results from the monitoring of biological communities, especially benthic invertebrates that reflect the overall improvement of the environmental quality of the system.

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Long term trends in Mercury, Cadmium and Lead in the Forth

Anonymous for the United Kingdom

December 2008

Driving Force

The Forth estuary and its catchment, located on the east coast of Scotland, has been a focus for industrial and commercial activity for many decades. The estuary receives discharges from the manufacture of yeast, paper, chemical and petrochemical industries plus waste water from approximately one quarter of the Scottish population (Figure1). Many of the discharges remained untreated until environmental legislation was introduced in the mid 1980’s. At the second Intergovernmental Conference in 1987 the UK Government agreed to reduce inputs of certain substances, including cadmium, mercury and lead, to the North Sea by 50% between 1985 and 1995. This led to the reduction and minimisation of point source discharges of these substances.

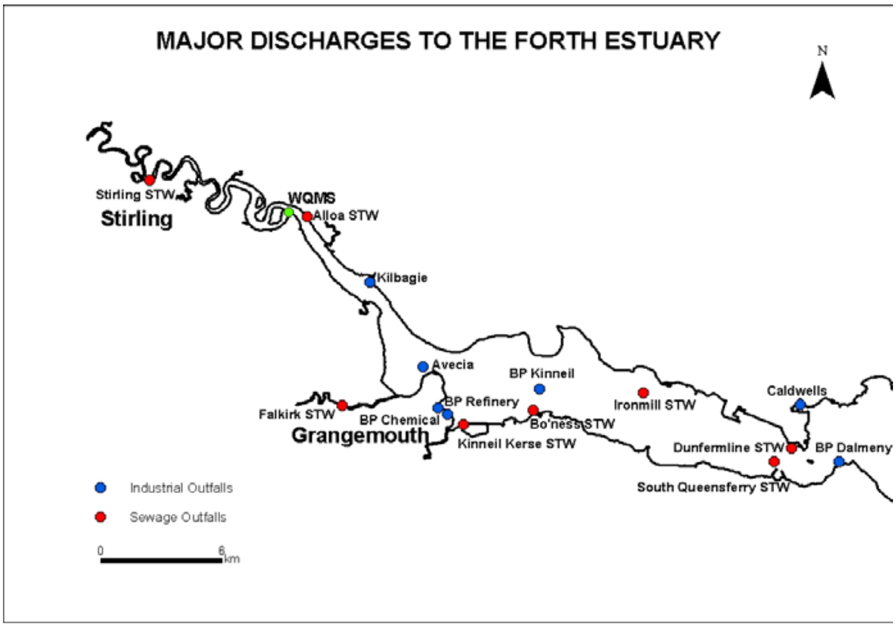

***Figure 1**. Location of point source discharges to the Forth estuary*

Pressure on the Environment

Assessment of annual inputs of cadmium, mercury and lead to tidal waters from riverine, sewage and industrial discharges commenced in 1990 (Figures 2a, 2b and 2c).[3]

