OSPAR
COMMISSION

Levels and trends in marine contaminants and their biological effects – CEMP Assessment report 2012

Monitoring and Assessment Series

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OSPAR Convention

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

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. Les Parties Contractantes sont :
l'Allemagne,
la Belgique, le Danemark, l'Espagne,
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, la Suisse et l'Union européenne.

Acknowledgement

This report has been prepared by the Working Group on Monitoring and on Trends and Effects of Substances in the Marine Environment (MIME). Special thanks to Dr Martin M. Larsen, Denmark and Dr Rob Fryer (UK) for their hard work in producing this report.

Contents

Executive Summary

Overall, most hazardous substances are decreasing in the North Sea with significant time series decreasing in sediment, biota and biological effects. The picture is not quite the same however for metals as not all metals are decreasing over time.

Organochlorine compounds – A downward trend was observed for 95% of the dioxins-furans and PCBs. A number of UK stations and Spanish stations are nonetheless showing increasing trends for CBs and some samples were above the Ecological Assessment Criteria (EAC). The source of these increases is currently unknown.

Downtrend trends for PCBs and Polyaromatic hydrocarbons (PAHs) have previously been observed along the Belgian coast. This however, cannot be associated with any specific management action but is more linked to the collective measures taken to reduce PCBs in the marine environment in the OSPAR area.

Polyaromatic hydrocarbons – Both downward and upward trends detected. Along the French coast, Villerville and Comprian showed some increasing trends for PAHs. Data for Villerville suggest that there was a peak at the turn of the century but that the trend is now downward. In contrast the upward trends at Comprian were unexplained. Although below the EAC, 2 Danish stations showed increasing trends for naphthalene. This will be closely monitored and investigated if the upward trends persist.

Metals – Concentrations of copper (Cu), Zinc (Zn) and lead (Pb) are generally increasing for significant time trends. The picture for mercury, cadmium and arsenic is more mixed with trend directions at the same level for cadmium while trends for mercury and arsenic are mainly in a downward direction. Increases in lead and cadmium need to be investigated as use of these metals is largely banned in the whole OSPAR Convention Area.

Metals in biota – Copper trends are upwards in mussels at some coastal stations on both sides of the Irish Sea. This upward trend is also seen in cadmium, mercury and lead on the Irish side.

Metals in sediments – Copper concentrations are upwards in Region II and III. Similarly there is an increase for lead and cadmium.

Metals - Source and diffuse pollution - Some areas have been affected by point source pollution due to mining in Region II and due to increased metal concentrations from metallurgical facilities in Region I. In the case of Pb, the major source of diffuse pollution was from leaded fuels, which were banned in 2000. Investigative methods indicate that concentrations of Pb in sediments is still high which in turn show that leaded fuels are still a major source of diffuse pollution. The main current source of concentrations of Pb in mussels however is anthropogenic pollution through wastewater of waste incineration.

Récapitulatif

Les niveaux de substances dangereuses ont dans l’ensemble baissé en mer du Nord, des séries temporelles significatives accusant une baisse dans les sédiments, le milieu vivant et les effets biologiques. Ce n’est pas tout à fait le cas, cependant, pour les métaux car ils ne diminuent pas tous dans le temps.

Composés organochlorés – on a relevé une tendance à la baisse pour 95% des dioxines-furanes et des PCB. Un certain nombre de stations du Royaume-Uni et d’Espagne révèlent cependant des tendances à la hausse pour les CB et les teneurs de certains échantillons dépassent les critères d’évaluation écologique (EAC). On ne connait actuellement pas la source de ces augmentations.

On avait relevé, antérieurement, des tendances à la baisse pour les PCB et les hydrocarbures aromatiques polycycliques (HAP) le long de la côte belge. Ceci ne peut cependant pas être lié à une quelconque mesure de gestion spécifique mais plus probablement à des mesures collectives de réduction des PCB dans le milieu marin de la zone OSPAR.

Hydrocarbures aromatiques polycycliques – On a relevé aussi bien des tendances à la baisse que des tendances à la hausse. Le long de la côte française, les stations de Villerville et Comprian ont révélé certaines tendances à la hausse pour les HAP. Les données de Villerville suggèrent un point culminant à la fin du siècle mais que la tendance est désormais à la baisse. Par contre, les tendances à la hausse de Comprian sont inexplicables. Deux stations danoises révèlent des tendances à la hausse pour le naphtalène bien que les teneurs soient inférieures aux EAC. On surveillera et étudiera de près cette situation si les tendances à la hausse persistent.

Métaux – Les teneurs en cuivre, zinc et plomb ont généralement augmenté pour les tendances temporelles significatives. La situation est plus mitigée pour le mercure, le cadmium et l'arsenic, les tendances pour le cadmium restant les mêmes alors que celles pour le mercure et l'arsenic sont principalement à la baisse. Il faudra étudier l'augmentation des teneurs en plomb et en cadmium car l'utilisation de ces métaux est fortement interdite dans l'ensemble de la zone de la Convention OSPAR.

Métaux dans le milieu vivant – les tendances pour le cuivre dans la moule sont à la hausse dans certaines stations côtières des deux côtés de la mer d'Irlande. Elle se retrouve également pour le cadmium, le mercure et le plomb, du côté irlandais.

Métaux dans les sédiments – les tendances pour le cuivre sont à la hausse dans les Régions II et III. Il en est de même pour le plomb et le cadmium.

Métaux - Source et pollution diffuse - Certaines régions ont été affectées par une pollution d'origine ponctuelle causée par des activités minières dans la Région II et une augmentation des teneurs en métaux due à des installations métallurgiques dans la Région I. Dans le cas du plomb, la source principale de pollution diffuse est les carburants au plomb qui sont interdits depuis 2000. Des méthodes d'investigation indiquent que les teneurs en plomb dans les sédiments demeurent élevées ce qui montre donc que les carburants au plomb sont encore la source principale de pollution diffuse. La principale source actuelle des teneurs en plomb dans la moule est anthropique, étant due aux eaux usées de l'incinération des déchets.

1. Introduction

The 2012 assessment of data collected under the OSPAR Coordinated Environmental Monitoring Programme (CEMP) was prepared by the OSPAR Working Group on Monitoring and Trends and Effects of Substances in the Marine Environment (MIME) at, and following, its meeting in December 2012 and is based upon data reported by Contracting Parties to ICES and held in the ICES Environmental databases.

The CEMP is the monitoring under the OSPAR Joint Assessment and Monitoring Programme where the national contributions overlap and are coordinated through adherence to commonly agreed monitoring guidelines, quality assurance tools and assessment tools. It covers temporal trend and spatial monitoring programmes for concentrations of selected chemicals and nutrients, and for biological effects. Monitoring under the CEMP aims to indicate the extent of contamination of fish, shellfish and sediments with hazardous substances and the intensity of their biological effects. The purpose is to support OSPAR assessments of the effectiveness of measures to reduce releases of hazardous substances to the environment. 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.

The assessment evaluates the status and trend of concentrations of hazardous substances in the marine environment for selected hazardous substances which have been prioritised for action by OSPAR due to their risk for the marine environment and which are being monitored under the Coordinated Environmental Monitoring Programme (CEMP). It builds on experience gained in the first comprehensive trend assessment of CEMP data in 2005 (OSPAR, 2005), and the annual CEMP assessments undertaken in the period 2006 – 2009 (OSPAR, 2006; OSPAR, 2007; OSPAR, 2008a; OSPAR, 2009a), which contributed to the OSPAR Quality Status Report 2010 (OSPAR, 2010) accessible at http://qsr2010.ospar.org.

This assessment collates explanatory comments from Contracting Parties on selected areas. On an ongoing basis, these comments are intended to report on areas of special interest, so that in 2015 in time for the next QSR most areas with specific problems have been highlighted and commented upon, and the way forward to minimising or fully understand the problems have been investigated and outcome can be reported in the upcoming QSR.

Focus in this year’s assessment has been on the biological effects and organotin (TBT), but the upward trends of other hazardous substances in selected areas are also noted, even when the majority of substances with significant trends are downwards. The reader should be aware that this focus on upward trends to some extent gives a false impression of problems if most trends are downward. It is to ensure that continued effort is put into the areas where current agreements or legislation might not be enough to ensure the OSPAR cessation goal for pollution by 2020.