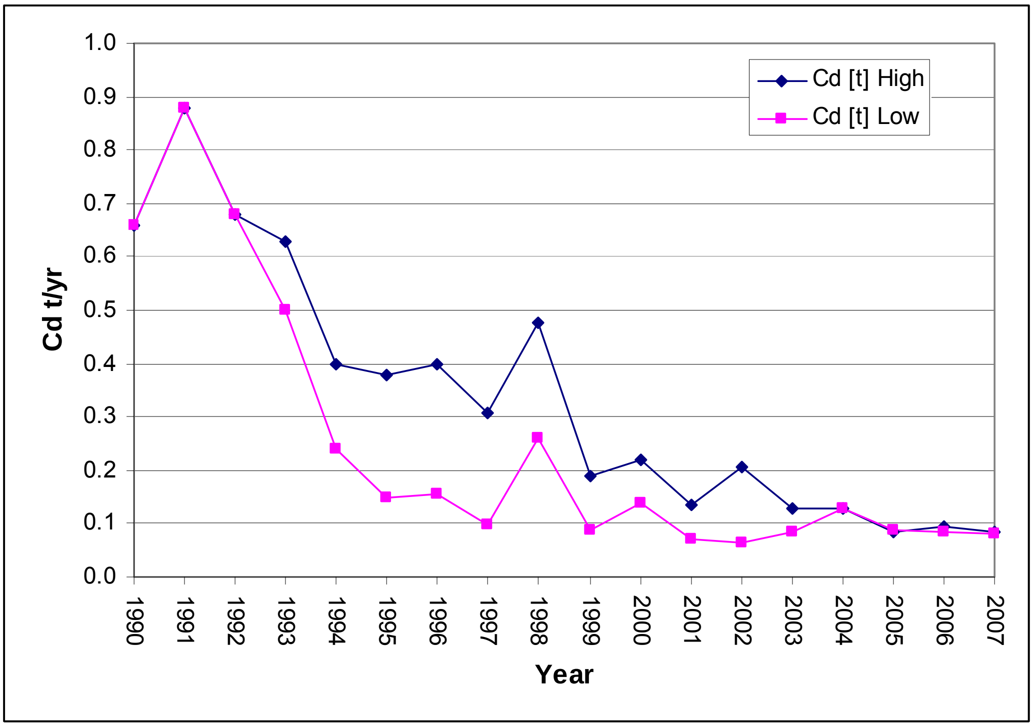

***Figure 2a**. Annual loads of cadmium* [3]

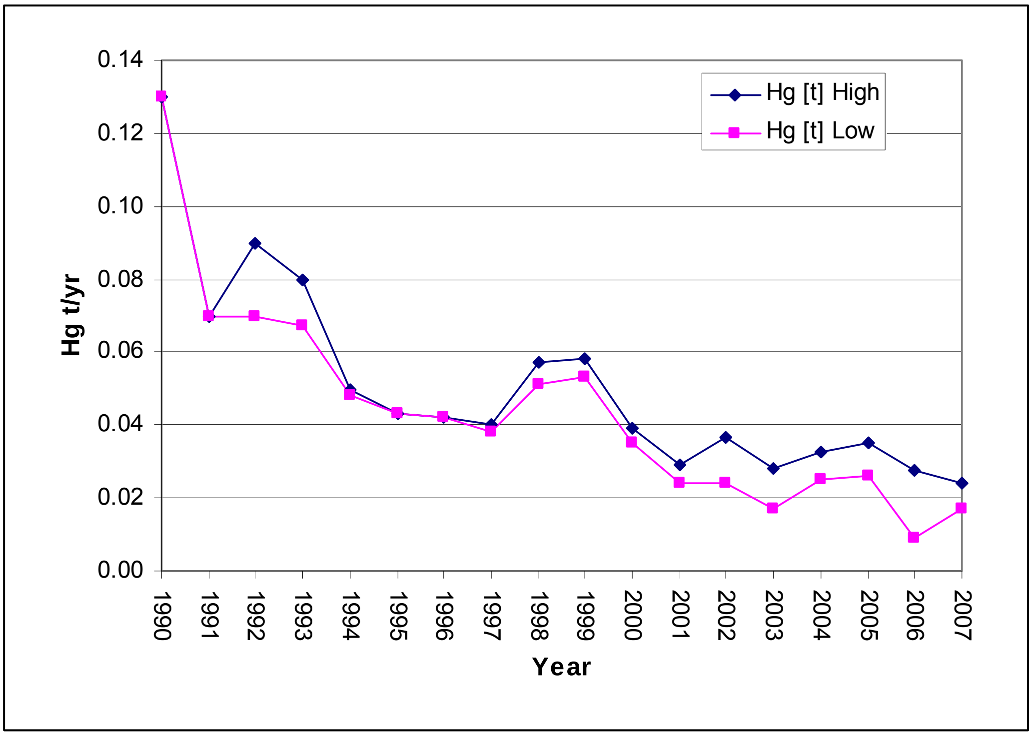

***Figure 2b**. Annual loads of mercury* [3]

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[3] The 'high' estimate is based on flow x the concentration at the limit of diction, the low estimate assumes that values less than the limit of detection of the analysis are 0.

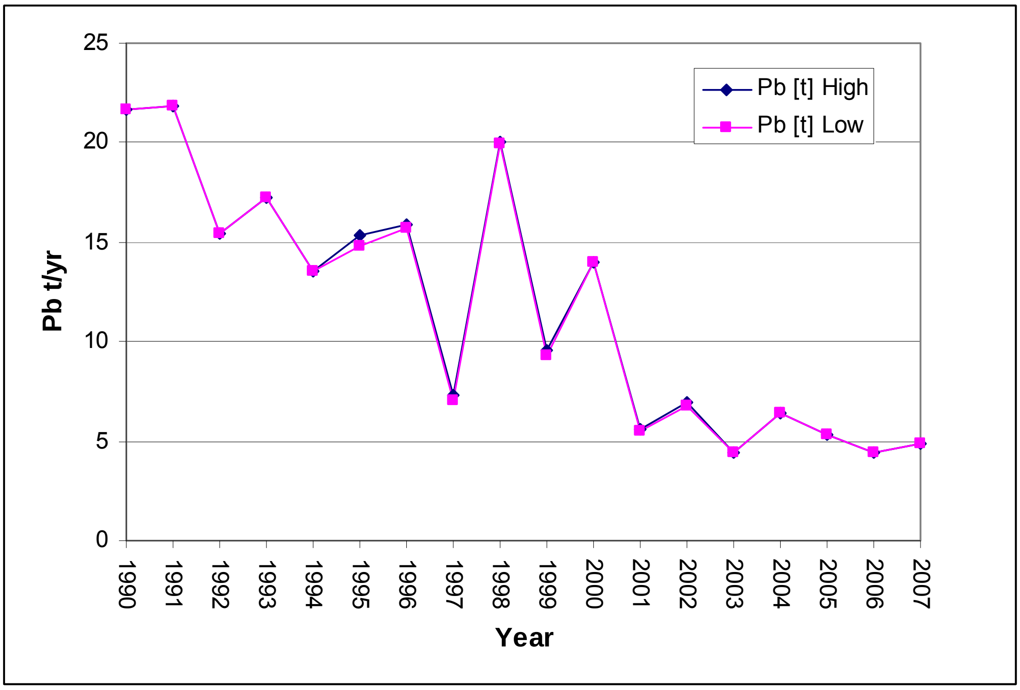

***Figure 2c**. Annual loads of lead to the Forth.*[3]

The discharge of all metals has reduced as a result of effluent treatment and minimisation of point source discharges (Table 1). Water companies are actively trying to reduce the discharge of mercury to sewer from dentistry to further reduce the input.

***Table 1**. Trends in sources of trace metals*

	Rivers		Sewage		Industry	
Year	**1990**	**2007**	**1990**	**2007**	**1990**	**2007**
Cadmium (kg/yr)	400	69	125	6	55	9
Mercury (kg/yr)	26	18	19	3	73	3
Lead (t/yr)	11	3.6	7	1.2	0.7	0.1

State of the Environment

Trace metals interact with particulate matter in the environment and may be adsorbed onto it. The Forth is a turbid estuary (Webb and Metcalfe 1987) and discharged particle-reactive metals are adsorbed onto its particulate matter (Balls *et al.* 1997). Mercury and lead are particle-reactive and are retained on the sediments whereas cadmium is more likely to remain in solution.

Contaminants in Sediments

It has been estimated that over 90% of the discharged mercury has been retained on the sediments of the estuary (Elliott and Griffiths 1986). Routine monitoring of the mercury and lead content of the sublittoral sediments has not shown any reduction consistent with the reduction in the discharge. Cadmium is less particle reactive and stays in solution. The cadmium content of the sediments is relatively low and there are no trends in the data (Figure 8.2.1). Mercury concentrations are above the upper EAC (0.5 mg/kg), lead is around the upper EAC (50 mg/kg) and cadmium is below the upper EAC (1 mg/kg).

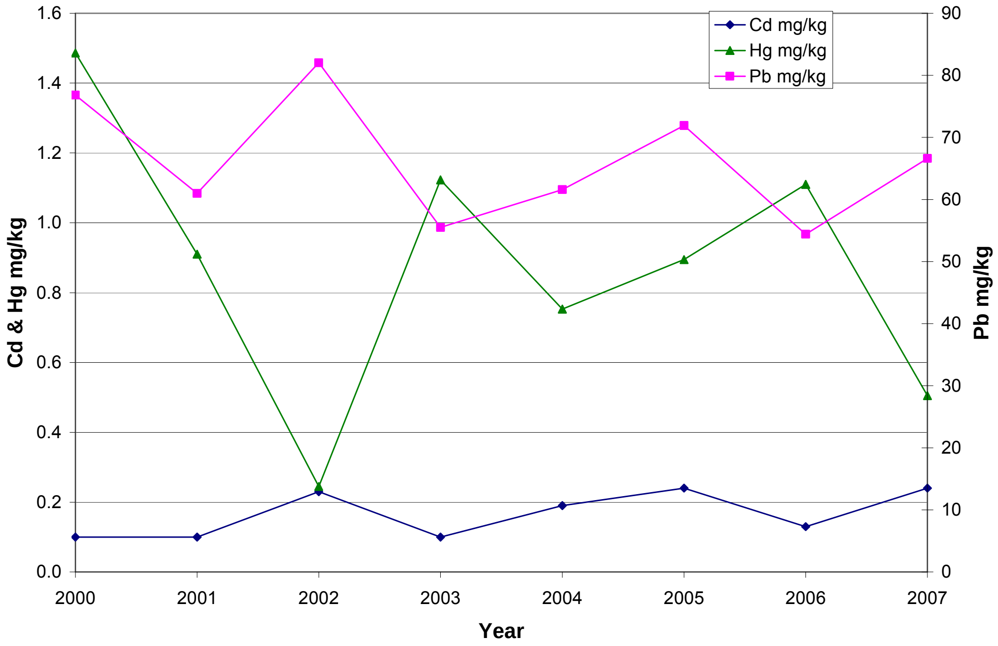

***Figure 3**. Mercury, cadmium and lead (mg/kg) at site KC in the Forth estuary.*

Contaminants in biota

Long-term data are available for mercury in fish muscle and mussels from the Forth estuary (Figure 4). The data show a decrease in mercury content over the years, consistent with the reduction in the industrial discharge.

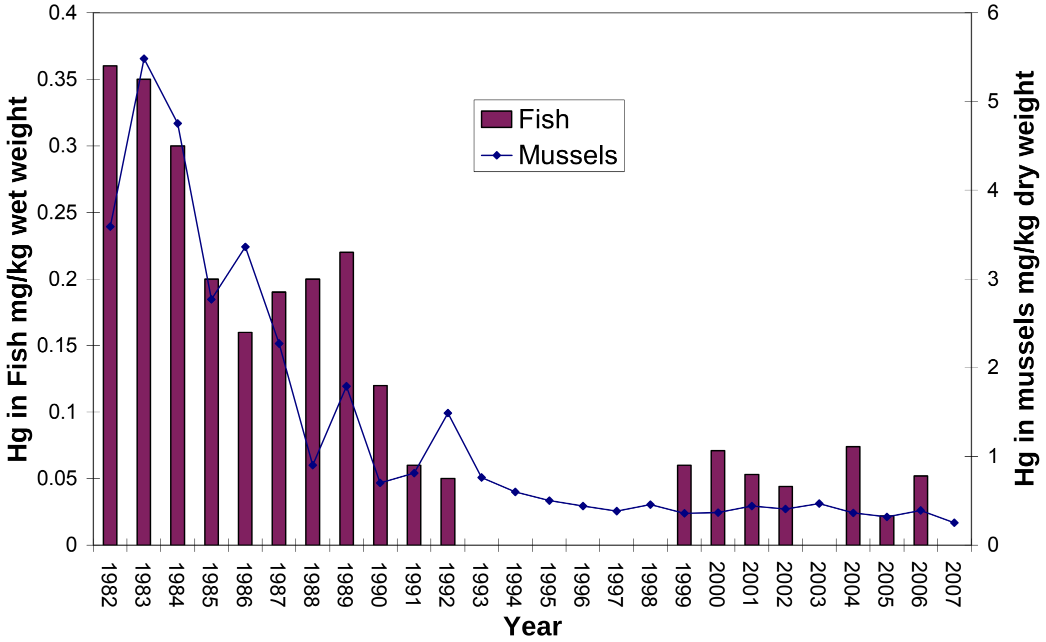

***Figure 4**. Mercury in fish and mussels in the Forth estuary.*

The concentration of mercury was above the EAC (1 mg/kg dw) in mussels until the 1990's whereas the concentration in fish fell below the EAC (0.3 mg/kg ww) in the early 1980's.

The cadmium content of mussels in the Forth estuary is below the EAC (5 mg/kg dw) and appears to be declining. (Figure 5). In recent years it has been close to the B/RC (1.4 mg/kg dw). The lead content of the mussels is substantially above the upper EAC (5 mg/kg dw) and recent results indicate less variability in the data.

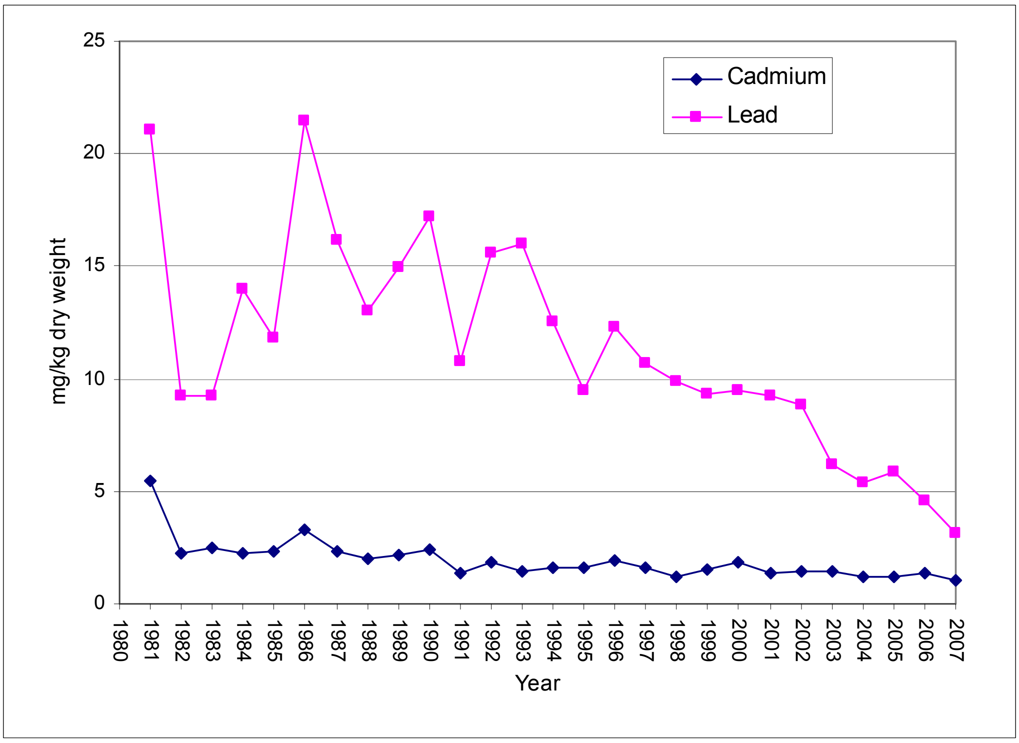

***Figure 5**. Lead and cadmium (mg/kg dry weight) in mussels in the Forth estuary*

Contaminants in Water

Concentrations of dissolved mercury, cadmium and lead in the water column were always substantially below Environmental Quality Standards and close to the limit of detection of the analysis. There are no trends in the data (Figure 6)