1.1 Web-based presentation of CEMP assessment results

The OSPAR assessment for 2013 covers in excess of 25000 measurements with more than 50 parameters and 7500 time trends in sediment, biota and for biological effects (Annexes 1-3). Assessment products are presented in the Web assessment tool at http://dome.ices.dk/osparmime/main.html , assessment data are also available at this location, together with supporting tables, plots, help files, and methodological information.

The web assessment tool have been further developed to also present biological effect data, adapted for the same presentation (blue-green-red dots) as for the hazardous substances evaluation, based on individual assessment criteria. Note that for some biological effects data, a larger number signifies a healthier environment, which is taken into account in the color scheme.

This report highlights some of the overall results but primarily focuses on organotin and biological effects in the “roll-over” assessment approach. The assessment procedure requires that Contracting Parties check their reported values, thus providing an extra quality assurance element of the dataset used in the CEMP report. The assessment process was completed as per the QSR 2010. Details of the individual parameter assessment criteria are described in the help files on the assessment web page.

1.2 Contaminants and matrices covered

The contaminants covered by the CEMP are metals (cadmium (Cd), mercury (Hg), lead (Pb), nickel (Ni), copper (Cu), zinc (Zn), chromium (Cr), arsenic (As) and the organic contaminants PCBs (congeners 28, 52, 101, 105, 118, 126, 138, 153, 156, 169, 180) and PAHs (naphthalene, phenanthrene, anthracene, dibenzothiophene, fluoranthene, pyrene, thiphenylene, benzo[a]anthracene, benzo[a]pyrene, benzo[ghi]perylene, and indeno[123-cd]pyrene). This summary report highlights the findings for PCBs and PAHs as a group and organotin and biological effects. Overall results are available for cadmium, mercury and lead, which are the metals selected by the OSPAR Commission for priority action. The other metals covered are either micronutrients (zinc and copper) or have other biological functions (arsenosugars, chromium, nickel).

The assessment covers the concentrations of a selection of hazardous substances from the CEMP in marine sediment, fish tissue (muscle and liver) and shellfish tissues.

1.3 Methods

The assessment was mainly prepared using the methods for data screening, treatment of quality assurance information, temporal trend assessment and assessment against assessment criteria which have been used in previous CEMP assessments and are described in the CEMP Assessment Manual (OSPAR, 2008b).

The assessment criteria used to assess environmental concentrations of hazardous substances are set out in OSPAR agreement on CEMP Assessment Criteria for the QSR 2010 (OSPAR agreement 2009-2). The derivation of these assessment criteria for hazardous substances is discussed in a Background Document on CEMP Assessment Criteria for the QSR 2010 (OSPAR, 2009b). The assessment criteria reflect a two stage process in which data are compared to concentrations that are unlikely to give rise to unacceptable biological effects (c.f. Environmental Assessment Criteria, EACs) and then against Background Concentrations (BCs) or zero, expressed as Background Assessment Concentrations (BACs). The latter reflects the objective of the OSPAR Hazardous Substances Strategy that concentrations should be at or close to background levels for naturally occurring substances or to zero for man-made substances.

An overview of the assessment criteria is at Appendix 1.

1.4 Overview of submission data

The data submissions by Contracting Parties are assessed from the ICES website (via http://info.ices.dk/datacentre/accessions/CommissionSummary.aspx?commission=OSPAR). The status of each submission is:
X: the Contracting Party has submitted data and this data is available for use from the ICES database;
P: the Contracting Party has submitted data, and data is still being processed (quality checks etc., by the Contracting Party and by the data host ICES).

The date stamp on this overview of data submissions is 8 March 2013.

The parameters reported within the 2005-2011 period are listed (only parameter groups assessed in MIME during the last years, others may occur). Data for each parameter are not necessarily reported every year for each station.

Imposex and other Biological Effects in Biota Data

Country	2006	2007	2008	2009	2010	2011	Parameters #
Denmark	**X**	**P**		**P**			**IMP**
France	X	X	X	X	X	X	IMP (Erod)
Germany	X	X		X			GRS, PAH
Ireland					X	X	
Netherlands	X	X	X	X	X	X	IMP, GRS
Norway	P	P	X	P	X	X	IMP, ALAD, EROD, PAH
Spain	X	X	X	X	X	X	IMP, Erod, TOX
Sweden	X	X	X	X	X	X	IMP
United Kingdom	X	X	P X	P P	P	X	IMP, GRS, Erod, PAH, TOX
Portugal			X	X			IMP

IMP: Imposex/intersex; GRS: Fish diseases; PAH: PAH metabolites.

Contaminants in Biota Data

Country	2006	2007	2008	2009	2010	2011	Parameters
Belgium	X	X	X	X	X		Metal, TBT, PAH, PCB, PBDE
Denmark	X	X	X	X	X	X	Metal, TBT, PAH, PCB, PBDE, Dioxin
Faroe Islands						X	Metal, TBT, PAH, PCB, PBDE
France	X	X					Metal, PAH, PCB
Germany	X	X	X	X	X	X	Metal, TBT, PAH, PCB, PBDE
Iceland	X	X	X	X	X	X	Metal, PCB
Ireland	X	X	X	X	X	X	Metal, PAH, PCB, PBDE, Dioxin, PFOS
Netherlands	X	X	X	X	X	X	Metal, PTB, PAH, PCB, PBDE
Norway	P	P	X	P	X	X	Metal, PAH, TBT, PCB, PBDE, Dioxin, PFOS
Portugal			P	P	P		Metal, PAH, PCB, Dioxin
Spain	X	X	X	X	X	X	Metal, TBT, PAH, PCB, PBDE
Sweden	X	X	X	X	X	X	Metal, TBT, PAH, PCB, PBDE, PFOS, Dioxin
United Kingdom	X	X	X	P	P	X	Metal, TBT, PAH, PCB, PBDE

Contaminants in Sediment Data

Country	2006	2007	2008	2009	2010	2011	Parameters
Belgium	X	X	X		X	P	Metals, TBT, PAH, PCB, PBDE
Denmark		X	X	X	X	X	Metals, TBT, PAH, PCB, PBDE, dioxin
Germany	X	X	X		P	X	Metals, TBT, PAH, PCB, PBDE
Ireland	X	X					Metal, PCB, TBT, PAH
Netherlands	X	X	X	X	X	X	Metal, PCB, TBT, PAH, PBDE
Norway	X		X				Metal, PCB, TBT, PAH, BDE, PFOS
Spain	X	X	X	X	X	X	Metal, TBT, PCB, PBDE, PAH
United Kingdom	X	X	P	P	P	P	Metal, PCB, TBT, PAH, PBDE

France has submitted Metals, PAH and PCB in 2003 sediments as the latest.

For information the submission of seawater data is illustrated below (no mandatory monitoring and not included in the CEMP assessment). The seawater parameters submitted are nutrients and related measurements, such as Chlorophyll a. Not all parameters are monitored and reported every year.

Contaminants in Seawater Data

Country	2006	2007	2008	2009	2010	2011	Parameters
Belgium	X	X	P	X	X	P	Metals, TBT, PBDE, PAH
France	X						
Germany	X	P X	P X	X	P X	P	PCB, PAH, Triazines
Ireland	X	X					
Netherlands	X	X	X	X	X	X	Metal
Spain	X				X		
United Kingdom	X	X	P	P	X	P	Metal, TBT, PCB, Triazines

2. Status and trends

Overall most hazardous substances are found to be decreasing in the North Sea, with 83-100% of the 1341 significant time series decreasing in sediment, biota and biological effects, whereas for metals not all metals are overall decreasing over time.

2.1 Organochlorine compounds

Of the Dioxins-furans and PCBs time trends, more than 95% are in a downward direction, and with only 1 to 3 stations indicated increasing trends for these parameters. Two sites in the southern Irish Sea were both below BAC or not detected in the last year, whereas two UK stations showed upward trends, one in the Irish Sea Clyde estuary (Seamill Adrossan) showed increasing trends and CBs above EAC in time series up to 2007, and the other in the Tyne-Tee estuary only for CB118 (TyneTees_TTInter_fi03) increasing to just above the EAC. Spanish samples at Iberian Sea (MPVBIA) and Gulf of Cadiz (PMGC) was also above EAC and upward trends were found for several CBs. The sources of these increases are currently unknown.

Downward trends for PCBs and PAHs at the Belgian coast have previously been observed, however it is not currently possible to associate these to any specific management action or measure taken in this area. In an overall context collective measures taken to reduce PCBs to the marine environment are expected to be the primary contributor to these downward trends. This is applicable to the whole of the OSPAR area.

2.2 Polyaromatic hydrocarbons

Overall, the trends of parent PAHs show downward trends, however for seven individual PAHs upward trends were found in 25 cases at 14 stations.

Along the French coast, some increasing trends are indicated for PAHs in Villerville (Seine estuary) and Comprian (Bay of Biscay), but data from Villerville 2008 and 2009 (not yet reported to ICES) suggests that the increase have peeked at the turn of the century, and in the last years decreasing concentrations are observed at Villerville. For Comprian, there is currently no explanation for the trend, and the trend will be re-examined and analysed further when new data becomes available.

In the Wadden Sea, two Danish stations show increasing trends for naphthalene still well below the EAC, but no other PAHs have significant trends. At a station in the northern Wadden Sea, trends for most PAH are downward, no generally increasing trend is therefore present. The upward trend will be followed in the coming years and potential sources should be investigated if it continues.

In the Iberian Sea, some Spanish stations are showing increasing concentrations of PAHs, in many cases after a downward trend between 1999 and 2004/5, but concentrations are now increasing to around the same levels as pre-2000. There is currently no explanation for this, and data will be investigated more thoroughly at the next assessment.

On the Scottish-Irish west coast, and the Scottish east coast, some increasing trends of several PAH (both larger 6-ringed and smaller 4-ringed PAHs) are seen, in most cases around the BAC level. For PAHs where assessment criteria other than BAC exist, all are currently below the levels expected to give rise to effects in the environment.

2.3 Metals

For the metals, the picture is more ambiguous with the majority of Cu, Zn and Pb trends increasing. Cd shows the same number of upward and downward trends (26 each) while Hg, As trends are mainly in a downward direction. It should be noted that a number of these trends have only data reported up to around 2007/8. Increases of especially Pb and Cd require further investigation, as use of these metals is largely banned in the whole Convention Area.

Exceptions are indication of increasing direct load in region III from 2009-2011 for Cd, Pb, Zn and Cu, but only from visual inspection of the total contribution to the Celtic Sea from direct discharges, and increasing atmospheric deposition at one of ten sites where Cd in precipitation are measured and one of six sites where Pb is measured in air. (see Box 1).

Copper show increasing trends in mussels at some of the coastal stations on both sides of the Irish Sea. For cadmium, mercury and lead some concentrations trends on the Irish side are also upward, whereas many on the British side are downward contrary to the copper concentration trend. For the British side, the increasing copper concentrations are also found in sediments, with concentrations in sediments from the Channel also increasing for lead and cadmium.

BOX 1:

OSPAR RID/CAMP timetrend

The mandatory RID cover nutrients and metals (Hg, Cd, Pb, Cu and Zn), and recommends monitoring of PAHs and oil, PCBs and organohalogens. Only time trends for metals and nutrients are available (OSPAR, 2013b), and for some of these, particularly in region II for rivers and region IV for direct discharges, results below the detection limit increases the “upper” estimate to a factor of 10 above the “lower” estimate of discharges. For the overall dataset, no statistical analysis was performed on the time trends.

The time trends for direct discharges of metals show a decrease in input to Region II from 1990’s to 2001 for Cd, Zn and 2006 for Hg, Pb and Cu. Visually, there is no or little trend from 2006 and onwards, perhaps except for Pb and Zn. For region II, the time trend is not so obvious, but still decreases was observed up to around 2005 for all metals, but it seems that only Hg remains low, with the other metals increasing with the lowest direct discharges in 2004-2006. In region IV, no data was reported before 1999, but except for Hg and Zn, results for 2010-11 are lower than the 1999-2001. No obvious time trends are seen for region IV though.

The time trends for riverine inputs to region I is generally lower after 2000 than before, except for Hg, but not all are decreasing during 2009-2011. For region II, the trend is generally decreasing from 1990 to 2011, although with a local maxima for most metals in the dry years from 2006 and 2007. In region III, no overall trend in inputs was visual. Region IV was particularly high in 2003-2006, as two major Spanish rivers were only reported in this period.

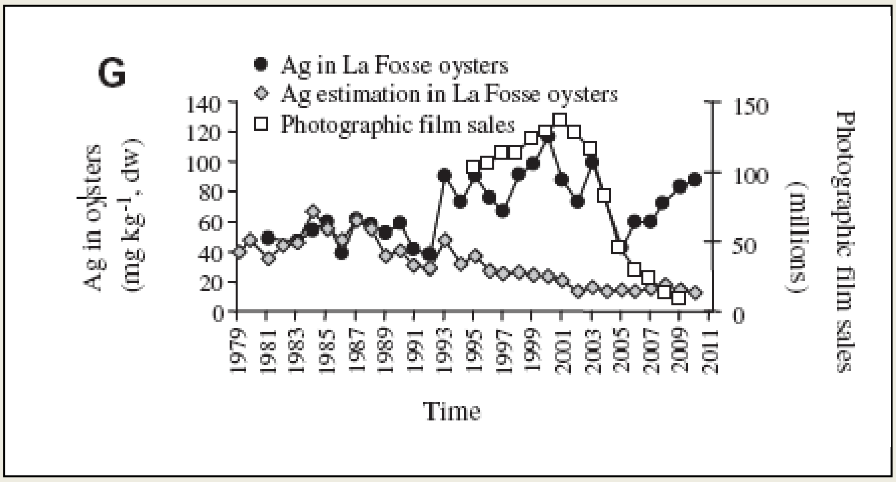
Some mathematical treated French time trends indicate decreasing concentrations Atrazine in both Seine and Loire, and are currently not detected. In the Seine, decreasing concentrations of g-HCH, Pb and Zn is observed, but Cu is irregular, and Cd, Hg have not been quantified for more than 2 years. In a similar Norwegian dataset, long term trends was generally decreasing for metals, with one not-significant upward trend for Cu in Otra, otherwise 6-9 of 9 rivers was significantly decreasing in concentration based on the upper estimates, whereas 3-6 was decreasing based on lower estimates. In all Zn, Pb concentrations was found to be significantly decreasing in 4 to 5 of the 9 rivers, whereas no firm conclusions could be made for Hg, As, Cr and Ni in the long term. No conclusions could be drawn for Lindane and PCBs, as a majority of samples was below detection limits.

For the atmospheric deposition (OSPAR 2013a), mandatory substances in precipitation includes metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn and g-HCH), and on a voluntary basis PCBs and PAHs. For airborne pollution both metals and hazardous substances are considered voluntary. Mandatory data for metals exclusive mercury are available from all contracting parties except Portugal, mercury are not measured in Denmark, France and Island, and g-HCH are not measured in these four countries or the UK. The time trend analysis has been broken down to 1990 – 2011 and 2000 – 2011, in the first case, none of the sites showed increasing trends; 50% of the sites was found to have decreasing trend of mercury in precipitation but none in air, whereas lead was 100% for both and for cadmium 83% of the sites showed decreasing concentrations in precipitation and 100% in air. For the last decade, 25% of the Hg sites were decreasing in precipitation, and around 70% for Pb and 50% for Cd of the sites was decreasing in both precipitation and air. But for Cd, 10% was showing increasing trends in precipitation and 17% was increasing for Pb in air. The mercury time trends have generally shifted from decreasing towards no clear tendency during the last 10-15 years.

In some areas, point source pollution due to mining have affected the environment with either specific metals (*i.e.* the Gironde estuary, France - see box) or more general increased metal concentrations from smelters and other metallurgical facilities (*e.g.* Hardanger Fjord, Norway). For Pb, the major source of diffuse pollution was from leaded fuels up until 2000, where leaded fuels were banned. Using lead isotopes ratios, it is possible to investigate sources of lead in mussels or surface sediments (see box) indicating that in mussels, the main source is anthropogenic pollution through waste water or waste incineration, whereas in surface sediments collected worldwide between 2006 and 2007, leaded fuels can be a major source still.