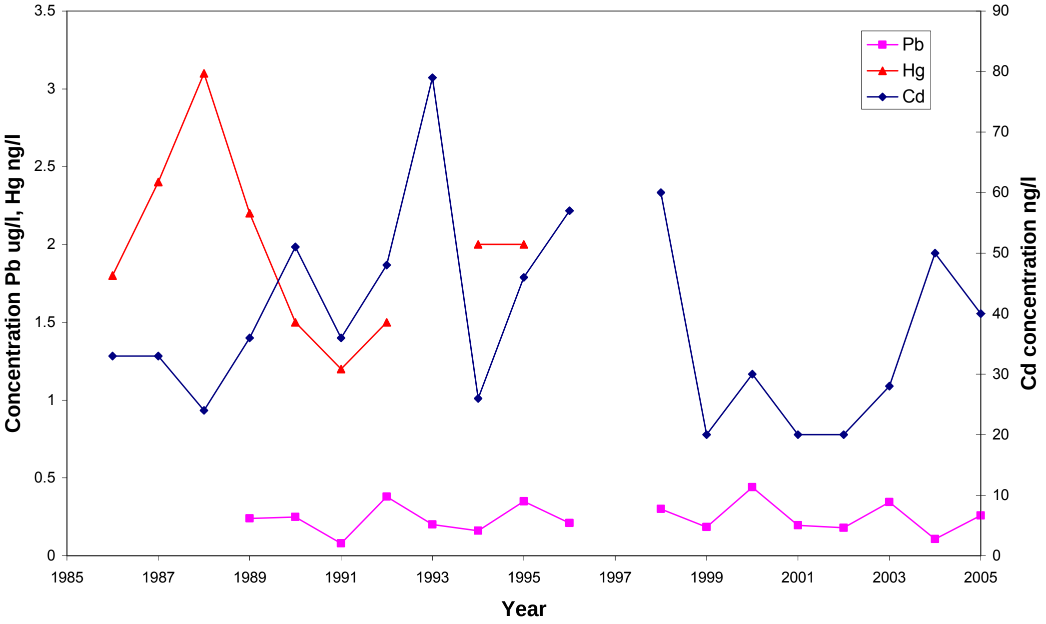

***Figure 6**. Dissolved trace metals in the Forth estuary.*

Impact on the biota

Surveys of the main channel of the estuary at Grangemouth have shown an increase in the total number of taxa found since 1975 (Figure 7). The samples are collected in the vicinity of an industrial discharge, which was the major point source of mercury.

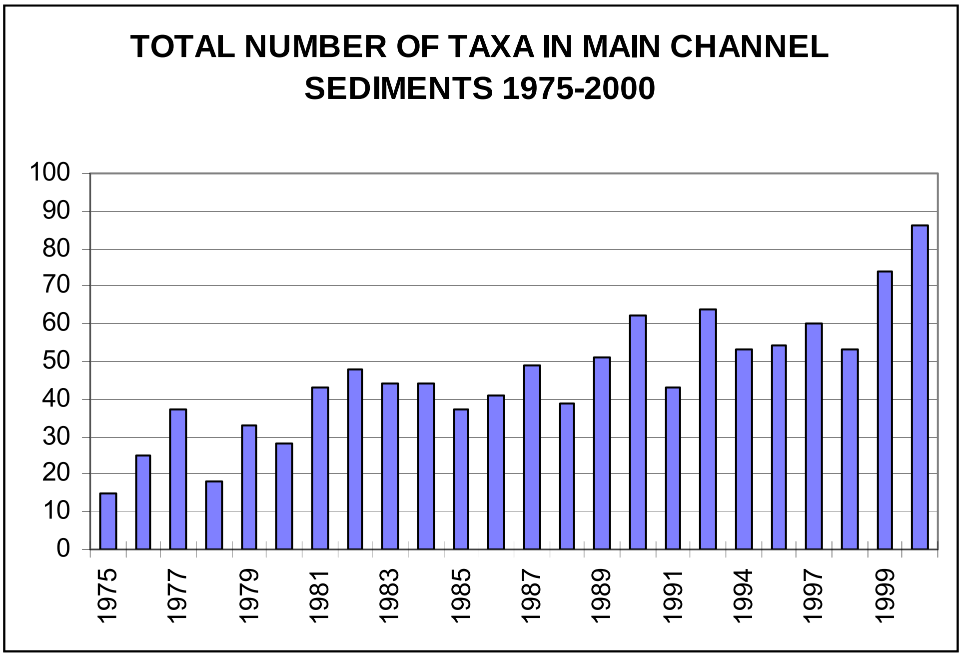

Figure 7. *Total Number of taxa in main channel sediments.*

Summary

The concentrations of dissolved metals in the Forth estuary are low as the Forth is a turbid estuary and particle reactive metals are absorbed onto the particulate phase. The sediments of the Forth are enriched with cadmium, lead and mercury relative to background levels. The enrichment factor is greatest for mercury and higher for lead than cadmium.

A substantial amount of the mercury discharged to the estuary has been retained on the sediments. Loss of mercury from the sediments of the Forth is expected to take decades because its flux out of the estuary on particulate matter is relatively slow (Davies *et al.* 1986). Fish and shellfish obtain contaminants from sediments by ingestion as well as from the overlying water column. Mercury contamination in fish and shellfish has reduced gradually following the reduction in input from the point source discharge.

The cadmium content of mussels reduced rapidly in response to the reduction in input from point sources. The lead content of mussels is highly variable and shows no distinct trend.

The macrofaunal community in the sediments of the Forth shows an increase in the number of recorded taxa which may be related to the decrease in the discharge of contaminants to this part of the estuary.