BOX 2:

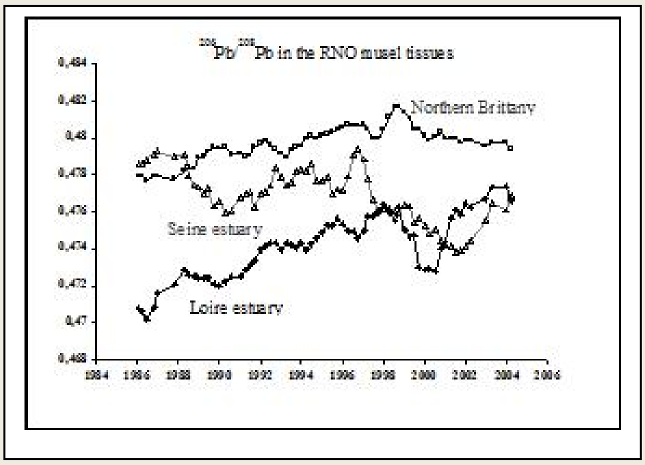
Ag and Cd monitoring in the Gironde estuary, France



In 2005, anomalously high Ag concentrations (up to 65 mg kg-1; dry weight) in oyster tissues (Crassostrea gigas) were revealed in the Gironde fluvial estuarine system, west of France (Lanceleur et al., 2005). Using oysters tissues preserved in the IFREMER (Nantes, France) specimen bank, historical trends (1979-2010) of Cd and Ag contamination were retrospectively studied and compared with long-term (1955–2001) records of Ag and Cd concentrations in reservoir sediment, in order to identify the origin and historical trend of the recently discovered Ag anomaly. Sediment cores from two reservoirs upstream and downstream from the main metal pollution source provided information on (i) geochemical background (upstream; Ag: ~ 0.3 mg kg-1; Cd: ~ 0.8 mg kg-1) and (ii) historical trends in Ag and Cd pollution. The results showed parallel concentration-depth profiles of Ag and Cd supporting a common source and transport. Decreasing concentrations since 1986 (Cd: from 300 to 11 mg kg-1; Ag: from 6.7 to 0.43 mg kg-1) reflected the termination of Zn ore treatment in the Decazeville basin followed by remediation actions. Accordingly, Cd concentrations in oysters decreased after 1988 (from 109 to 26 mg kg-1, dry weight (dw)), while Ag bioaccumulation increased from 38 up to 116 mg kg-1, dw after 1993. Based on the Cd/Ag ratio (Cd/Ag ~ 2) in oysters sampled before the termination of zinc ore treatment (1981–1985) and assuming that nearly all Cd in oysters originated from the metal point source, the respective contribution of Ag from this source to Ag concentrations in oysters was estimated. The evolution over the past 30 years clearly suggested that the recent, unexplained Ag concentrations in oysters are due to increasing contributions (>70% after 1999) by other sources, such as photography, electronics and emerging Ag applications/(nano)materials.

BOX 3:

Monitoring of Pb and its stable isotope in the west of France



Using mussel tissues preserved in the IFREMER (Nantes, France) specimen bank, historical trends of Pb stable isotope composition was measured in 216 composite samples of 50 blue mussels (*Mytilus edulis*)) collected quarterly between 1985 and 2005 at three sites along the French Atlantic coast, one in the clean region of northern Brittany and the others in the more contaminates Loire and Seine River estuaries. Depending on the sites and time periods, Pb concentrations extracted from the monitoring data bank were 5-66 times higher than the natural background value for the North Atlantic.

Even for the samples with the lowest Pb concentrations, the isotopic signature of Pb is very different than that of the regional natural Pb, suggesting that most of the bioaccumulated Pb is anthropogenic in origin. Stable Pb isotope ratios measured in the mussels differ markedly from that of Pb emitted in Western Europe as a result of leaded gasoline combustion, which was still a dominant source of contaminant Pb to the atmosphere during most of our study period. The isotope composition of Pb in the mussels was instead more typical of that of the Pb released to the environment by wastewater treatment plants, municipal waste incinerators, and industries such as metal refineries and smelters. Continental runoff, rather than atmospheric deposition, is therefore identified as the leading transport pathway of Pb along the French Atlantic coast. From the strong seasonal variations in 206Pb/208Pb ratios in the mussels from the Seine Estuary site we also conclude that the resuspension of contaminated sediments, triggered by high river runoff events, is a chief factor affecting the bioaccumulation of Pb in M. edulis. The value of this organism as a biomonitor of coastal contamination is thus further demonstrated (Coulture et al, 2010).

Using lead isotopes, it is was possible to attribute 30-80% of the lead in surface sediments in major harbours around the world, with Boston and Sydney harbour showing both the highest concentrations and largest share from leaded fuel. Also sediments from Virgin Islands was high in Pb, whereas minor harbours in South Africa, New Zealand and Solomon Islands had lower concentrations but still a considerable amount (about 1/3) of the lead attributed to leaded fuels fuels (Larsen et al, 2012).

3. Organotin and biological effects of organotins

Time trend data for chemical measurements of organotins in biota are mainly available from Danish stations, supplemented with status assessments from Norway and Belgium in Region I and II. For sediments, more informal assessment (one-two years of results) are available, but no time trends are currently available for assessment[1].

Data in sediment are available for region II and III, courtesy of Norway, Denmark, Germany, Netherlands, Belgium and UK (Northern Ireland). All significant time trends for both chemical measurements (5 of 8) and biological effects (84 of 140) are downward (figure 1, Table 1).

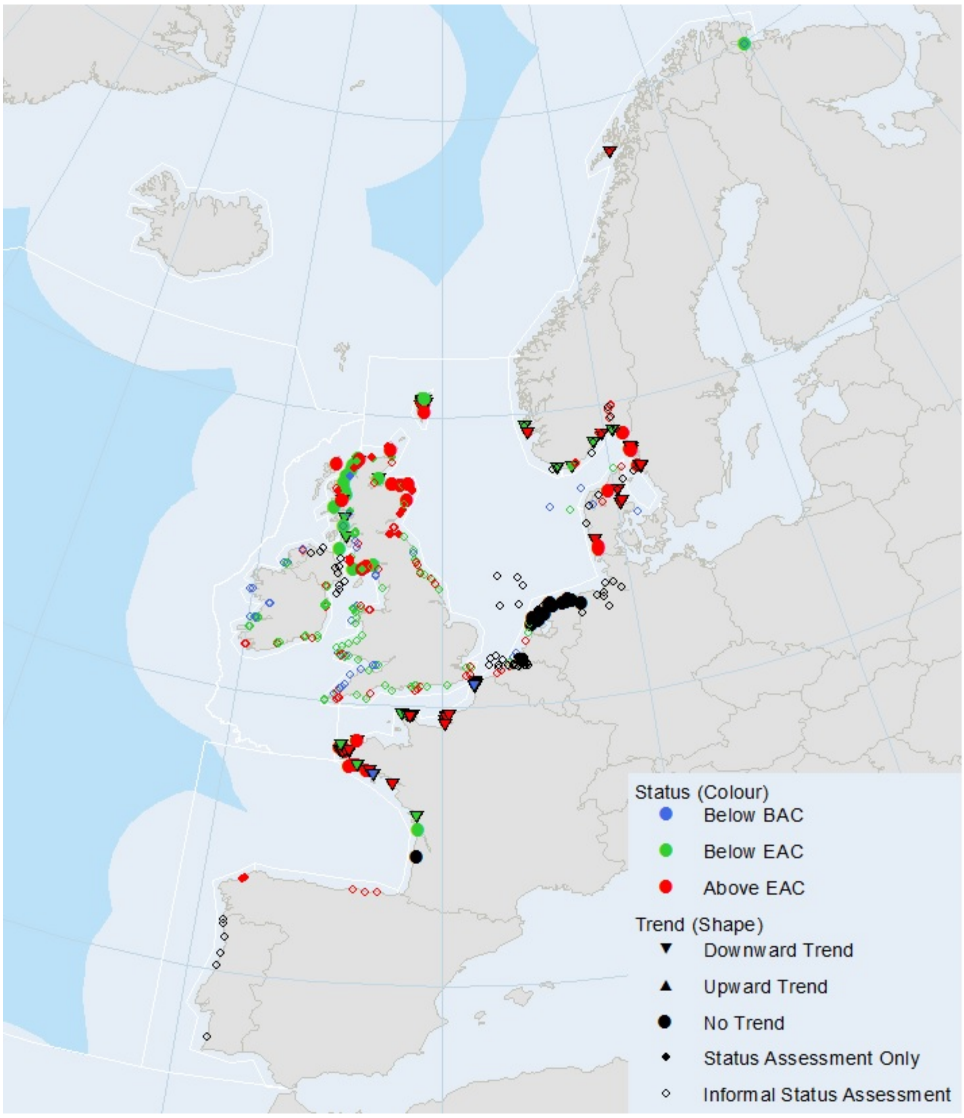


Figure 1. Overview of all biological effect and chemical measurements of TBT in sediment and biota relating to organotin**.**

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[1] Danish sediment samples are collected using a rotating scheme, so the same stations are only visited every 3-5 years, so the only way to establish time trends would be well sorted sediment cores.

Table 1. Overview of time trends relating to organotin pollution. In all cases Up is worse and Down is improving condition of the environment.

Organotin	# stations	# Timeseries	% Up	%Down
IMPS	6	0	0.0%	0.0%
INTS	9	7	0.0%	77.8%
VDSI	375	133	0.0%	35.5%
TBTIN	51	8	0.0%	62.5%

Overall, the banning of the use of TBT in antifouling paints on all vessels (implemented 2003-2008) is expected to restore good status in relation to imposex (as shown by the VDSI) to “good” over the next decade or so by curtailing TBT inputs, but historic pollution in sediments may act as a source of TBT for a longer time period than this in certain areas. The breakdown products DBT and MBT should probably be taken into account in the next assessment, to see if the DBT levels increase as TBT are degraded. It should also be borne in mind that DBT is still in use in its own right, in plastics and other uses, so DBT and MBT will continue to be found even in the absence of TBT, but are also less toxic than TBT. Periodic imposex monitoring should, therefore, continue on a convention wide basis until all areas are shown to be below EAC or Background concentrations, and after that perhaps be restricted to any remaining hot spots. It should also be noted that the intersex monitoring is not sufficiently sensitive to follow concentration levels to non-impacted levels, so imposex should be monitored instead of intersex, if the more sensitive species re-appear in areas currently monitored using intersex.

4. Other biological effects

The biological effects data reported to ICES and included in the assessment are for the more specific biomarkers: Lead-indicator aminolevulinic acid dehydratase (ALA-d), PAH-metabolites determined as concentrations of 1-hydroxypyrene (PYR1OH) or equivalents (PYR1OHEQ) and 3-hydroxyBenzo(a)Pyrene (BAP3OH). For the general effect biomarkers, EROD and acetylcholine esterase (AChE) activity are included. An overview of the number of data available for each technique is shown in Table 2, including their status in relation to time trends. All significant time trends for biological effects are indicating improvements in status, in accordance with the majority of chemical measurements.

Table 2. Overview of biological effects time trends. *Note that for ALA-d, an increasing time trend in the assessment web tool is indicative of less pollution (i.e., improving environmental status). For the 1-hydroxypyrene equivalent and AChE, no data series longer than 3 years was available, and so no time trend information was available.*

Substance	# stations	# TT	% Worse	%Improving
ACHE	24	0	-	-
ALAD	4	3	0.0%	66.7%
EROD	109	66	0.0%	22.7%
PYR1OH	4	4	0.0%	75.0%
PYR1OHEQ	33	0	-	-
BAP3OH	4	3	0.0%	0.0%

The links between biological effects monitoring and chemical monitoring are given in JAMP Guidelines for the Integrated Monitoring and Assessment of Contaminants and their effects, agreement 2012-09, and summarised in table 2. It should be noted that not all biological effects have direct link to individual determinants included within chemical monitoring, especially for the general biological effect techniques.

Substances not determined within the current chemical monitoring programme may have impacts that would not be seen by correlation or other statistical tools based on the data currently available, but the general techniques can demonstrate that other, currently unidentified, compounds are having effects and that is a part of their role as tools for assessing the ecological impacts of individual substances and the cumulative impacts of mixtures of substances.

Table 3. Links between biological effects monitoring and chemical monitoring parameters

Type	**Most relevant**	Alternative methods
Metal specific	**Methallothionine, ALA-D**	Oxidative stress
TBT specific	**Imposex**	Intersex in fish, intersex in gastropods
PAH specific	**Cytochrome P4501A activity (EROD), DNA adducts, PAH metabolites**	Mussel histopathology, Liver pathology including neoplasia/hyperplasia
Endocrine disruption		Vitellogenin
DNA damage		Comet assay
Organophosphates		Acetylcholinesterase
Dioxin/PCB	**Dr CALUX**	
EDC		Gonadal histology, YES/YAS
Genotoxic carcinogens		Micronucleus formation
General		Whole sediment bioassays, Sediment pore-water bioassays, Sediment sea water elutriates, Water bioassays Lysosomal stability (Cytochemical and neutral Red), Liver nodules, Externally visible fish diseases, Reproductive success in fish, Scope for growth, Cellular energy allocation, Condition indices (GSI, HIS), Stress on Stress (SoS), Gametogenesis , MXR, GST, Embryo crustaceans assay
Unspecified		RIA and ELISA

The aim for both biological effects monitoring and chemical monitoring is to have a fully integrated monitoring scheme (Agreement 2012-09), but this aim has not been realised to date for these reported data, as very few of the sites within the ICES database and their data extracted into the web assessment tool had both biological effects and chemical measurements undertaken at the same sites and at the same time. The submitted data are not in accordance with the expected monitoring undertaken within the pre-CEMP programme, as several contracting parties have not reported data although they are believed to have conducted monitoring studies including application of biological effects techniques. Only Norwegian, UK and Spanish data were available. The limitations encountered by CPs in reporting were investigated and the main causes cited were:

- Station Dictionary issues
- Reporting format difficult
- Data not available in database/format readily applicable to reporting
- lack of funding/separation of measuring and reporting

For the data presented in 2012, most of the Spanish data for acetylcholine esterase activity were reported at stations for which chemical data were also available, and these data (based on 1-2 years of monitoring) were correlated slightly with concentrations of lindane (gamma-HCH) and hexachlorobenzene (HCB) at a statistical level of just below p-value of 0.4. As data for polyfluorinated compounds were not reported for these stations, the expected link to concentrations of these compounds could not be evaluated.

EROD data were reported by both UK and Norway, but no correlations were found with chemical data, and some problems in direct comparison of biological effects and chemical data were found. It was noted that the reported EROD values were missing supporting data, such as season of sampling, temperature and salinity, making it difficult to do a thorough assessment of the EROD data. The assessment tool will be updated to reflect the most valid supporting data in time for the next assessment. No direct correlation was obtained with the chemical data available in the central North Sea area, where time trends were significant for EROD, but this was not expected with the chemical substances measured at these stations. The analysis will be redone in 2012 using spatially interpolated concentrations for chemical substances so as to retain as much data as possible from nearby stations as possible.

5. ALA-D in blood cells

ALA-d activity in the blood of cod is inhibited by the exposure to lead. In 2011, activity in cod from the Inner Oslofjord (station 30B) and Inner Sørfjord (station 53B) were lower than the Karihavet area (station 23B). No significant temporal trends could be observed over the previous 10 years using the Norwegian statistics, whereas the CEMP assessment tool found some significant temporal trends.

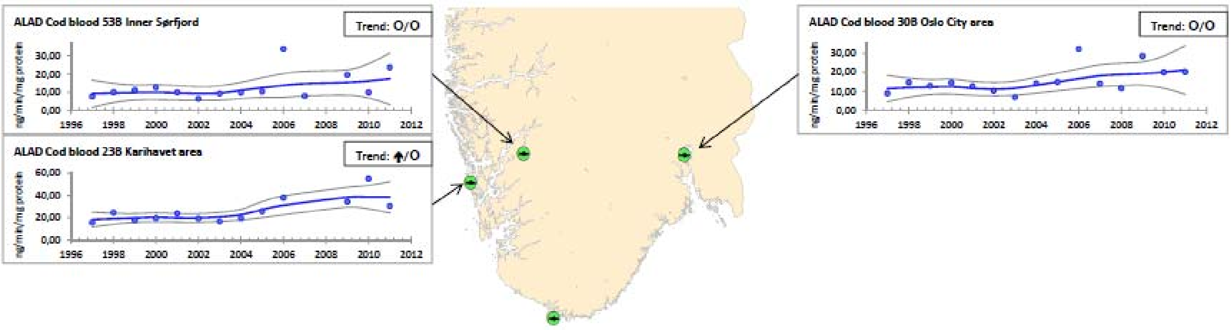

Figure 3. ALA-d activity in fish blood around Oslofjord (figure 54 from TA2974) Trend results are indicated as 0/0 or /0 and sho⇧that with one exception no trends were found either for the entire sampling or for the past 10 years, the exception being an upward trend found at st.23B for the whole period.