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Integrated study on mercury in the German Bight

Stefan Schmolke (Bundesamt für Seeschifffahrt und Hydrographie)

December 2008

Introduction

The German Bight covers the south eastern part of the North Sea. It is a shallow marine region with a mean depth of about 25m. The deepest point of approximately 50m is located south of Helgoland, and the southern and western edge is bounded by the German Wadden Sea. The regional current is dominated by a general anticlockwise circulation of water masses in the North Sea. Thus the general current pattern flows into the German Bight from the west, and leaves it to the north. Major fresh water suppliers to the German Bight are the drainage areas of the Elbe, Weser, Ems and Eider rivers. By far, the most important one is the Elbe river with a long term average discharge of 860 m^3/s. Also the more westerly located big continental and British river systems are contributing to the German Bight water sheet by transport with the North Sea current system. About 60% of the German territory is drained to equal shares by the Elbe and the Rhine river. The Rhine catchment covers the highly populated and industrialised western part of Germany, where approximately 50% of the German population lives. Major areas of eastern Germany are drained by the Elbe river. The Elbe catchment covers the industrialised core region of the “Neue Bundesländer”, in particular the region around Halle, Leibzig and Bitterfeld, where major parts of the chemical industries, *e.g.* the caustic soda production facilities of the former GDR were installed.

Pathways of pollutants to the marine environment are the transport via river systems, atmospheric transport, direct discharge and run off. It is important to understand that metals like mercury are naturally occurring chemicals. They are released by natural mobilisation, like weathering and volcanic activities, which account for the natural background concentration. On top of the natural occurring concentrations, the mercury inputs due to anthropogenic activities add to the environmental concentrations. They can be distinguished from the mobilisation of mercury impurities in raw materials by *e.g.* coal burning, or the intentionally use of mercury in products and processes and its release due to leeks, disposal or incineration (UNEP 2002). The environmental concentration of metals is a result of dynamic mobilisation, cycling and deposition processes. Mercury is a chemical element, it can’t be degraded like organic molecules, thus the quantitative removal from the environment is impossible, and the only remaining long term sink is sedimentation in the deep sea, or, to a certain extent, the controlled land fill, where mercury is physico-chemically immobilised. Due to the buffering capacity of the entire environmental mercury pool even a short term substantial reduction of anthropogenic mercury release would give only a slow, and delayed decline of its content in the environmental media.

Mercury is a toxic and bioaccumulating element. It is part of the OSPAR List of Chemicals for Priority Action and is assessed as a priority hazardous pollutant by the EU Water Framework Directive (WFD). Mercury appears in the environment in different inorganic and organic chemical forms. The dominating form is elemental mercury, which is liquid at room temperature and is characterised by a high partial pressure. Thus environmental mercury exists in all marine compartments, including a significant fraction as gaseous elemental mercury in atmosphere. Elemental mercury is oxidised under environmental conditions. The products are much more soluble than the elemental form. In the water phase they are easily transformed to mercuric ions. Biological activity in the water column and sediment has the potential to transform inorganic mercury to organic species (*e.g.* methyl mercury).

The over all toxic potential of mercury increases in the line: elemental Hg < inorganic Hg < organic Hg species.

What are the problems?

The particular regional significance of mercury as a pollutant in the German Bight

Until now the German Bight is a region of elevated mercury burden. The average concentration in the fines (<20µm) of surface sediments south-west of the island Helgoland (54°04'N 08°07.5'E) of 0.45 ± 0.14 mg/kg (average 2000-2008) is still about five fold elevated against the OSPAR background concentration. Combined Mercury monitoring data from 2006 (North Sea sediment survey) and 2000 (highly spatial resolved data from the German EEZ) represent a general overview about the spatial mercury pattern (Figure 1) in OSPAR region II. Increased concentrations are measured in the German Bight, and expand preferably to the north. There is a distinct decreasing mercury concentration gradient with increasing distance to the coast line.

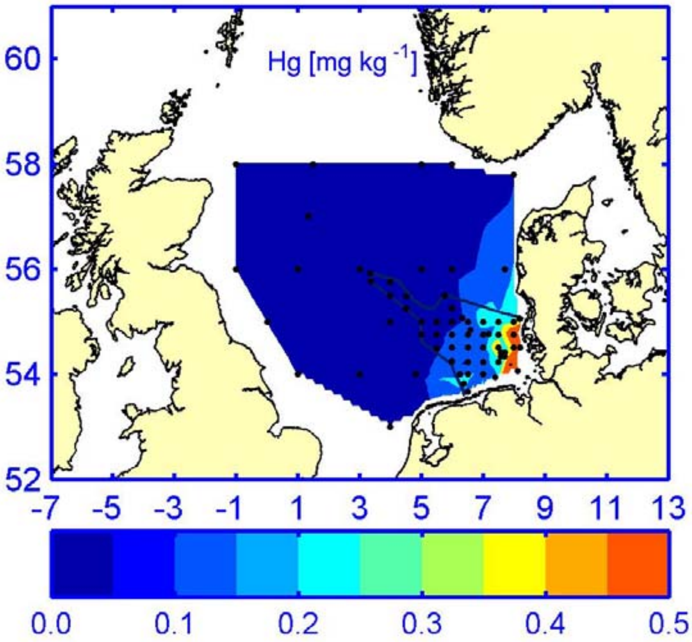

Figure 1. *Mercury burden in surface sediment fines (<20µm). A combination of spatial highly resolved data in the German EEZ (2000), and a North Sea sediment survey (2006). The depicted concentrations are normalised on 5% Aluminium.*

What are the reasons for this particular pattern? The comparison of national annual mercury riverine inputs and direct discharges to the North Sea still displays a significant German contribution to the total. In 2005 the total riverine mercury input to the North Sea was estimated to 4.8 t/a (OSPAR 2007). The German share summed up to 2.6 t/a, which is more then 50% of the total. Despite a significant reduction of mercury inputs to the Elbe river still almost 60% of the German total riverine inputs to the North Sea accounts for the Elbe river. The general anticlockwise circulation pattern of the North Sea takes the mercury loads from the Elbe discharges, as well as that of the more westerly located river systems (*e.g.* Weser, Rhine) and spread them along the northern German and Danish coast.

What has been done?

Improved and harmonised environmental legislation subsequent to the German reunification.

Looking back to the 1980ies and 1990ies, the mercury discharge of the German river systems, and in particular of the Elbe, was about 10 times higher than today. The 1986 estimate of mercury input to the North Sea, by the Elbe River, summed up to 22 t/a (ARGE 2005). A major fraction of this load was due to industrial discharges. The total mercury emission to German surface waters in 1985 was estimated to 29 t/a. About 75% of it accounted to direct industrial input, 10% to municipal sewage treatment plants, and less then 10% to direct urban run off (BMU 2006). Also the German contribution to the atmospheric load of mercury was significantly high during that time. Berdowski at all (1997) estimated the German mercury emissions to atmosphere during the year 1990 to 113 t/a, which was almost 50% of the total emissions of the OSPAR 15 countries. A view on the spatial spread of these emissions to atmosphere (Figure 1) displays a clear concentration of sources on the area of the German "Neue Bundesländer", which was the territory of the former German Democratic Republic (GDR). The major part of this high emission area was drained by the Elbe river.