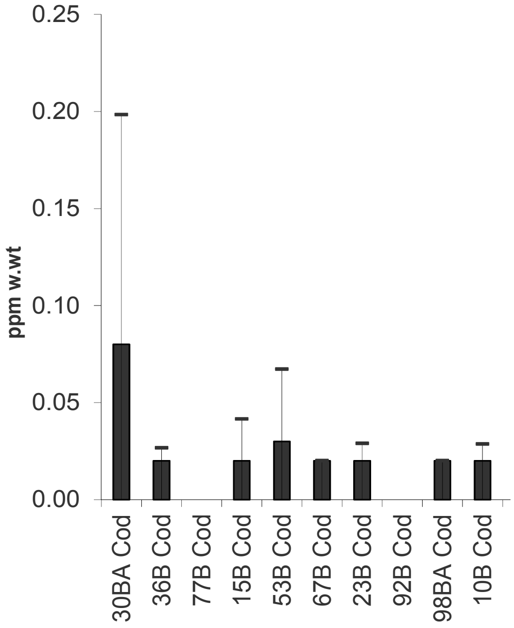

Figure 4: Concentration of lead in fish and the individual variation (extract of Figure 62 from TA2974)

6. Conclusion

The general trend for the OSPAR area is one of improving environmental status. Many substances are still not at levels at which impacts on the environment can be excluded, and concentrations of some metals and PAHs are increasing in specific areas, at which their sources and the mechanisms behind the upward trends should be investigated further.

Biological effects measurements corroborate the results from the chemical monitoring, but implementation of the integrated monitoring scheme for the two sets of measurements together is still in its infancy.

BOX 4:

ICON text-box (T. Burgeot)

Between 2008 and 2012 the ICON project aimed to demonstrate the application of the proposed integrated monitoring and assessment scheme for contaminants and their effects developed through various ICES / OSPAR study and working groups, which was recently reported to OSPAR in the form of ICES advice in 2011. The ICON project was supported by national means and for some countries by the ministries.

Integrated monitoring to provide a dataset that could be applied within the assessment framework was undertaken during 2008 at a large number of sites across the inshore and offshore environments of the North Sea, as well as Iceland and Spain for comparison purposes. Analyses of contaminants and effects measurements relevant to the integrated assessment framework were completed and, to the extent possible, applied using the scheme published in 2011. The results of the ICON integrated assessment should be viewed as a demonstration of how this scheme could be applied and what the final assessment products might look like.

The ICON project represents the first large scale integrated assessment of the status of a marine region for both contaminants and their effects. This approach is considered to be suitable for the determination of GES for Descriptor 8 under the MSFD. Although a fully complete dataset was not available for the demonstration of the integrated assessment framework, the ICON project has provided one of the most comprehensive integrated monitoring datasets of its kind and was found to be suitable for assessment using the framework developed within ICES and OSPAR. The scheme can be applied to datasets with missing data and determinands, but the validity of the assessment decreases with increasing missing data. Further guidance on the minimal requirements for undertaking an integrated assessment and the development of a robustness indicator is required.

The ICON project has shown that it is feasible to apply the OSPAR framework for integrated chemical and biological monitoring. The results indicate that Iceland has locations less impacted by contaminants than other locations in Europe, followed by offshore locations in the North Sea, with coastal locations being most clearly impacted.

The selected methods are appropriate and can be performed by laboratories in most European countries. Vitellogenin analysis will, however, need to become more widely available as it requires materials not available outside a few institutions. Assessment criteria for passive sampling techniques and in vitro bioassays need further development before they can be included within the integrated assessment framework.

Institutions in some European countries are currently applying this assessment framework to their monitoring data, so further case studies are likely to emerge in the year to come. It is recommended that they are reviewed by OSPAR MIME at their meeting in 2013.

Guidelines for site selection inshore and offshore are needed. The number of locations and type of sites to be included in a regional integrated assessment need careful consideration to avoid sampling site bias.

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Annex 1 – analysed substances and significant time trends in sediment

Substance (code)	# stations	# TT	% Up	%Down
Anthracene (ANT)	356	132	1.5%	12.9%
Arsenic (AS)	356	180	7.2%	2.8%
Benzo[a]anthracene **(BAA)**	354	157	4.5%	14.0%
Benzo[a]pyrene (BAP	354	158	2.5%	19.0%
2,2',4,4',5,5'-hexabromodiphenyl ether (PBDE153) (BD153[$]	286	2	0.0%	0.0%
2,2',4,4'-tetrabromodiphenyl ether (PBDE47) (BDE47[$])	290	1	0.0%	0.0%
2,3',4,4'-tetrabromodiphenyl ether (BDE66) **(BDE66[$])**	243	1	0.0%	0.0%
benzo[ghi]perylene **(BGHIP)**	354	159	1.9%	13.2%
2,2',4,5,5'-pentachlorobiphenyl (CB101)	332	91	1.1%	20.9%
2,3,3',4,4'-pentachlorobiphenyl **(CB105)**	254	24	4.2%	0.0%
2,3',4,4',5-pentachlorobiphenyl (CB118)	332	90	1.1%	18.9%
2,2',3,4,4',5'-hexachlorobiphenyl **(CB138)**	332	93	0.0%	23.7%
2,2',4,4',5,5'-hexachlorobiphenyl (CB153)	332	103	1.9%	16.5%
2,3,3',4,4',5-hexachlorobiphenyl (CB156)	157	11	0.0%	0.0%
2,2',3,4,4',5,5'-heptachlorobiphenyl **(CB180)**	332	70	1.4%	14.3%
2,4,4'-trichlorobiphenyl **(CB28)**	332	64	1.6%	20.3%
2,2',5,5'-tetrachlorobiphenyl **(CB52)**	332	52	0.0%	9.6%
Cadmium (CD)	354	146	1.4%	14.4%
chrysene + triphenylene (CHRTR)	140	38	0.0%	13.2%
Chromium (CR)	356	187	2.7%	9.1%
Copper (CU)	356	186	7.0%	12.9%
Dibenzothiophene (DBT)	73	14	0.0%	28.6%
C1 Dibenzothiophene (DBTC1)	81	20	0.0%	15.0%
C2 Dibenzothiophene (DBTC2)	75	20	0.0%	30.0%
C3 Dibenzothiophene (DBTC3)	75	19	0.0%	21.1%
dibutyltin (DBT) - expressed as Sn-atom (DBTIN)	220	0	-	-
Fluoranthene **(FLU)**	358	160	3.1%	15.0%
Mercure (HG)	355	166	1.8%	18.1%
indeno[1,2,3-cd]pyrene (ICDP)	354	158	2.5%	20.3%
monobutyltin (MBT) - expressed as Sn-atom (MBTIN)	220	0	-	-
Naphthalene (NAP)	162	50	4.0%	12.0%
C1 Naphthalene (NAPC1)	20	12	0.0%	0.0%
C2 Naphthalene (NAPC2)	97	35	0.0%	17.1%
C3 Naphthalene (NAPC3)	97	36	0.0%	13.9%
Nickel (NI)	356	187	1.6%	4.8%
Phenanthrene (PA)	358	166	1.2%	15.1%
C1 Phenanthrene (PAC1)	82	25	0.0%	16.0%
C2 Phenanthrene (PAC2)	82	24	0.0%	20.8%
C3 Phenanthrene (PAC3)	75	25	0.0%	20.0%
Lead (PB)	356	185	2.7%	7.6%
pyrene **(PYR)**	358	164	2.4%	14.6%
tributyltin (TBT) - expressed as Sn-atom **(TBTIN)**	221	0	-	-
Zinc (ZN)	355	182	2.7%	12.1%

$: BD28, BD85, BD99, BD100, BD154, BD183, BD209: No TT data in 80 – 291 stations monitored

Annex 2 – analysed substances and significant time trends in biota

Substance	# stations	# TT	% Up	%Down
Anthracene (ANT)	237	81	0.0%	9.9%
Benzo[a]anthracene (BAA)	237	118	4.2%	22.9%
Benzo[a]pyrene (BAP)	234	85	4.7%	8.2%
2,2',4,4'-tetrabromodiphenyl ether (PBDE47) (BDE47$^{\$}$)	169	29	0.0%	24.1%
benzo[ghi]perylene (BGHIP	235	108	2.8%	8.3%
2,2',4,5,5'-pentachlorobiphenyl (CB101)	395	164	0.0%	15.9%
2,3,3',4,4'-pentachlorobiphenyl (CB105)	285	116	0.0%	25.0%
2,3',4,4',5-pentachlorobiphenyl (CB118)	396	195	1.0%	14.9%
3,3',4,4',5-pentachlorobiphenyl (CB126)	51	7	0.0%	14.3%
2,2',3,4,4',5'-hexachlorobiphenyl (CB138	382	191	1.0%	16.2%
2,2',4,4',5,5'-hexachlorobiphenyl (CB153)	396	221	0.5%	14.9%
2,3,3',4,4',5-hexachlorobiphenyl (CB156)	285	83	3.6%	13.3%
3,3',4,4',5,5'-hexachlorobiphenyl (CB169)	50	7	0.0%	0.0%
2,2',3,4,4',5,5'-heptachlorobiphenyl (CB180)	395	139	0.7%	25.9%
2,4,4'-trichlorobiphenyl (CB28)	396	90	0.0%	14.4%
2,2',5,5'-tetrachlorobiphenyl (CB52)	395	124	0.0%	12.1%
Cadmium (CD)	442	284	8.5%	10.2%
2,3,7,8-tetrachloro-dibenzofuran (CDF2T)	36	7	14.3%	14.3%
chrysene + triphenylene (CHRTR)	159	15	0.0%	26.7%
Copper (CU)	417	244	4.9%	5.3%
Dibenzothiophene (DBT)	125	25	0.0%	12.0%
DDE (p,p') (DDEPP)	261	99	0.0%	11.1%
Fluoranthene (FLU)	232	147	1.4%	6.8%
1,2,5,6,9,10-hexabromocyclododecane (HBCD)	9	1	0.0%	0.0%
Hexachlorobenzene (HCB)	219	69	0.0%	13.0%
alpha-HCH (alpha-hexachlorocyclohexane) (HCHA)	244	22	0.0%	31.8%
gamma-HCH (gamma-hexachlorocyclohexane) (HCHG)	244	60	6.7%	26.7%
Mercury (HG)	441	277	4.7%	8.7%
indeno[1,2,3-cd]pyrene (ICDP)	229	95	4.2%	7.4%
(Naphthalene) NAP	187	71	2.8%	38.0%
Phenanthrene (PA)	237	144	3.5%	11.8%
1-hydroxy phenanthrene (PA1OH)	4	4	0.0%	0.0%
Lead (PB)	441	257	4.7%	13.6%
Pyrene (PYR)	232	146	0.7%	9.6%
tributyltin (TBT) - expressed as Sn-atom (TBTIN)	51	8	0.0%	62.5%
polychlorinated dibenzo-p-dioxins (TCDD)	32	3	33.3%	0.0%
Zinc (ZN)	417	246	4.1%	11.8%

Appendix 1

Assessment criteria used in the CEMP data assessment

Group	Substance	SEDIMENT (µg/kg dry weight)						MUSSELS (M) AND OYSTERS (O) (µg/kg dry weight except EC for metals: wet weight (ww))				FISH (µg/kg wet weight, except: $EAC^{passive}$ for CB: lipid weight (lw))			
		Background/low concentrations		Blue (T_0)		Green (T_1)			Blue (T_0)	Green (T_1)			Blue (T_0)	Green (T_1)	Amber (T_1)
		BC	LC Spain	< BAC	< BAC Spain	< EAC	< ERL	BC/LC	< BAC	< EAC	< EC	BC/LC	< BAC	< EAC passive	< EC max. food limit
Metals	Cd	200	86	310	129		1200	M-600 O-1800	M-960 O-3000		M-1000 O-1000	a	26		1000 (bivalve. tissue)
	Hg	50	53	70	91		150	M-50 O-100	M-90 O-180		M-500 O-500	a	35		500
	Pb	25000	15500	38000	22400		47000	M-800 O-800	M-1300 O-1300		M-1500 O-1500	a	26		1500 (bivalve. tissue)
	As	15000		25000			---								
	Cr	60000		81000			81000								
	Cu	20000		27000			34000		6000						
	Ni	30000		36000			---								
	Zn	90000		122000			150000		63000						
	TBT	---		---		---		1.0	5.0	12.0					
PAHs	Naphthalene	5	---	8	---		160	---	---	340					
	C1-naphthalene						155[2]								
	C2-naphthalene						150								
	Phenanthrene	17	4.0	32	7.3		240	4.0	11.0	1700					
	C1-phenanthrene						170								
	C2-phenanthrene						200								
	Anthracene	3	1.0	5	1.8		85	---	---	290					
	Dibenzothiophene (DBT)	0.6	---	---	---		190	---	---	---					
	C1-dibenzothiophene						85								
	Fluoranthene	20	7.5	39	14.4		600	5.5	12.2	110					
	Pyrene	13	6.0	24	11.3		665	4.0	9.0	100					
	Benz[a]anthracene	9	3.5	16	7.1		261	1.0	2.5	80					
	Chrysene (Triphenylene)	11	4.0	20	8.0		384	4.0	8.1	---					
	Benzo[a]pyrene	15	4.0	30	8.2		430	0.5	1.4	600					
	Benzo[ghi]perylene	45	3.5	80	6.9		85	1.5	2.5	110					
	Indeno[1,2,3-cd]pyrene	50	4.0	103	8.3		240	1.0	2.4	---					
PCBs	CB28	0.0/0.05		0.22		1.7		0.0/0.25	0.75	3.2		0.0/0.05	0.10	64 lw	

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[2] Sum of 1-methyl naphthalene and 2-methyl naphthalene

Group Substance		SEDIMENT (µg/kg dry weight)						MUSSELS (M) AND OYSTERS (O) (µg/kg dry weight except EC for metals: wet weight (ww))				FISH (µg/kg wet weight, except: EAC^{passive} for CB: lipid weight (lw))			
		Background/low concentrations		Blue (T_0)		Green (T_1)			Blue (T_0)	Green (T_1)			Blue (T_0)	Green (T_1)	Amber (T_1)
		BC	LC Spain	< BAC	< BAC Spain	< EAC	< ERL	BC/LC	< BAC	< EAC	< EC	BC/LC	< BAC	< EAC passive	< EC max. food limit
	CB52	0.0/0.05		0.12		2.7		0.0/0.25	0.75	5.4		0.0/0.05	0.08	108 lw	
	CB101	0.0/0.05		0.14		3.0		0.0/0.25	0.70	6.0		0.0/0.05	0.08	120 lw	
	CB105	---		---		---		0.0/0.25	0.75	---		0.0/0.05	0.08	---	
	CB118	0.0/0.05		0.17		0.6		0.0/0.25	0.60	1.2		0.0/0.05	0.10	24 lw	
	CB138	0.0/0.05		0.15		7.9		0.0/0.25	0.60	15.8		0.0/0.05	0.09	316 lw	
	CB153	0.0/0.05		0.19		40		0.0/0.25	0.60	80		0.0/0.05	0.10	1600 lw	
	CB156	---		---		---		0.0/0.25	0.60	---		0.0/0.05	0.08	---	
	CB180	0.0/0.05		0.10		12		0.0/0.25	0.60	24		0.0/0.05	0.11	480 lw	
Pesticide	γ-HCH	0.0/0.05	0.13				3.0	0.0/0.25	0.97	1.45	---	---	---	11[b]	
	α-HCH	---	---				---	0.0/0.25	0.64	---	---	---	---	---	
	DDE (p,p’)	0.0/0.05	0.09				2.2	0.0/0.25	0.63	---	---	0.0/0.05	0.10	---	
	Hexachlorobenzene	0.0/0.05	0.16				20.0	0.0/0.25	0.63	---	---	0.0/0.05	0.09	---	
	Dieldrin	0.0/0.05	0.19				2.0	---	---	---	---	---	---	---	