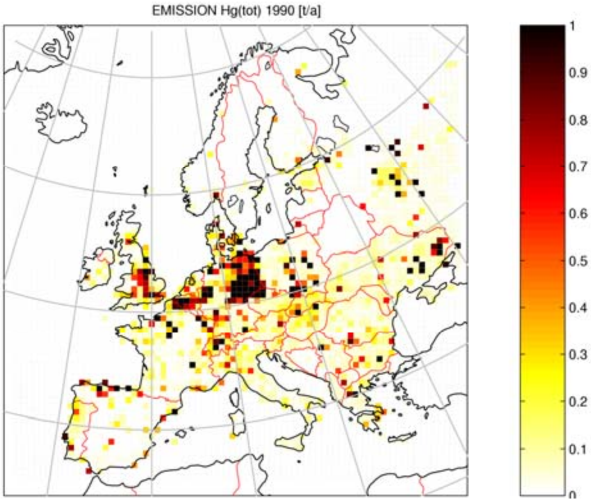

***Figure 2**. Spatial spread of estimated total mercury emissions to atmosphere in 1990 (Berdowski et al., 1997). The emission data base is visualised on a 56 x 56km grid.*

Due to the historic political and economical division of Germany, the industrial and environmental standards differed substantially in the western and eastern parts during the 1980ies. High industrial activity, combined with at least partial obsolete technologies and minor implemented emission control in the former GDR led to a comparable high pollution load to almost all environmental media. After the reunification in 1990 improved industrial and environmental standards were established. One big step forward in environmental protection was the German wide application of the Federal Water Recourses Act (Wasserhaushaltsgesetz WHG), which regulates the approval of waste water discharges to surface water. The harmonised legislative framework and the change from a controlled to a marked economic system in the new federal states, lead to the closure of major obsolete industrial facilities. In general the increasing international competition and strengthened environmental regulations were the reason for a dramatic reduction of heavy industries and renovation of the remaining facilities in the "Neue Bundesländer". In this context the German mercury cells technique facilitating chlorine and caustic soda production capacity declined from approximately 2200 to 1200 kt/y (OSPAR 2006). Emission reduction due to closure of obsolete industries and increasing investments in emission control techniques led to a significant decrease in mercury emissions to surface waters and atmosphere. On the international level Germany agreed to the declaration of the Intergovernmental Conference on the protection of the North Sea 1987 (London) and 1990 (Den Haag). The reduction of particular chemical loads to the North Sea by 50%, till 2000, was agreed.

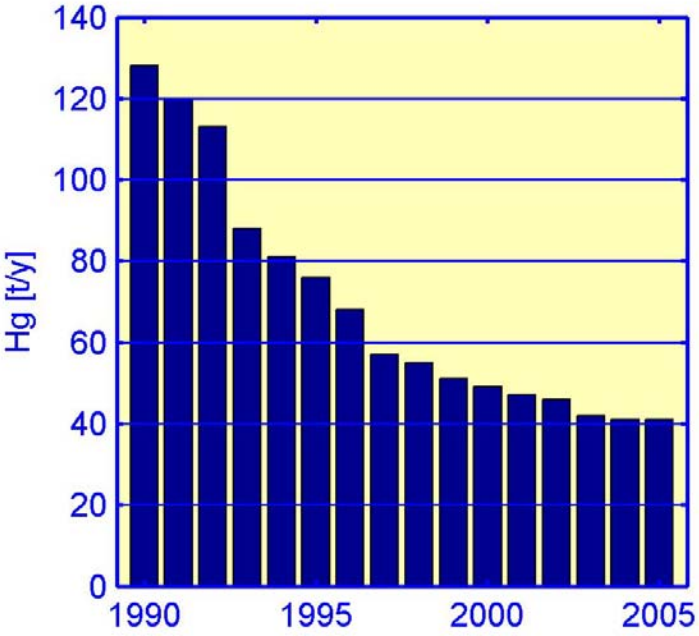

Figure 3. *German mercury emissions to atmosphere during the period 1990 to 2005.*

Did it work?

Significant decreasing trends in the mercury burden in the marine environment.

Germany met the international agreed reduction targets for metal inputs to the North Sea. During the Bergen conference (2002) a reduction of mercury inputs to surface waters from 31 t/a in 1985 to 4.7 t/a in 2000 (BMU 2006) was reported, that was a decline of about 85%. Also the atmospheric mercury emissions were substantially reduced. From 1990 to 2005 a reduction from 130 t/a to 40 t/a (UBA 2007), that is about 70%, was achieved. The declining inputs sighted significant effects in major environmental matrices. The burden of surface sediments and suspended particular matter (SPM) in German river systems got significantly down during the 1990th. A particular improvement of sediment and SPM quality was achieved along the Elbe river. Here the mercury burden of surface sediments and SPM decreased by almost 90% during the period from 1990 to 2007 (Figure **4.**4).

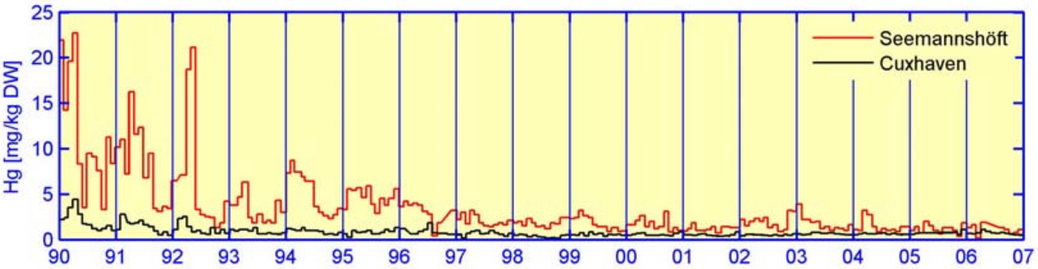

***Figure 4**. Mercury concentrations in suspended particulate matter (Seemannshöft, Hamburg) and in surface sediment fines (Cuxhaven, Elbe mouth) during the years 1990 to 2007.*

The declined fluvial and atmospheric transport and the improved sediment and SPM quality in the Elbe river continued in the German Bight. Since the beginning of the monitoring of mercury concentrations in the surface sediment fines (<20µm) till now, decreasing mercury concentrations were observed almost over the entire German EEZ. The spatial pattern of the trend measurements displays a distinct SE to NW decreasing concentration gradient. In the outer part of the German EEZ (TE, Figure **5**5 right) the mercury concentrations decreased continuously by almost 60% from 0.13+-0.01 to 0.05+-0.01 mg/kg (1990-2004), in the SW (Station ES) by 16% form 0.32+-0.09 mg/kg to 0.26+-0.08 mg/kg, and in the NW (Station L) by 37% from 0.51 +-0.07 to 0.31+- 0.08mg/kg. All observed trends are almost linear. The time series in the SE of the EEZ, the sampling site is located SE of Helgoland close to the Elbe river outflow, displays a more complex temporal structure (Figure **5**5 left). In the period during 1980 to 1998 an almost continuously decreasing trend was observed. Subsequent to that almost undisturbed period, since 1999, a substantial increased variability, including frequently high concentrations, comparable to values found during the 1980th, were measured. The proof of possible reasons for this particular effect is an object current investigations. May local changes in the sediment stratification, due to a change in hydromorphology, brought older, higher mercury contaminated horizons to the surface.

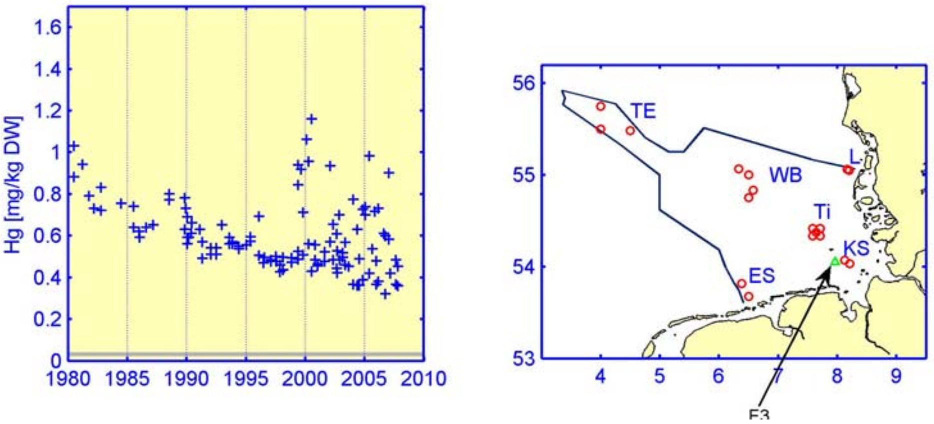

***Figure 5**. Right: Time series of mercury burden in surface sediments fines SE of Helgoland (KS). Left: Map of sediment sampling sites in the German EEZ.*

Changes in mercury burden are reflected also in the biological matrices. Mercury shows a strong tendency to bioaccumulate, thus concentration effects should be most obvious in top predator tissue, such as seabirds. Part of the German coastal monitoring is the long term collection of seabird eggs of different species. Nowadays there are long term time series of mercury burden in different species seabird eggs available. The metal monitoring in Herring Gull eggs displays similar mercury pattern, as found in surface sediment samples. The general decreasing trend since the 1980ies is well supported by samples, which were collected in the Elbe estuary (Trieschen). Even the special pattern of increased sediment concentrations and variability in the region SE and E of Helgoland, which was observed in surface sediments since the early new century, is reflected with some delay in this egg tissue (Figure 6.).

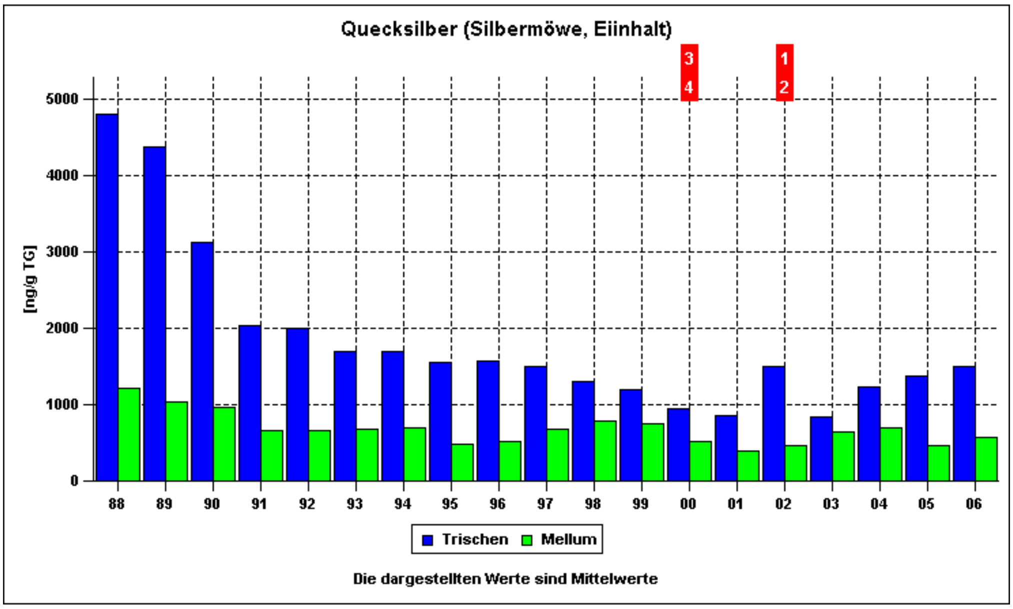

Figure 6. *Time series of mean Mercury content in Herring Gull eggs during 1988 to 2006. Sampling sites are located in the Elbe river estuary (Trieschen) and in the Jade (west of the Elbe estuary)*

Related samples, which were taken more westerly (Mellum), at a site of less Elbe influence, display a lower concentration level in general, and less significant trends. A relation between the mercury burden of surface sediments and the mercury accumulation by seabirds is well supported by these time series.

Monitoring of seabird eggs is also part of the monitoring activities under the framework of the Trilateral Waddensea Plan. Essink *et al.* (2005) published time series of mercury burden in Oystercatcher and Common Tern eggs in the period from 1991 to 2003. Both, the spatial pattern with highest concentrations in the Elbe estuary, as well as the general decreasing temporal trend supports the findings in Herring Gull eggs, although the detected over all mercury enrichment decrease in the line from Hering Gull > Oystercatcher > Common Tern. Even the increased sediment burden in the inner German Bight since 1999 is reflected by a one to two years delayed increased mercury concentration in eggs of both species, which were also collected at Trieschen.