[a] datasets too limited to allow recommendation for BCs for metals in fish; [b] EAC for fish liver derived by applying a conversion factor of 10 on EAC for whole fish

Notes

- No assessment criteria for PBDE.
- Assessment criteria are used to assess contaminant concentrations
    - **B**ackground **A**ssessment **C**oncentration (BAC)
    - **E**nvironmental **A**ssessment **C**riteria (EAC)
    - **E**ffects **R**ange **L**ow (ERL)
    - **E**uropean **C**ommission food standard (EC)
- BACs were developed by the OSPAR Commission (OSPAR) for testing whether concentrations are near background levels. Mean concentrations significantly below the BAC are said to be near background.
- BACs and EAC^{passive}s are available for seven CBs.
- EACs were developed by OSPAR and the International Council for the Exploration of the Sea for assessing the ecological significance of sediment concentrations. Concentrations below the EAC should not cause any chronic effects in marine species.
- BACs and / or EACs are available for ten PAHs.
- EAC^{passive}s were developed by OSPAR for assessing the ecological significance of sediment concentrations. Concentrations below the EAC^{passive} should cause no chronic effects in marine species.
- ERLs were developed by the United States Environmental Protection Agency for assessing the ecological significance of sediment concentrations. Concentrations below the ERL rarely cause adverse effects in marine organisms. Concentrations *above* the ERM will often cause adverse effects in some marine organisms.
- ECs have been used in the absence of any satisfactory criteria for assessing the ecological significance of biota concentrations. ECs are the maximum acceptable concentrations in food for the protection of public health.

Appendix 2

CEMP assessment web-application

Cadmium

Cadmium occurs naturally in geological ores and is found at background levels in the marine environment. Cadmium is toxic and liable to bioaccumulate and thus is a contaminant of concern both for the marine environment and for human health in terms of consumption of fish and other seafood. Because of its properties, the OSPAR Commission has selected cadmium as chemical for priority action.

Cadmium enters the environment via the atmosphere and water. The main sources are emissions from combustion processes primarily in power plants and industry, but also other commercial and domestic sources. Other relevant sources are from the metallurgical industry, road transport and wastes (*e.g*. dump sites).

As much of the reduction in inputs of cadmium occurred before 2000, changes in environmental concentrations have been relatively small since then as concentrations approach, but do not reach, background levels in large parts of the OSPAR area.

Concentrations of cadmium in sediments generally present no environmental risk in large open sea areas in all OSPAR Regions. Levels are mostly approaching or are at background. However, in some coastal areas, such as the inner German Bight and around the industrial estuaries of the Rhine, Seine, Tyne, Tees and Thames, cadmium is at levels which give rise to risk of pollution effects. Concentrations of cadmium in fish and shellfish are above EU food limits around the coasts of Scotland and some locations in southern Norway, the southern North Sea, the Channel and the Bay of Biscay.

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. Industrial and commercial use of mercury has led to the dispersion of mercury in the environment. Mercury is extremely toxic to both man and marine life and can be transformed within the aquatic environment into more toxic organic compounds (*e.g.* methyl mercury). Because of its properties, the OSPAR Commission has selected mercury as chemical for priority action.

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 and cement production. Mercury also enters into the environment through the disposal of products containing mercury, including car parts, batteries, fluorescent bulbs, medical products, thermometers, and thermostats.

As much of the reduction in inputs of mercury occurred before 2000, changes in environmental concentrations have been relatively small since then as concentrations approach, but do not reach, background levels in large parts of the OSPAR area. Detected time trends are mostly downward, with few locations in Regions III where mercury concentrations have risen (*e.g.* western Irish Sea). Many of the OSPAR data series are currently too short to determine trends as – owing to the large amount of natural variation in the marine environment – trends in concentrations can only be determined using data collected systematically over relatively long periods.

Concentrations of mercury in sediment are at levels giving rise to risk of pollution effects in the southern North Sea, North-East coast of the UK, both on the coast and offshore on the Dogger Bank, in the Channel and the Irish Sea and at some locations near urban industrialised areas in northern and southern Spain.

Concentrations of mercury in fish and shellfish are generally below EU food limits other than in the northern Wadden Sea of Denmark and in certain industrialised estuaries around the UK.

Background concentrations of mercury in sediment, fish and shellfish are measured at coastal locations in Regions I, III and IV, but rarely in Regions II.

Appendix 4

CEMP assessment web-application

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 widespread elevation of environmental lead concentrations. 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. Because of its properties, the OSPAR Commission has selected lead as chemical for priority action.

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.

Much of the reduction in inputs of mercury occurred up to 2000, when lead in petrol was prohibited in the European Union. The changes in environmental concentrations have been relatively small since then as concentrations approach, but do not reach, background levels in large parts of the OSPAR area. Detected time trends are mostly downward, with few locations in Regions II and III where lead concentrations in biota have risen (e.g. western Irish Sea). Many of the OSPAR data series are currently too short to determine trends as – owing to the large amount of natural variation in the marine environment – trends in concentrations can only be determined using data collected systematically over relatively long periods. Overall, concentrations of lead in biota show a consistent downward trend across OSPAR Regions.

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. Scattered high concentrations are also found along the East coast of the UK and in some locations near urban industrialised areas in northern Spain. However, concentrations in northern Norway, northern Spain and a few areas in the northern UK, are generally approaching or at background.

Concentrations in biota exceeding EU food limits are less widespread, and the locations can generally be linked to urban and industrial activity, e.g. several UK estuaries and certain sites in Ireland, southern Norway 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 are at background levels in western Ireland, the north west coast of Norway, 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 volcanic activity

Appendix 5

OSPAR COMMISSION

CEMP assessment web-application

Polychlorinated biphenyls (PCBs)

Polychlorinated biphenyls (PCBs) are a group of substances with 209 forms (congeners) which are very persistent, concentrate in fatty tissues and have varied harmful effects on marine organisms. Because of their properties, the OSPAR Commission has selected the group of PCBs as chemicals for priority action.

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). CB153 is generally present in the highest concentration and correlates well with other analysed PCBs. CB118 is representative of the more toxicologically relevant mono-ortho/planar PCBs.

Production of PCBs was banned in the mid-1980s but European-wide action has not been enough to eliminate all inputs to the marine environment. Remaining sources are PCB-containing equipment, waste disposal, remobilisation from marine sediments contaminated with PCBs as a result of historic releases, and, to an unknown extent, formation as by-products in thermal and chemical processes.

Contamination from PCBs is widespread and there are few areas where concentrations are close to zero. Concentrations are lowest along the northern coast of Norway (Region I). PCBs are however among the most prevalent pollutants in the Arctic and are widely distributed by long-range atmospheric transport. At most locations in Regions II, III and IV, concentrations of at least one PCB congener in fish and shellfish pose a risk of causing pollution effects. PCB 118 is the congener most often above EAC,

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.

Appendix 6

CEMP assessment web-application

Polycyclic aromatic hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are natural components of coal and oil and are also formed during the combustion of fossil fuels and organic material. They are one of the most widespread organic pollutants in the marine environment of the OSPAR area, entering the sea from offshore activities, operational and accidental oil spills from shipping, river discharges and the air. Long-range atmospheric transport is an important pathway for PAHs within and to the OSPAR area and is of regional and global concern.

PAHs 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. Because of their properties, the OSPAR Commission has selected the group of PAHs as chemicals for priority action.

OSPAR environmental monitoring has concentrated on a set of 6 PAH compounds: Fluoranthene can be quantified well using the most regularly used analytical methods and was found at relatively high concentrations (compared to other PAHs) in the 2005 CEMP assessment. Benzo[a]pyrene has recognised toxicological importance and is generally one of the more abundant PAHs. Benzo[ghi]perylene and phenanthrene are representatives of higher and lower condensed PAHs, respectively, and can be used to study the behaviour of PAHs in the environment. Phenanthrene and anthracene can be used to investigate differences in the pyrogenic or petrogenic origin of PAHs.

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

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. 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.

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