How does this affect the overall quality status?

Since the beginning of routine mercury monitoring in surface sediments of the German Bight in the 1980ies, almost over the entire area linear decreasing temporal trends of 1-4 %/a were found. The application of current mercury OSPAR assessment criteria (mercury background concentration (BC), background assessment concentration (BAC) and effect range low (ERL): 50, 70, and 150 µg/kg dry sediment (OSPAR 2008)) to the 1990 monitoring data leads to a classification of almost the entire German EEZ as above the ERL level. Only the 1990 samples in the very outer part of the German EEZ (Figure 5; TE) could be assessed as close to BC, *i.e.* below BAC. The ongoing substantial decrease of mercury burden lead to a current state, where almost the entire NW half of the German EEZ could be assessed as close to BAC. Although the substantial decrease of mercury burden also took place at the western and northern German coast, the concentrations are here still above the applied effect criterion (ERL). A specific local situation was found in the outer Elbe estuary, SE of Helgoland, where the recent increase of mercury concentrations and variability, lead even to an over all increase of mercury burden of about 10% since 1990. There is evidence that this effect is not driven by increasing input due to fluvial input or atmospheric load. One potential cause of the effect could be the mobilisation of former deposited, higher contaminated, deeper sediment horizons.

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PCBs and PAHs in the Russian Arctic

Norman Green (Norwegian Institute for Water Research (NIVA)

January 2009

A pilot study for JAMP was initiated in Northwest Russia in 2002 as part of the bi-lateral project between Russia and Norway on OSPAR harmonisation of monitoring of hazardous substances. Participating Russian institutes are: the Federal State Unitarian Research and Production Company for Geological Sea Survey (SEVMORGEO), Murmansk Regional Department for Hydrometeorology and Environment Monitoring, Knipovich Polar Research Institute on Marine Fishery and Oceanography (PINRO), White Sea Biological Station “Kartesh” of Zoological Institute, Russian Academy of Sciences (WSBS ZIN RAS), Centre for Environmental Chemistry of Scientific Production Association “Typhoon” (CEC Typhoon), Murmansk Marine Biological Institute, Kola Scientific Centre Russian Academy of Sciences (MMB KSC RAS), Arkhangelsk Branch of Arctic Directorate for Technical Control at the Sea, Ministry of Nature Resources. Akvaplan-niva has acted as Norwegian coordinator with support from the Norwegian Ministry of the Environment, Norwegian Pollution Control Authority and the Norwegian Institute for Water Research.

Investigations have focused on metals and POPs in surface sediment and biota from the Russian coastal areas of the Barents Sea, Pechora Sea and White Sea. Sampling and analyses have followed the OSPAR monitoring guidelines. Analytical laboratories have participated in intercalibration exercises with positive results. Not only have legacy contaminants such metals, PCBs, PAHs, pesticides been monitored but also dioxin-like PCBs, PBDEs, dioxins/furans, and PCNs. The results presented here represent a small fraction of what the programme has generated since monitoring started in 2003. These results also represent the first time that Russian data have been represented in an OSPAR report.

As a glimpse of what the Russian JAMP has produced the levels of PCBs and PAHs were classified based on the same system applied for the CEMP (cf. Webster *et al.* 2008). Sediment and blue mussel stations were selected from Barents Sea in 2003 (Alexeeva *et al.* 2004), the White Sea in 2006 (Savinova *et al.* 2007), and the Perchora Sea in 2007 (Savinova *et al.* 2008). For comparison with the CEMP PCBs included the congeners 28, 52, 101, 118, 138, 153 and 180 and PAHs included phenanthrene, anthracene, fluoranthene, pyrene, benzo[*a*]anthracene, chrysene, benzo[*a*]pyrene, indeno[*1,2,3cd*]pyrene and benzo[*g,h,i*]perylene. The system has assessment criteria for each of these compounds to distinguish in which of three classes monitoring data falls. Values in the red assessment class (worst class) are considered unacceptable, whereas values in the blue or green classes are acceptable. An aggregated assessment of PCBs or PAHs is determined by the second worst case of the compounds involved (OSPAR HA-1 meeting 19-23.01.2009). The sediment results were normalized to 2.5% organic carbon in accordance with the OSPAR data assessment procedures.

Comparison of the selected results from the field studies with the CEMP assessment criteria showed that levels of PCBs and PAHs in the Russian Arctic in general were low (acceptable status). However, it is important to take precautionary action to keep the levels low and to continue monitoring of emerging pollutants in the Arctic.

Russia has continued JAMP monitoring in 2008 (Savinova *et al.* 2008) and there is an on-going process to maintain the programme in 2009 and onwards. The 2003-2008 results will also be presented in a cooperative Norwegian-Russian environmental quality report due in 2009. This is a positive development will provide continuing assessments of environmental status (concentrations of contaminants) but also provide valuable temporal trend data and studies of the effects of contaminants on biota in a remote OSPAR region.

A. PAHs in sediment (○) and blue mussel (□) **B.** PCBs in sediment (○) and blue mussel (□)

Figure 1. *Samples from Russian JAMP 2003 – 2007. Classification of (A) PAHs and (B) PCBs according OSPAR CEMP system, where blue indicates acceptable status and concentrations are close to background or zero, i.e. the ultimate aim of the OSPAR Strategy for Hazardous Substances has been achieved and green indicates acceptable status and concentrations are below levels designed to protect the environment and its living resources at the population or community level (Weber et al., 2008). See also text.*

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Appendix: Summary of conclusions from sample of Russian JAMP 2003-2007

SEDIMENT (normalized to 2.5%)

	2003 Barents Sea	2006 White Sea	2007 Pechora Sea
	69.509	**64.117**	**69.118**
	33.010	**37.587**	**59.228**
PCB	Green	Green	Green
PAH	Green	Green	Blue

BLUE MUSSEL

	2003 Barents Sea	2006 White Sea	2007 Pechora Sea
	69.117	**66.337**	**69.668**
	36.083	**33.660**	**60.392**
PCB	Blue	Blue	Blue
PAH	Blue	Blue	Blue

OSPAR
COMMISSION

New Court
48 Carey Street
London WC2A 2JQ
United Kingdom

t: +44 (0)20 7430 5200
f: +44 (0)20 7430 5225
e: secretariat@ospar.org
www.ospar.org

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